Intestinal Stomas
Principles, Techniques, and Management
Second Edition, Revised and Expanded

edited by
Peter A. Cataldo
John M. MacKeigan

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**PRINTED IN THE UNITED STATES OF AMERICA**
To my wife, Eileen, and to my daughters, Colleen and Anna, my advisors and my best friends. —PAC

With appreciation to Suzie, my family, and my teachers. —JMM
Preface

Ten years have passed since the publication of the first edition of *Intestinal Stomas: Principles, Techniques, and Management*. That text was envisioned and created in response to a need for a comprehensive reference on intestinal stomas. Prior to our first edition, *The Atlas of Intestinal Stomas*, authored by Drs. Rupert Turnbull and Frank Weakley nearly 30 years ago, was the only textbook dedicated to intestinal stomas and remained the authoritative source. Thanks to the contributions of many intelligent and dedicated surgeons, our first edition was recognized as the up-to-date source for ostomy creation and care. Only by standing on the shoulders of the “fathers of the field” of intestinal stomas and enterostomal therapy were we able to create that book, and we now stand also on its shoulders to bring to our readers a second edition.

This edition contains two entirely new chapters, “Pediatric Intestinal Stomas” and “Technical Tips for the Difficult Stoma.” The first is a superb compilation of stomas in children used in the treatment of Hirschsprung’s disease, imperforate anus, necrotizing enterocolitis, and constipation. The second new chapter, Technical Tips for the Difficult Stoma, covers solutions to age-old problems of emergency stoma creation, particularly in obese patients with inflammatory conditions leading to thickened and shortened intestinal mesentery.

In addition, all remaining chapters have been revised, often by a new author in order to ensure a fresh approach. New, current references have been added to all chapters. A new section on endoscopically assisted trephine stomas has been added to the chapter “Minimally Invasive Stomas.” New approaches to the treatment of stomal prolapse, parastomal hernias, and peristomal pyoderma gangrenosum have also been included.

Much has changed since the completion of our first edition. We have made every effort to ensure that the second edition addresses all these
changes and will be considered the authoritative source on intestinal stomas.

Thank you to our dedicated contributors, without whose help this text would not exist, and to our publisher Marcel Dekker, Inc., who coordinated and facilitated our efforts. Special thanks to Tina Blais-Armell, without whose dogged determination and persistence this textbook would still be a pile of papers on the office floor. Thank you to our enterostomal therapists, Cindy Whitehead, Randy VanAlst, and Kristin Hurt, who continue to teach us invaluable lessons about living with ostomies, and to our students, who teach us more than we will ever be able to teach them. Finally, we would like to extend our deepest gratitude to our patients, who have inspired us, learned with us, and taught us lessons that can be learned only by living with an intestinal stoma.

Peter A. Cataldo
John M. MacKeigan
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INTRODUCTION

Currently, there are approximately 1 million individuals with an ostomy living in the United States, and an industry has developed solely for the purpose of supplying ostomy products. These people live normal lives, and some of them even compete in the National Football League and play golf on the professional tour. However, this situation was not always the case. Great advances in both stoma surgery and the development of ostomy management systems have made it possible for individuals with an ostomy to lead a normally active life.

The history of stomas has its beginnings in biblical times, but the first purposeful creation of a stoma occurred slightly more than 200 years ago. In a relatively short time, thanks to many of the great pioneers in surgery and enterostomal therapy, the stoma has evolved from a hastily constructed, foul-smelling, and unsightly artificial anus covered with only moss and leaves and held in place with a crude leather strap to an odorless, barely noticeable, and often continent opening that may require no device whatsoever.

NATURE’S STOMAS

The earliest stomas were not envisioned or created by imaginative surgeons but by the forces of nature (e.g., the result of a strangulated hernia in those individuals fortunate enough to survive) or by ancient warriors (e.g., survivors of abdominal wounds with visceral injury who occasionally lived with

*The opinions expressed in this chapter are those of the author and do not reflect the opinions of the United States Air Force or the Department of Defense.
a permanent enterocutaneous fistula). One of the earliest accounts of visceral injury comes from the Old Testament, when Eglon was stabbed by Ehud: “He [Eglon] could not draw the dagger out of his belly and dirt came out” [1].

The first purposeful stomas were created for the treatment of abdominal trauma and bowel obstruction. A brief outline of the evolution of the medical and surgical treatment of trauma and bowel obstruction will add insight into the origin of abdominal stomas.

One of the earliest accounts of the treatment of traumatic abdominal wounds is found in ancient Hindu writings. Susruta (600 B.C.) advocated the closing of traumatic intestinal wounds with the pincers of black ants, followed by emolument washings and reintroduction of the intestines into the abdominal cavity [2]. In the early sixteenth century, injuries of the gut followed one of three courses: the person died, the wound healed spontaneously, or an external fistula formed. The accepted surgical teaching involved supportive care only. Contrary to established principles, Von Hohenhiem, a German surgeon, began teaching his students to repair small intestinal wounds over silver cannulas [3]. However, he was not enthusiastic about this treatment. In the early sixteenth century, he was probably the first surgeon to suggest the creation of an artificial anus for penetrating gut injuries. However, there is no evidence that he actually performed his procedure.

In 1757 Lorenz Heister (1683–1758) (Fig. 1), after observing the spontaneous formation of stomas following abdominal trauma, recommended exteriorization of the injured intestine. He wrote “that the lips of the intestines so wounded, would sometimes quite unexpectedly adhere to the wound of the abdomen; and therefore there seemed no reason why we should not take hints from nature” [4]. In response to criticisms related to the inconvenience of exteriorized intestine, Heister said: “It is surely far better to part with one of the conveniences of life than to part with life itself” [4]. This philosophy was certainly not accepted by all surgeons. In the eighteenth century, Jean Palfin [5] and John Bell, both barber-surgeons, emphasized closing the wound of the abdominal wall while leaving the injured intestines alone. Exteriorization, however, grew more popular throughout the eighteenth century. Begny, Schafer, and François de la Peyronie [6] all used this technique in the treatment of abdominal wounds. In 1783 Benjamin Bell modified the exteriorization procedure by creating a double-barreled ostomy in order to prevent stoma stenosis [7].

**BOWEL OBSTRUCTION**

Bowel obstruction and its treatments have been extensively reported throughout medical history. Incarcerated hernias and intestinal tumors were
in the past, as they are now, the main causes of obstruction. The first surgical treatment of bowel obstruction was prescribed by the ancient Greeks. Praxagorus, a contemporary of Aristotle, wrote the following in 400 B.C.: “He [unidentified] seemed to be a very bold practitioner for in this distemper [bowel obstruction] if the remedies did not operate, he ordered an incision to be made into the belly and even into the gut itself and the excrements to be drawn out and the wound sewed up again” [8]. However, no reports exist on the performance or results of such a procedure.

For the next 20 centuries, the treatment of bowel obstruction remained medical and centered around purgatives and enemas. Hippocrates (a cousin to Praxagorus) advocated a honey suppository anointed with the gall of a bull and followed by an enema. If this method failed, rectal insufflation with a smith’s bellows was prescribed [9]. Dolaeus recommended drinking a concoction containing horse dung “because excrement expels excrement,” whereas some physicians recommended rubbing the abdomen with slough of a snake seethed in oil or wine [9]. Other experts prescribed anal insufflation of tobacco smoke in the treatment of bowel obstruction.
Ambroise Paré and many of his contemporaries treated bowel obstruction with large doses of crude mercury taken by mouth in the belief that the weight of the heavy metal would correct the blockage [3]. Application of heat to the abdominal wall was also a popular treatment. Willis and James covered the abdomen with calf’s omentum while Thomas Sydenham preferred using a live puppy [9]. Even stimulation with galvanic current was tried. Opium, a popular treatment in the seventeenth century, often accompanied these ingenious remedies for the obstructed intestines.

As previously mentioned, physicians had observed relief of bowel obstruction as a consequence of spontaneous stoma formation (Fig. 2) and had exteriorized injured intestines, thus creating stomas. However, no one had yet proposed the purposeful creation of a stoma to relieve intestinal obstruction.

**INTRODUCTION OF COLOSTOMY**

In 1710 Alexis Littré (1658–1726) suggested the creation of an abdominal stoma for the treatment of imperforate anus after observations made during the autopsy of a 6-day-old infant. This event was reported by Fontanel, the historian to the Royal Academy of Sciences in Paris [10]:

![Image](image.png)

**Figure 2** In 1750 Margaret White developed a spontaneous colostomy as a result of a strangulated umbilical hernia. (From Devlin HB. Colostomy. Ann R Coll Surg Engl 52:393–395, 1973.)
M. Littré saw in the dead body of an infant of six days a maldevelopment of the rectum. The rectum was divided into two portions both closed and connected by only a few threads of tissue about an inch long. The upper portion of the closed bowel was filled with meconium. The lower portion was entirely empty. M. Littré, wishing to render his observation useful, imagined and proposed a very delicate operation in the case where one would recognize a similar confirmation. It would be necessary to make an incision into the belly, open the two ends of the closed bowel, and stitch them together, or at least to bring the upper part of the bowel to the surface of the belly wall, where it would never close, but perform the function of an anus. Upon this slight suggestion a clever surgeon could imagine for himself details which we suppress. It often suffices to know in general that a thing may be possible and not to despair of it at first sight [11].

Littré’s idea remained untested for 66 years, until Pillore, a country surgeon from Rouen, France, performed a cecostomy for the treatment of an obstructing rectal cancer. Pillore’s great achievement might have gone unnoticed were it not for Jean Amussat’s inquiries. At the request of Amussat, who learned of the procedure through hearsay, Pillore’s description of the first colostomy was found in his memoirs by his son many years later. Pillore’s eloquent account was translated by Tilson Dinnick [10]:

M. Morel, a wine merchant and posting master of Vert-Gallant in the district of Brai, was in the course of the year 1776 taken with difficulty in going to stool. He had first experienced some slight pain in the anal region. These pains became a little greater, without, however, becoming insupportable; but the difficulty in his motions increased to such a degree that he became anxious and determined to come to Rouen for consultation and the necessary remedies. He presented himself to M. Delaroche, a capable physician, who ordered him laxatives and gentle purgatives. These softened the bowel contents and relieved him for some time. But finally, as his difficulties increased daily, he was advised to make use of mercury (or quicksilver) in sufficiently large doses that by their mass would overcome the obstacle in the bowel. The patient indeed took 2 pounds of quicksilver. It was watched for every day but did not appear. The motions became totally suppressed and the belly increased in size from day to day, without, however, being tender or inflamed. In this state of affairs I was consulted. (It is now a month since the patient had taken the mercury without having passed a single drop of it.)

I first examined the rectum, thinking indeed it was there the obstruction would be found, believing it was possibly formed by the hardened and incarcerated feces, as I had often seen to happen; but instead of the species of obstruction I found the upper part of the bowel fixed and scirrhous, forming a very large tumor which totally obstructed the rectum. I tried to pass sounds and cannulae of all shapes and sizes, continuing my efforts for several days, but uselessly. In this state, that
is to say, the patient having passed nothing from the bowel for over a
month, and his belly enlarging daily in spite of his most austere diet—I
proposed to him that I should make him an artificial anus. He agreed
with me and cited the case of a man in his village who for several
years had had an artificial anus which nature had provided following a
strangulated hernia. I knew of this case and also one of another woman
in from the same cause.

I was then indeed determined to perform the operation, but as the
case was a very delicate one I first asked five or six of my colleagues
to see the patient in consultation with me. No one was of my opinion
and no one agreed with me. But the patient, a man of great sense, being
present at our consultation, prayed my colleagues to show him another
means by which he might be saved. They answered that they knew
none. “Very well,” he replied, “it is indeed imperative to operate since
my illness is mortal and you know of no other means to save me.”

Encouraged by so strong an argument, I performed the operation
in the presence of my confreres, and six pension pupils who were with
me at the time. I chose the cecum as the part of the bowel most suited
to our need, as much by its situation as because it would furnish a
reservoir, and by its continual and involuntary action would hasten the
evacuation of intestinal contents. A small plate furnished with a sponge
in the shape of a large button and held by an elastic bandage was
devised in the place of a sphincter, so that the patient could at all times
voluntarily remove it when he felt the need, and, by means of a small
clyster, he could from time to time cleanse out the reservoir. My patient
and I conferred together and thought of all these things before the oper-
ation. I then operated.

I commenced with a transverse incision a little above the groin
which I deepened above and below to the depth of the cellular tissue.
I arrived at the aponeurosis of the external oblique which I incised to
the same extent a little above the fallopian ligament (Poupart’s) in or-
der to have at least a good inch of space from the integuments of the
cecum. I made a transverse opening in the muscles in peritoneum al-
most to the same extent. The base of the cecum, easy to recognize by
its appendix, presented itself—I did not have to search for it. I drew
the cecum out as far as possible and without effort; there held by an
assistant and myself, I opened it transversely and stitched it to the two
lips of the wound by means of a thread on two needles which I passed
from one side to the other. I passed them from within outward and
pulled the thread in the middle, thus obtaining two ligatures which I
tied above and below to compresses to press together the edges of the
wound. The contents of the bowel came out in abundance. For a dress-
ing I applied burnt charcoal and towels. I used no pressure in order
that the issue of fecal matter might not be interrupted. In fact, it ran
out in abundance for several days. And the belly diminished consider-
ably in size. As the quicksilver was giving us anxiety and we had not
seen a single drop of it appear, we caused the patient to be put in all
possible positions that might give it an easy issue. There was not the slightest sign of it, however. Fourteen or fifteen days had passed since the operation, during which time the wound had separated and the bowel was glued to the skin. I had taken out the stitches and all appeared to be in the best possible state when the patient reported vague pains in different parts of the belly. We first attributed this to gasses shut in the intestines, but the patient, uneasy, always said the pains were due to the mercury and consequently continued to take positions that might help it to come out. On the 20th day the belly, which had been very flat, became swollen and painful. Emollient fermentations were applied, and through our artificial anus we threw some injections into the colon. It bled twice, but in spite of all our efforts the symptoms quickly augmented and the patient died on the 28th day after his operation.

I performed the autopsy in the presence of the same surgeons, colleagues, and pupils and found as follows:

The cecum and the whole colon were healthy and in good condition. The cecum was adherent to the lips of the wounds, except in one angle where there was a small area of suppuration in the neighboring cellular tissue, which did not, however, communicate within. The colon was opened to the whole of its extent, and only contained some glairy mucous. The cancerous obstruction which was the primary illness was 8 or 9 inches long, situated at the end of the colon in the beginning of the rectum, totally obliterating the intestinal canal. The tissues surrounding the rectum were hard and fixed. At the site of the rectum was an opening whose calloused edges announced it to be a species of chancre from which issued fecal and purulent material. The peritoneum in the neighborhood of the kidney was inflamed, without, however, being separated. The peritoneum was inflamed and inherent to the folds of the intestines. The quicksilver which the patient had taken was found in one of the last convolutions of the jejunum, which it had dragged down by its weight to the pelvis, behind the bladder. It was pocketed in that portion of the bowel which contained it. This bowel presented here and there gangrenous areas, and was inflamed, the inflammation extending to the loins. The mercury was all recovered and had not lost a bit of its weight. We believed that we could conclude that if the operation has not met our expectations for success it was because of the mercury. For it is very probable that when the intestines, which because of their greatest dilatation had lost the power of action, became empty of stercoral material, the peristaltic action was not sufficiently powerful to move the mercury. Then followed inverted retrograde movements, as announced by the nausea and colic which the patient experienced on the 20th day of his illness. Considering the pull on the mesentery in the intestines by the massive two pounds, one is not surprised that gangrenous inflammation occurred and produced the death of the patient.

In 1783 Dubois, a Parisian surgeon, performed an iliac colostomy on a 3-day-old child suffering from imperforate anus. Dubois was successful
in relieving the obstruction but not in curing the patient. This child died on the 10th day following surgery [10].

The colostomy had its true beginning with the surgery of Duret, a naval surgeon at the Military and Marine Hospital at Brest. In 1793 Duret performed the first successful left iliac colostomy in the treatment of imperforate anus in a 3-day-old infant. Tilson Dinnick [10] has provided us with a translation of Duret’s original account:

Friday, October 18, 1793, Marie Poulouen, midwife of Brales, delivered the wife of Michael Ledreves, a laborer, of a child. She noticed that the infant had no anus and that the sexual parts were malformed; judging that in the best state of affairs the child had not long to live she advised the parents to bring the child to Brest to receive surgical aid. On Saturday at ten in the morning the father came to my house and I examined the child. The sexual organs were so formed that the scrotum was divided at the raphe into two equal parts, each containing a testicle. At first sight, one believed the child to be female. The glans penis lay upon the perineum pierced by the urinary meatus from which the urine issued freely. The region of the anus showed no sign of the existence of a rectum. The skin was natural consistency in color, and no tumor presented when the child strained. After making this examination I believed the case to merit the attention of those most skilled in the art of healing, and with this view I called a consultation of all the physicians and surgeons attached to the various hospitals in the city. The consultants advised opening the skin at the spot where the rectum should be present and searching for the bowel. The operation was not successful. I was able to appreciate by passing a sound through the wound into the pelvis that the lower portion of the big bowel was absolutely missing. It was now four in the afternoon; the infant appeared without resource. The vomiting, the extraordinary swelling of the belly, and the coldness of the lower limbs seemed signs of certain death. To my surprise, however, the next morning the child still lived. This decided me to call a second consultation, at which I proposed as a last resort, to prolong the life of the child, the performance of laparotomy and establishment of an artificial anus. To give me confidence in this most extraordinary procedure I performed it upon the dead body of a child of 15 days which I took from the poor house of the city. I made an incision on the left side between the last of the false ribs and the iliac crest about two inches long. I exposed the pole of the kidney and a portion of the left side of the colon; this last was opened. I then injected some water by anus. A portion of the fluid came out through the opening of the colon and a portion escaped into the belly. I then recognized by opening the belly that in the fetus the lateral areas of the colon are not extra-peritoneal as in the adult, but that the colon has a mesocolon which renders it free and floating. This circumstance caused me to reject the operation in this region in the fear that it would give rise to an escape of meconium into the belly. Those assembled after witnessing this trial and after prolonging the discussion sufficiently to
prove both its interest to humanity and to surgery, decided: (1) that without some extraordinary intervention the death of the child was inevitable; (2) that the axiom of Celsius, “that it is better to employ a doubtful remedy than to condemn the patient to certain death,” here found its application; and finally (3) that the decisions of M. Hevin upon laparotomy were not transgressed by this operation, as a cause and course of the malady were, as here, recognized.

I opened the belly of the little patient in the left iliac region in the neighborhood where the sigmoid colon was forming a tumour a little apparent to the eye in where the meconium already imparted a slightly deeper colour to the skin. I made an opening about an inch and a half long which served for me to introduce the index finger into the belly, with which I lifted and pulled out the sigmoid colon. In the fear that it would immediately fall back into the belly I stitched it by two waxed threads passed through the mesocolon. I then opened the colon longitudinally. Gas and meconium came out in abundance. When the bowel had emptied itself to a certain extent I applied a dressing. It was simple and composed of a pierced compress. And the night between Sunday and Monday the baby slept well, the body heat returned, the vomiting ceased, and child took breast easily on several occasions. The day following the operation, all who had witnessed the operation the evening before expressed themselves satisfied with the advantageous changes they perceived. The bandages which had surrounded the child were filled with meconium, and his voice, which had previously hardly been distinguishable, was now heard lustily.

On the third day, as things were going from better to better, I charged the parents to bring the child twice daily to the hospital. Citizen Massac, Chief of the Administration, and Citizen Coulon, Physician in Chief, were charged to provide the necessary dressings. On the 4th day, the stools became yellow and less in quantity, so I ordered a washing out with simple water and 2 drops of serum of rhubarb. This produced a good effect and gave the patient several stools.

On the 5th day, the threads which held the bowel appeared useless, so I removed them, as they were already producing redness and irritation in the region of the artificial anus.

On the 6th day, about an inch of the internal coats of the bowel appeared through the opening, giving the wound the appearance of a chicken’s egg. I attempted to reduce the prolapse by passing a lead cannula into the fistula, both to obstruct the further herniation and to keep a free passage of feces, but the child’s cries made me defer this means. The instrument has, however, since been perfected by Citizen Morier, a clever cutler of this city. On the 7th day, the child was so well, both at the site of operation and in exercise of his functions, that I judged him no longer in need of care of supervision by a person of the art.

This patient survived with an artificial anus until age 45. Duret was unaware of Litttré’s prior suggestions or Pillore’s cecostomy. Duret’s in-
sight into colostomy surgery was remarkable. He antedated Callisen in the suggestion of lumbar colostomy. He used a mesenteric stitch to secure the colon to the abdominal wall (90 years prior to Allingham’s famous mesenteric stitch). He noted and treated prolapse and used a colostomy for colonic washouts [10].

In 1797 Professor Fine, surgeon-in-chief to the Hospital in Geneva, performed the first transverse loop colostomy in a 63-year-old woman suffering from rectal cancer [10]. Through a midline incision, he drew out an inflamed loop of bowel, passed a stitch through its mesentery, and sewed it to the skin. The patient’s obstruction was relieved, and she lived another 3 months. Fine believed that he had created an artificial anus from the terminal ileum; however, autopsy revealed a successful transverse colostomy.

With the advent of colostomies, it became necessary to create a means for the collection of feces. The first mention of such a collecting device was reported by Daguesceau in 1795. He performed an inguinal colostomy in a farmer who impaled himself on a cart stake while unloading wheat. The farmer, then age 57, survived until the age of 81, and “conveniently collected his feces in a small leather pouch” [10]. Daguesceau also performed the first colostomy for the treatment of intractable perianal fistulas. It is interesting to note that the fistulas healed and 2 years later the colostomy spontaneously closed.

**INGUINAL VS. LUMBAR COLOSTOMY**

By the 1800s the colostomy became an acceptable surgical solution to refractory intestinal obstruction. At that time debate centered on the technique of construction, and two distinct schools emerged, those favoring inguinal colostomy and those preferring lumbar colostomy [12].

As mentioned earlier, lumbar colostomy was first suggested by Duret. Callisen, however, a professor of surgery at Copenhagen, is often cited as the first to perform a lumbar colostomy [13]. He performed a lumbar colostomy on the corpse of an infant who had died of imperforate anus. During the procedure he inadvertently entered the peritoneal cavity, yet was able to complete the lumbar colostomy through a second incision. Because of the difficulties he encountered, Callisen never became an advocate of the procedure.

Jean Zulema Amussat (1796–1856) (Fig. 3) can be considered the father of the lumbar colostomy. He began his medical career as a “medic” in the French army during the Napoleonic wars and became a studied anatomist as the result of many dissections performed on Russian corpses [14]. Amussat published manuscripts on hemorrhoidectomy, surgery for uterine fibroids, and experimental intestinal anastomosis. He is most famous, however, for his description of the lumbar colostomy.

After being called in consultation to see a 48-year-old woman with bowel obstruction, Amussat and his colleagues suggested enemas, uterine
pessary, rectal sounds, aloe suppositories, and even galvanic current. When none of these standard remedies cured the intestinal obstruction, they recommended the creation of an artificial anus. Amussat, after hearing of Callisen’s approach [13], planned a lumbar operation and performed the procedure on a cadaver. The following day the patient underwent surgery. Amussat [12] described the procedure in the following way:

The patient was placed on her abdomen leaning toward the right side, and two pillows were placed side by side under her abdomen. By this exposure the left side of the lumbar region was well exposed. There appeared, at this point, a round protuberance, indicating the point where the incision should be made.

The skin incision was made two fingers above the iliac crest. I continued the incision deeper in a transverse fashion. An artery was twisted and after having incised the aponeurosis as well as after having gone through a considerable area of fat, I clearly recognized the intestine, which was very distended and outside the peritoneal cavity. Being at the point of perforating the bowel with the trocar, I thought that perhaps it could be decompressed, and then I decided to place two sutures into the bowel approximately one thumb’s distance apart. The intestine was held by these two sutures by one of my assistants. I then punctured the point between the two sutures. Gas and fecal matter escaped through the trocar and cannula. Immediately after I passed a hernial probe adjacent to this cannula which permitted me to enlarge the opening I had created with the trocar. This allowed a copious amount of gas to escape as well as more fecal material.
Two irrigations of the artificial anus were performed—one in the direction toward the lower part of the bowel and the other toward the upper bowel, which again resulted in more fecal material appearing. The quantity was so large that 3 buckets were quickly filled. The evacuation, as well as the gas which had previously distended the abdomen and created so much discomfort, caused the patient to state how much better she felt. The intestinal opening was then brought forward and anteriorly sutured to the skin in 4 points by evertting the mucosa. The first suture was made of an ordinary curved needle. And the others were made with acupuncture needles which I usually employ, and were hardly felt at all. The posterior angle of the wound was reconstructed with sutures.

The patient stoically withstood the operation. Immediately afterwards she was returned to her bed and a simple dressing of oiled cloth was applied. During the day the patient felt a great deal of relief. However, she slept very little that night.

The patient did well postoperatively and was discharged 39 days after surgery. At that time she was having one bowel movement every 24 hr. It is interesting that her lumbar colostomy was described as “continent” by Amussat.

Amussat collected and reported on 29 cases of artificial anus between 1776 (Pillore’s cecostomy) and 1839 (his own first case) [10]. Of the 29 cases, 20 patients died. Twenty-one operations were performed for imperforate anus, and there were only four survivors. (All four survivors were from Brest, the seaport town where Duret performed the first successful colostomy.) Of the eight adult cases, there were only five survivors. All 29 patients had been operated on via the abdominal route. Amussat attributed the high mortality to peritonitis; therefore he considered the lumbar route to be the preferred approach for the creation of an artificial anus.

In 1820 Daniel Pring, a surgeon from Bath, performed a left iliac colostomy in the treatment of an obstructing rectal cancer, which made him the first English surgeon to successfully create an artificial anus. (Freer performed a similar procedure in 1815, but the patient died on postoperative day 9.) In his memoirs Pring made these comments concerning the artificial anus [10]:

1. The operation prolongs life in cancer of the rectum. 2. It is always acceptable in imperforate anus. 3. It would be useful in simple strictures of the bowel. 4. Peritonitis is a danger. 5. It is imperative to always open distended bowel. 6. Cecostomy is advocated for obstruction in the transverse colon. 7. The opening can be controlled to act once in 24 hours. 8. Prolapse can be prevented and the opening protected by means of a truss and a pad.

After Amussat’s success with the lumbar approach, the debate between abdominal and retroperitoneal creation of an artificial anus swung in favor of the retroperitoneal route. The fear of peritonitis expressed by
Amussat influenced many surgeons. Additional advantages attributed to the lumbar colostomy included the absence of a spur (then considered a disadvantage), less tendency to prolapse due to greater parietal fixation, a tendency toward constipation rather than incontinence, dependent drainage in the supine position, and absence of an offensive artificial anus on the abdominal wall. Until 1852 the debate continued based on personal preferences, not scientific evidence. However, in 1852 Caesar Hawkins, president of the Royal College of Surgeons in England, reported on a series of 44 patients treated surgically for intestinal obstruction [13]. Seventeen patients underwent transperitoneal colostomy, and 27 patients were operated on via the lumbar approach. The outcome was similar for both groups, and Hawkins concluded that neither approach was clearly better. With the advent of general anesthesia and improved surgical techniques, the abdominal approach gradually replaced the lumbar operation. However, in 1912 Paul of Liverpool emphasized that the lumbar colostomy was still a valued procedure. In his text *Personal Experiences with the Large Bowel*, Paul [15] advocated the right lumbar approach for obstructions beyond the cecum, because this approach would not complicate a subsequent abdominal procedure, and for inflammatory conditions of the colon. He recommended left lumbar colostomy for old or weakened patients with rectal obstructions, noting that it was safer than the transperitoneal route.

An interesting addition to the history of colostomy came from New Zealand. In 1876 de Lautour reported the case of a 37-year-old man with a carcinoma of the rectum so painful that he was afraid to have a bowel movement [9]. The patient, completely unaware of any previous achievements in colorectal surgery, placed his hand over his left groin and implored the surgeon to create an opening in his side through which his bowels might pass. Abiding by his patient’s wishes, de Lautour created a left-sided colostomy, which successfully relieved the patient’s pain.

In 1880 de Lautour presented to the Royal College of Surgeons Museum in London a specimen of a lumbar colostomy found in the loin of a sheep [9]. The case was remarkable not only for its occurrence but also for its method of creation. The colostomy had been made by the kea parrot (*Nestor notabilis*). Apparently this type of parrot feeds on sheep, most commonly dead ones but occasionally live ones. The birds hunt in pairs and tear through the wool of the sheep until they reach the meat on the sheep’s sacral area. Most often this action results in the death of the sheep. However, in several instances it has resulted in a lumbar colostomy, as in the case of de Lautour’s sheep.

**END COLOSTOMY**

Until this point in time, only loop stomas had been created, but they were prone to prolapse and often did not completely divert the fecal stream. In
1881 Schitzinger [10], and in 1844 O.W. Madelung [16] described a procedure of creating a proximal “single-barreled” stoma while returning the distal closed loop to the abdominal cavity. F.T. Paul [17] also advocated complete transection of the bowel in order to adequately defunctionalize the distal colorectum (Fig. 4). In conjunction with this procedure, he described the placement of a glass tube into the proximal colon to remove the intestinal contents from the wound and to prevent subsequent wound infection. These efforts represent the beginnings of the end colostomy.

**COLONIC RESECTION AND ANASTOMOSIS (MIKULICZ PROCEDURE)**

In most cases (i.e., imperforate anus or obstructing rectal carcinoma) a stoma is required for the remainder of the patient’s life. However, in many cases only a temporary colostomy is needed, and the natural question is: How can the natural passage of feces per anum be resumed? The Mikulicz technique of intestinal anastomosis, described by Johann von Mikulicz-Radecki in 1903, solved that very problem [18].

However, the idea had been alluded to by Schmalkalden [19] in 1798, over 100 years prior to Mikulicz. In his doctoral thesis, Schmalkalden de-

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**Figure 4** Double-barreled colostomy with attached glass tubing to remove feces from the surgical wound, as described by F. T. Paul of Liverpool. (From Devlin HB. Colostomy. Ann R Coll Surg Engl 52:393–395, 1973.)
scribed a 23-year-old man left with a double-barreled ostomy from a gangrenous inguinal hernia. Schmalkalden reported passage of a suture between the proximal and the distal intestinal ends and placement of a linen tent. He noted that this procedure eventually eliminated the ostomy spur and allowed the patient to pass feces normally per anum.

A brilliant paper entitled “Memoir on a New Method of Treating Accidental Anus,” written by Baron Guillaume Dupuytren [20] in 1828, detailed the formation of a fecal fistula following a strangulated groin hernia. Dupuytren accurately described the proximal and distal intestinal ends appearing in the wound in the shape of a double-barreled gun, an analogy he ascribed to Sir Astley Cooper, and the intestinal spur. He also understood the importance of removing the obstruction between the proximal and distal limbs while creating a fibrous bond between the two limbs to prevent fecal peritonitis. After learning of the achievements of Schmalkalden [19] with the linen tent, Dupuytren performed a similar procedure in 1813 on a 36-year-old man with a fecal fistula resulting from a strangulated inguinal hernia. Eventually the patient passed feces via the normal route. However, during Dupuytren’s attempts to cure the residual fistula (by dividing the deepest portion of the spur), the patient developed peritonitis and died. Dupuytren studied the effects of this procedure on dogs and realized that adhesive inflammation caused by the sutures prevented the escape of feces and prevented fatal peritonitis. Unhappy with the outcome with the linen tent, Dupuytren [20] experimented further and suggested a device called an enterotome. The enterotome contained a “male” and “female” limb, each having serrated edges. The male limb was fitted into a groove in the female limb, and both limbs were closed over the intestinal spur. The clamp was slowly tightened, which eventually resulted in the elimination of the intestinal spur.

Dupuytren studied the effects of his enterotome on animals and found well-formed fibrous adhesions between the proximal and the distal limbs in 2–3 days, long before the spur was divided (6–8 days). In 1815 Dupuytren first used this device in the treatment of a 26-year-old man with a strangulated hernia. The enterotome was induced into the double-barreled stoma and closed without producing any pain. Pressure was gradually increased. The patient passed some stool normally on day 6, and the clamp loosened and came away on day 8. Examination of the enterotome revealed two complete intestinal walls. The fecal fistula persisted, but eventually it closed with the help of silver nitrate, pressure dressings, and finally sutures.

Dupuytren [20] noted that he thought his method had received “the sanction of experience.” He collected and reported on a series of 41 intestinal anastomoses performed with the help of his enterotome, 21 performed by him and 20 done by others. Of the 41 patients, 38 survived, and in 29 cases the fecal fistula had healed completely in 2 to 6 months. Of the remaining 9 patients, Dupuytren [20] said:
It remains to find in all cases a means of producing the cicatrization in a useless opening. . . . I declare that without hesitation the discovery of a sure method of promptly achieving in all cases the healing of this disgusting malady would constitute one of the greatest steps of which the healing art was capable.

Soon after Dupuytren presented his work but before it was published, his pleas were answered. Because of the new developments in intestinal anastomosis, he added the following footnote to his paper just prior to publication. It concerns the methods of intestinal suture described by Lembert and Jobert: “Both of them [methods] seem to be perfect and, if I accord the preference to that of M. Lembert, I should fail not to say that he has been preceded by M. Jobert” [20].

Technical advances in the creation of ostomies continued throughout the nineteenth century, and “resection with exterioration” became the favored method of colonic resection. At this time, despite the work of Antoine Jobert de Lamballe and Antoine Lembert, primary intestinal anastomosis was considered too risky and therefore was not widely practiced. Paul, Morrison, Schede, Gussenbauer, Mady, and von Volkman all contributed to technical advances [21]. However, Mikulicz-Radecki was primarily responsible for the wide acceptance of resection with exteriorization in the surgical community.

Although Mikulicz popularized intestinal resection and the procedure that now bears his name, the first colonic resection was performed many years earlier. At Guys Hospital in London in 1832, Thomas Bryant [22] performed the first elective colonic resection followed by a double-barreled colostomy for a stricture of the descending colon.

Johann von Mikulicz-Radecki (1850–1905) (Fig. 5) was born in Cernowicz, Austria [23]. He earned his doctorate in medicine in Vienna and soon became assistant to C. A. Theodor Billroth. Mikulicz’s titles included professor of surgery at Krakow, Konigsburg, and Berslaw. He died at the age of 55 of carcinoma of the stomach [24].

Mikulicz [18] presented his technique of intestinal resection and anastomosis in a now famous article entitled “Surgical Experiences with Intestinal Carcinoma,” first read before the Thirty-First Congress of the German Society of Surgery in 1903. He not only detailed his technique of intestinal resection but also included his personal experience in over 100 cases. Mikulicz eloquently described the presenting symptoms, anatomic distribution, microscopic pathology, surgical treatment, complications, and survival rate of 106 patients with intestinal (mainly colonic) carcinoma.

Mikulicz understood and explained the danger of primary anastomosis in the face of acute and chronic obstruction and in the malnourished, chronically ill patient. He appreciated the increased difficulty in colonic (vs. small intestinal) anastomosis: “The lessened strength of the wall of the large gut, the poor blood supply, the sluggish peristalsis as a result of which
Mikulicz realized, as did his contemporaries, the pathophysiological and often fatal consequences of intestinal spillage, peritonitis, and sepsis; yet he showed unusual insight [18].

We can almost say as a rule a slight amount of bacterial invasion is overcome by the peritoneum; the effect produced is the circumscribed peritonitis observed in all stomach and intestinal operations. The capacity to overcome successfully an insignificant peritoneal infection of such a nature depends, in the first place, on the resistance of the entire organism.

He also appreciated the increased risk of bacterial seeding in the immunocomprised patients [18]:

The patient [with intestinal cancer] is found in a state of chronic intoxication by which he is doubtless less resistant to intestinal bacilli. . . . I do not doubt that the frequent pneumonias following this operation in part at least are to be attributed to a bacterial infection of the peritoneum which is locally overcome but which leads to pneumonia by way of small pulmonary emboli.

Because of the aforementioned problems, Mikulicz considered primary anastomosis to be too risky in the treatment of intestinal carcinoma. He reviewed his peers’ experience with primary suture and compared it to that of his two-stage procedure, citing a reduction in mortality from more
than 50% to 12.5%. He described three main advantages of the two-stage resection: (1) the proximal dilated bowel is decompressed and the patient is detoxified, (2) the intestinal anastomoses are performed on normal intestine, and (3) the risk of peritonitis is minimized.

Mikulicz [18] described his technique in the following way:

The intestinal tumor along with the diseased lymph glands in the corresponding portion of the mesentery are freed from all attachments as in the single stage resection, so the tumor is finally connected only with the gut leading to and from it. The mesentery must be loosened sufficiently to allow the section of bowel which is to be resected to be laid out on the surface of the abdomen without tension. When this is done the abdominal wall is closed off so that only the cleft necessary for passage of the afferent and efferent segments of the gut is left open; this cleft must not be so narrow that the afferent section is compressed. A series of serosal sutures is placed at the point where the parietal peritoneum comes into contact with the protruding portion of the bowel, these sutures also closing off the peritoneal cavity at this point. The outer skin is sutured carefully to the protruding bowel (with tamponades). Next a line of sutures as well as the surface of the contact between the exposed gut and the skin wound are thickly spread with zinc paste and over this a sterile dressing is placed. Over the bandage comes a large piece of waterproof material with a slit just large enough to allow the protruding gut to be drawn through. Thus the tumor which is to be resected is finally separated from the abdominal cavity not only by the secured abdominal wall but also by the protective dressing. Formally, I removed the tumor only after the passing of 12 to 48 hours, but now I usually do it at once. A thick glass tube is fastened into the discharging segment of gut and a thick rubber tube fastened to the glass one so that the intestinal contents flow off.

The wound in the abdominal wall in this procedure heals, as far as it is sutured, by primary intention. After 2 to 3 weeks, by means of my spur-crusher, I transform the artificial anus resulting from the removal of the tumor first into a fecal fistula and then later make a closure by suture.

The advantages of this procedure are evident. The main operation is shorter than by the single stage method, the peritoneal infection during the operation is absolutely avoided, and one can thus attempt it much earlier on a patient debilitated by disease. A further advantage is that the operation can be performed in cases of wide extension of the tumor or in deep locations as for example in the lower part of the sigmoid flexure, where it would be too dangerous to unite the intestines because of too forceful tension on the loops of gut. The method is not only less dangerous but also more easily performed. Of course, the procedure also has its drawbacks. The duration of the treatment is longer and the patient operated must bear with the unpleasantness of an artificial anus for a long time. But I think these disadvantages are
greatly outweighed by the advantages of greater safety and increased ease of performance.

Mikulicz recommended his two-stage technique for all resections and anastomoses of the large bowel and for the small bowel when ileus (obstruction) was present. For resections of the small intestine without obstruction, he advocated primary anastomosis. For cecal resections in healthy patients, Mikulicz recommended primary anastomosis with simple resections; for patients in ill health or with large tumors requiring extensive dissection, he recommended a two-stage procedure.

Of the 106 patients who comprised his report, Mikulicz performed a two-stage resection in 16 cases. Two patients died, one from marasmus 7 weeks following surgery and one from injury to the descending colon, which was infiltrated with cancer and accidentally torn down during the procedure. No patients died as a result of anastomotic leakage. It is interesting that also included in Mikulicz’s report were 21 patients who underwent resection and primary anastomosis nine of whom died (mortality, 42.9%). Mikulicz’s “Surgical Experiences with Intestinal Carcinoma” received much attention because Mikulicz was a well-respected surgeon and an eloquent speaker. Following his presentation, the two-stage resection with exteriorization, a procedure that still bears his name, became the preferred technique for the treatment of carcinomas of the intestine. Mikulicz never acknowledged the contributions of Schmalkalden, Bryant, or Dupuytren to this procedure.

While Mikulicz was refining the two-stage resection, several other inventive surgeons were contributing technical advances of their own. Raybard of Lyon, in a report in the memoirs of the Paris Academy for Surgery in 1844, described the successful resection of an “orange-sized” tumor of the sigmoid colon with primary intestinal anastomosis by means of a “furrier’s suture” in 1833 [25]. However, the specimen was disposed of, and an autopsy was not performed after the patient’s death 10 months later. The Paris commission found the report insufficient and lacking in precision.

In 1879 Martini of Hamburg may have been the first surgeon to perform what was later to become the Hartmann procedure [25]. After removing a large tumor in the sigmoid colon, he was unable to approximate the intestinal ends. Instead he closed the distal end and returned it to the abdominal cavity while creating an end colostomy with the proximal colon.

As previously mentioned, Schitzinger and Madelung advocated complete transection of the bowel with reintroduction of the closed distal end into the peritoneal cavity, even when a simple colostomy without resection was being performed. This idea was not widely accepted. In general, surgeons had two main concerns: (1) the fate of the undrained distal loop returned to the abdominal cavity, and (2) the possibility that the proximal loop would be inadvertently closed, thus creating an intestinal obstruction.
Polloson championed this procedure, however, and after his presentation at the German Surgical Society, its popularity grew. As explained by Madelung, the advantages of complete fecal diversion included the following [25]: (1) no feces came in contact with the obstructing region, and therefore the patient experienced less irritation; (2) feces could no longer reflux from the distal end into the stoma; and (3) the accumulation of feces in the distal segment was avoided.

Polloson suggested, although he never received credit for, another important use for the completely diverting colostomy. He was first to recommend its use prior to transanal resection for rectal tumors in order to prevent the dreaded complication of pelvic sepsis, a use that is still occasionally employed today.

In 1886 Sonnenburg developed a method of avoiding the undrained distal loop. Operating through a lower midline incision, he implanted the closed lower loop just below the incision so that if infection and perforation did occur, a harmless intestinal fistula would develop [25]. In fact, Sonnenburg observed this occurrence in one of his patients who was thus treated.

**COLOSTOMY SPUR**

Sir Charles Ballance first used a rubber tube passed under the loop of bowel to lengthen the colostomy spur and to completely divert the fecal stream [9]. After using this method, however, he thought that it caused obstruction of the proximal loop and led to the death of his patient, and therefore he abandoned this technique.

Madyl is credited with being the true father of the colostomy rod. He described the use of a rigid rod covered with iodoform gauze. The rod was passed beneath the loop colostomy and left to rest on the abdominal wall, thereby preventing retraction of the bowel. The proximal and distal loops were further approximated by two sutures, one anterior and one posterior, in order to ensure proper spur formation and complete diversion of the fecal stream.

Bryant in England and Kelsey of New York described similar methods of creating a colostomy spur [9,25]. A harelip pin was passed through the skin and peritoneum, through the intestinal mesentery at the junction of its middle and lower two thirds and back through the peritoneum and skin on the opposite side (Fig. 6). This technique produced a protuberant stoma with a large spur that completely diverted the fecal stream.

Allingham considered Madyl’s technique to be too dangerous, and subsequently developed “Allingham’s mesocolic suture,” a mattress suture placed through the mesentery to secure the bowel and create an adequate
spur. To this suture application, Paul of Liverpool added his glass tube, which diverted feces away from the wound and thereby prevented infection.

While these modifications were being introduced and confusion surrounded the proper method of creating the colostomy spur, Reeves published “Sigmoidostomy Simplified” in the *British Medical Journal* [25]. He stated that an adequate colostomy spur could be created by passing a vulcanite rod through the mesentery of the exteriorized intestine and that sutures were generally unnecessary. Reeves thought that the bowel should be left unopened for 3–4 days and that the rod should be left in place for approximately 1 week. Reeves believed that many of the other modifications were unnecessary and considered simplicity to be always advantageous, as illustrated by the following quote: “The simplification of operative procedures should in the interest of the patients be the aim of the surgeon, and experience abundantly proves that the simpler the operation is the better are its results” [25].

### RECTAL RESECTION

While stoma surgery progressed, other important advances were occurring in the surgical world. Rectal excision was particularly important in the development of intestinal stomas. In 1793 Faget performed the first rectal
Cataldo

resection for extensive ischiorectal suppuration [26]. In 1826 Lisfranc reported the first rectal extirpation for cancer, and 5 years later he reported a personal series of nine cases (six of which were successful) [27].

Early excisions were performed through the anal canal or the perineum but exposure was limited and only lesions confined to the lower half of the rectum were amenable to excision. In 1873 Verneuil, at the suggestion of Amussat, excised the coccyx to extend the limits of resection [28]. This approach was also adopted by Kocher [29]. However, it was Paul Kraske who popularized the transsacral approach. After witnessing the removal of a sacral sarcoma Kraske realized that the lower sacrum could be removed with minimum morbidity and that its removal provided excellent exposure to the upper rectum. Following Kraske’s presentation to the Fourteenth Congress of German Surgeons in Berlin, transsacral excisions of the rectum flourished [30]. Other approaches also were attempted. A.T. Norton [31], in 1889, described a transvaginal resection with the reestablishment of continuity and postoperative continence.

H. T. Byford [32] replaced the excised rectum with a vaginal segment in which both the proximal and distal ends were sutured to the vagina and the vaginal introitus was closed. L. L. McArthur [33], after resecting recurrent rectal cancer, was unable to attach the rectum to the anus; therefore he sutured it to the upper vagina and claimed that his patient (with a surgically created rectovaginal fistula) had good postoperative continence.

In 1883 Vincent Czerny performed the first combined procedure for rectal cancer. Unable to complete a transsacral resection of a high rectal lesion, Czerny turned the patient and completed the procedure transabdominally [34]. Unfortunately, the patient died.

As mentioned earlier, Polloson advocated a diverting colostomy prior to transanal rectal excision to prevent sepsis. Quénu, Hartmann, Juillard, Bishop, and Jaboulay also favored this approach. Ball and Edwards recommended preliminary colostomies on selected patients, but Kraske and Czerny thought that such colostomies were unnecessary except in unusual cases. Although pelvic sepsis was a concern in the early postoperative period, tumor recurrence was a major worry of surgeons. Allingham reported a 100% recurrence in 18 personal cases, whereas Cripps reported only a 38% survival in 85 cases. Vogel reviewed 1500 cases of rectal cancer treated by 12 prominent surgeons prior to 1900 and found an astonishing recurrence rate of 80%.

Charles Mayo and Sir Ernest Miles (Fig. 7) had similar experiences and believed recurrence was caused by the failure to resect perirectal lymphatics. Charles Mayo [35] in 1904 and Miles [36] in 1908 described their techniques of abdominoperineal resection. In the early period the perioperative mortality was high (20%), but the long-term survival was much improved. Colostomy had found a secure place in the management of rectal cancer.
HARTMANN PROCEDURE

During the nineteenth century the colostomy was extensively used in the treatment of rectal cancer. First, it was important for its palliative role in treating obstructing rectal lesions; second, for its protective role prior to transanal rectal excisions; and finally, for its curative role in association with abdominoperineal resections. However, colostomy is often used in the treatment of other diseases of the colon and rectum. In 1907 Mayo et al. [37] first described the use of the right transverse colostomy to “defunction” the sigmoid colon in the treatment of diverticulitis. The colostomy was often permanent, but it was occasionally closed after the acute episode has subsided. In the 1930s a three-stage approach, consisting of (1) diverting transverse colostomy and drainage, (2) sigmoid resection with anastomosis, and (3) closure of transverse colostomy, was independently described by Mayo [38] and by Rankin and Brown [39]. These procedures, however, are rarely, if ever, used today, having been replaced by the Hartmann procedure in the surgical treatment of complicated diverticular disease.

Henri Hartmann (1860–1952) (Fig. 8) was born in France and was graduated from the University of Paris medical school in 1887. He became the professor of surgery at Hotel Dieu in Paris in 1909 [40]. During his medical career Hartmann performed over 30,000 operative procedures, and on his retirement he turned over to his successor his personally kept records for each patient. Sometime between 1909 and 1923, he devised what is
now called the Hartmann operation. The details of this procedure were published in his text *Chirurgie du Rectum* in 1931 [41]. Hartmann described resection of the sigmoid colon and upper rectum, oversewing of the distal rectal stump, and creation of an end descending colostomy. However, he advocated this procedure for the treatment of carcinoma of the sigmoid colon. He even mentioned reanastomosis as a second procedure but thought it a very difficult undertaking. It is unknown whether Hartmann ever performed his procedure in the treatment of diverticulitis. It is believed that sometime in the 1930s an unknown surgeon first performed this two-stage resection and anastomosis for diverticulitis. Possibly, that surgeon was the first to call it the Hartmann procedure [40]. Albeit through a circuitous route, sigmoid resection with creation of a descending colostomy has become the most popular procedure for the treatment of complicated diverticulitis and is known as the Hartmann procedure.

**CECOSTOMY AND APPENDICOSTOMY**

In the late 1800s colostomy was first employed in the treatment of ulcerative colitis. Ulcerative colitis was first described by Sir Samuel Wilks [42] in 1875. In 1895 Keetley [43] of London described appendicostomy, and in 1902 Weir [44] of New York described appendicostomy with colonic irrigation in the treatment of severe ulcerative colitis. In 1895 Hale White reported the use of cecostomy and colonic irrigation with boric acid for severe “membranous colitis” [45]:

![Image of Henri Hartmann](image_url)
It has been suggested that in a very intractable case it might be justifiable to open the colon high up and by allowing the feces for some time to pass out through the artificial anus to give it a rest and at the same time to flush it from the artificial anus to the natural anus with boric acid lotion.

Bolton in 1901, Braun in 1913, and Cattell of the Lahey Clinic in 1935 all used cecostomy and colonic irrigation in the treatment of severe ulcerative colitis.

Cecostomy and appendicostomy also were described in the treatment of chronic constipation. Keetley, a true champion of appendicostomy, Murray, and Sir William Bennett advocated appendicostomy in the treatment of intractable constipation.

**ATTEMPTS AT CONTINENT COLOSTOMY**

Shortly following the acceptance of abdominal colostomy, surgeons began to focus their attention on the establishment of a continent stoma. Cromar [25] classified the early attempts into three main categories: (1) obturation, (2) external pressure, and (3) sphincterization.

**Obturation**

In 1901 Payer created a skin flap to cover the colostomy outlet. Apparently he met with little success, and his technique never gained any popularity.

**External Pressure**

In 1889 Witzel directed a colostomy through the subcutaneous tissue over the crest of the ileum. With use of an external bandage, he compressed the colon to maintain continence. Lenkinheld and Borchardt used this method with success but found the external bandage unnecessary. Roux cut a V-shaped defect in the symphysis pubis and brought the sigmoid colostomy between it and the rectus muscle to maintain continence. Bailey, Tuttle, Braun, Andrea, and Burrows all used modifications of a subcutaneous tunnel combined with external pressure to maintain colostomy continence. Goldschmidt and many other surgeons maintained continence by means of a colostomy clip held in place with a tubular skin graft. Lambert created *anus en trompe*, a 10-cm spout covered with skin grafts that was compressed against the abdominal wall by means of an adhesive strap. This technique was later modified by Hayem and Briscoe.

**Sphincterization**

In 1888 Maydl, the creator of the colostomy rod, and Hartmann advocated a muscle-splitting incision similar to McBurney’s to create an artificial co-
lostomy sphincter. Gersuny and Lilenthal both brought the colostomy through the rectus muscle and twisted the proximal end 180 to 360 degrees and claimed perfect continence within 1 month of the procedure. Bernays attempted a “sphincteropoiesis” by placating the circular muscle fibers of the terminal sigmoid colon without much success. Ryall attempted to create a sphincter by using fibers of the rectus muscle, again without success. Failure of both of these methods was attributed to the lack of autonomic nerve supply. In 1932 Spivack attempted to create an artificial sphincter with a reversed ileocecal valve. None of these methods met with any long-term success, and therefore all have been abandoned.

LOOP STOMAS

In 1888 Maydl first suggested the use of an external appliance to support a loop stoma and to facilitate creation of a spur. Since that time, hundreds of modifications have been used, but all are based on Maydl’s idea. Maydl [46] described the use of an Indian rubber rod or goose quill passed through the mesentery and left to rest on the skin. Reeves used a vulcanite rod for the same purpose. In 1900 Hartmann [47] advocated rolled iodoform gauze passed through the colonic mesentery. He also covered the peristomal skin with iodoform gauze. These two maneuvers prevented stomal retraction while protecting the peristomal skin. Greig Smith devised a glass rod for stomal support, to which Makins added a piece of rubber tubing to prevent slippage. Mouat further modified the glass rod by adding a metal cap to prevent dislodgment and called it a “colostomy fixation pin” [25].

In the 1960s the glass rod was replaced by rubber tubing sewn to the abdominal skin, which facilitated the placement of an ostomy pouch. Wangensteen [48] developed a colostomy support device consisting of two glass rods connected to a belt with rubber tubing. With this device, the two ends of the bowel were pulled apart in order to better divert the fecal stream. Plastic devices created by Greene [49] and Aries [50] and in the 1970s by Hollister, Inc. (Libertyville, IL) involved the development of a butterfly-shaped stoma bridge, which is most commonly used today.

ILEOSTOMY

Although the history of colostomy dates back to the early 1700s, the ileostomy is a much more recent event. The first reported creation of an ileostomy was by Baum [51] in Germany in 1879. Baum performed a diverting ileostomy in the treatment of an obstructing right colon cancer. Eight weeks following the first surgery, he resected a tumor and performed an ileocolostomy. Unfortunately, the patient died on postoperative day 9, after an anas-
tomotic leak. In 1883 Mayd [52] of Vienna, the inventor of the colostomy rod, performed the first successful ileostomy in combination with colonic resection. Six years later, J.M.T. Finney described the flush-loop ileostomy for the treatment of small bowel obstruction in association with appendiceal abscess [53]. Severe skin irritation resulted, and the procedure never gained any popularity.

The widespread use of ileostomy was a result of the work of John Young Brown (1865–1919) (Fig. 9), a St. Louis surgeon. In 1912 Brown [54] reported his experience with 10 patients. All 10 patients underwent ileostomy after failure of colonic irrigation following either a cecostomy or appendicostomy. These patients suffered from colon cancer, bowel obstruction, tuberculous colitis, amebic dysentery, and ulcerative colitis. Brown brought the end ileostomy through the lower pole of a midline laparotomy incision. This stoma protruded 2–3 in. beyond the abdominal wall and was emptied by means of a catheter sewn in place (Fig. 10). Eventually the catheter was removed, and, as a result of serositis caused by the ileal effluent, the mucosa everted to reach the abdominal wall. Brown was the first to advocate diversion of the fecal stream in the treatment of ulcerative colitis, and his technique was used for the next 40 years. However, ileostomy still remained a procedure of last resort, and most ileostomy patients were almost chronic invalids. In 1932 the mortality of ileostomy for the treatment of ulcerative colitis at the Mayo Clinic was an astounding 32% [55].

Minor improvements occurred in the 1930s and 1940s. Rankin [56] of the Mayo Clinic described creating an ileostomy in a separate wound in

Figure 9  John Young Brown. (From Royster HA, ed. Trans South Surg Assoc 32:526, 1919.)
the right lower quadrant. The use of skin grafting around the stoma to prevent serositis gained some brief popularity [57] (Fig. 11). However, subsequent stenosis of the grafted skin led to ileostomy obstruction and dysfunction, and therefore the idea was abandoned. No significant advances occurred until the 1950s, when Crile and Turnbull [58] of the Cleveland Clinic described ileostomy dysfunction and Bryan Brooke of the University of Birmingham in London described the now famous Brooke ileostomy [59].

In a 1952 paper entitled “Management of the Ileostomy and Its Complications,” Brooke (Fig. 12) described the ileostomy that remains in use today. One sentence, “A more simple device is to evaginate the ileal end at the time of operation and suture the mucosa to the skin; no complications have occurred from this” [59], accompanied by a single illustration, changed the ileostomy from a chronically inflamed and ulcerative stoma, frequently associated with dysfunction, to the functional “rosebud” we know today. In his article Brooke described the classic technique of primary eversion and maturation of the ileostomy, which eliminated ileoserositis and stomal dysfunction.

However, Crile and Turnbull were the first to fully understand and describe ileostomy dysfunction. Ileostomy dysfunction consisted of partial stomal obstruction manifest by watery diarrhea, abdominal pain and distention, and dehydration. They attributed this obstruction to serositis of the “naked” ileal serosa now exposed to ileal effluent [58]. The serositis led
Figure 11  Skin-grafted ileostomy as described by Lester Dragstedt. (From Dragstedt LR, Dack GM, Kirsner JB. Chronic ulcerative colitis: A Summary of evidence implicating Bacterium neocrophorum as an etiologic agent. Ann Surg 114:655, 1941.)

Figure 12  Bryan N. Brooke. (Courtesy W. C. McGarity, M.D.)
to a rigid stoma without peristalsis, which caused a functional intestinal obstruction and resolved only when the ileostomy had matured. Maturation, as described by Crile and Turnbull, was the natural process of eversion of the ileal mucosa to reach the abdominal wall. For the treatment of ileostomy dysfunction, they recommended catheter drainage of the ileostomy as having good results.

Unaware of Brooke’s work in London, Crile in 1952 suggested “mucosal grafted ileostomy” to prevent ileostomy dysfunction. He described removing the distal 3–4 cm of serosa and muscle from the ileostomy and folding over and suturing the redundant mucosa to the abdominal skin in order to “mature” the ileostomy at the time of surgery [58]. Through the work of Brooke, Turnbull, and Crile, we now have an easily matured ileostomy rarely associated with dysfunction.

CONTINENT STOMAS

Even when functioning well, the Brooke ileostomy drained constantly and required the full-time use of a pouch. Many patients were disturbed by this feature, which led Nils Kock (Fig. 13) to begin work on a continent ileostomy. In 1969 Kock [59] described the creation of an ileal reservoir drained by a tiny stoma brought through the rectus muscle. This method, however, did not lead to complete continence. Therefore in 1972 he added a nipple value of intussuscepted ileum. Dozois et al. [60], at the Mayo Clinic, fol-

Figure 13  Nils G. Kock. (Courtesy W. C. McGarity, M.D.)
History of Stomas

allowed a series of patients and found that most were fully continent, their stomas requiring only intermittent catheter drainage. Initially, valve spillage rates were high, but they were later reduced to less than 20%.

More recently, Barnett has developed a new continent ileostomy. A reservoir of ileum similar to the Kock pouch is created; to this is added a collar of functioning ileum. This collar functions similarly to a Nissen wrap, generating higher pressures (and therefore preventing leakage) when the intestine is distended with fluid. Early results with this method were encouraging. However, since the advent of J, S, and W pouches combined with ileoanal anastomosis, continent ileostomies are rarely required.

In 1974, Drs. Feustel and Henning in Germany developed a “colostomy plug,” the Erlangen magnetic ring. This involved implanting a magnetic ring subcutaneously around the stoma neck. Following recovery from surgery a magnetic plug was inserted into the stoma opening, thereby maintaining continence. Removing the plug led to convenient stoma emptying. Unfortunately, complications with this system outweighed benefits, and it was therefore abandoned.

ENTEROSTOMAL THERAPY

In the 1950s Brooke in England and Turnbull and Crile at the Cleveland Clinic changed the ileostomy from a procedure of last resort to a well-tolerated solution for the treatment of ulcerative colitis. As the Brooke ileostomy gained popularity, the number of patients with long-term ileostomies increased dramatically. These patients required specialized care that needed to be continued long after hospital discharge. Because of this need, the field of enterostomal therapy developed. Rupert Turnbull had a special interest in intestinal stomas and realized the need for trained professionals dedicated to stoma care.

In 1954 Turnbull operated on a young mother of three, Normal Gill (Fig. 14), for ulcerative colitis, leaving her with a permanent ileostomy [61]. Since Gill’s mother had a colostomy, Gill was well aware of the problems of living with a stoma. During her own recovery period she became interested in helping other ostomy patients. When Gill returned to her home in Akron, Ohio, she began to volunteer her services to individuals with stomas in her local area. In 1958 Turnbull hired Gill as an ostomy technician. Together they later coined the term enterostomal therapist. As the word spread, other hospitals became interested in sending personnel for specialized training with Turnbull and Gill.

In 1961 Turnbull opened the first school of enterostomal therapy because of increasing demand for trained enterostomal therapists. Only people with stomas were accepted as students, but many were also trained nurses. Joy Richey, a registered nurse from California, was the first graduate of the
school in 1961. Similar schools opened in Grand Rapids, Michigan (Ferguson-Droste-Ferguson Hospital) and in Harrisburg, Pennsylvania.

At the United Ostomy Association (UOA) national meeting in Phoenix, Arizona, in 1968, the American Association of Enterostomal Therapists (AAET) was born. The first national meeting of the AAET was held at the Cleveland Clinic in 1969. Edith Lenneberg, who had had an ileostomy and was instrumental in the development of the UOA, was elected president, and Norma Gill was named as secretary. In 1969 the name of the organization was changed to the North American Association of Enterostomal Therapists (NAAET) and in 1971 to the International Association of Enterostomal Therapists (IAET).

In 1976, Annelise Eidner, a nurse working in the proctology department at the University Hospital Erlangen, Germany, attended the Enterostomal Therapists Nursing Education Program (ETNEP) at the Rupert Turnbull School of Enterostomal Therapy. She attended at the suggestion of Dr. Thorlolph Hager, who had just returned from training visit with Dr. Turnbull.

The training of nurse Eidner led to the origin of an enterostomal therapy program in Germany, the first in Europe. Patients throughout Germany were referred for combined specialized proctological and stomal care. In addition, advanced ostomy management systems became available in Germany for the first time.

In 1977 Anneliesse Eidner and Dr. Hager established 2-week courses in enterostomal therapy. Participants attended from all over Europe, as this was the first time specialized enteral stomal therapy training was available in continental Europe.
In 1978 a more extensive 8-week course began at the Heinrich-Heine University of Düsseldorf, led by Professor Kievelitz and ET nurse Nortrud Schienzilorz. This eventually lead to the founding of the first enteral stomal therapy association in Germany, the German Association of Enterostomal Therapists.*

OSTOMY MANAGEMENT SYSTEMS

Although spontaneous stomas had occurred for centuries, the first mention of an ostomy pouching device was not until 1795. In France, Dageusceau created an inguinal colostomy in a 57-year-old farmer who had impaled himself on the stake of a wheat cart. For the following 24 years, the farmer “collected his feces in a small leather pouch” [10]. In 1824 Martland of Blackburn, England, created an ostomy device from a self-adjusting truss containing a tin box in the center for the collection of feces [62]. However, the advances in stoma surgery were not accompanied by advances in stoma management. As late as the early twentieth century, patients were using Model-T inner tubes, tunafish cans, and bread bags with talcum powder, cornstarch, or aluminum gel to prevent leakage. Vanilla and peppermint extracts, mouthwash, perfume, parsley, and bicarbonate of soda were used to diminish odors [61].

Despite the fact that colostomy irrigation had been reported in the early 1800s, it did not gain popularity until the 1920s. In 1924 Dudley Smith, a California surgeon, and John Greer, who worked for a surgical supply company, developed the Colostogator [63]. This device, which consisted of a metal cup held around the colostomy by means of a belt, was the first commercially available irrigation system. Attached to the cup was a long rubber sleeve that ran into a bucket placed at the patient’s feet. The colostomy was irrigated by a rubber catheter placed through a hole in the sleeve. With this device patients were able to irrigate once every 24 hr, between which they wore a “simple belt of plastic webbing . . . [with] several pieces of absorbent paper” [61]. The John R. Greer Company also developed a device for people who did not wish to irrigate. It consisted of a canvas bag lined with several thicknesses of toilet paper and a single sheet of oiled paper attached to a stoma ring in a belt.

In 1944 Henry Koenig of Chicago, who had undergone an ileostomy, was encouraged by his surgeon to create a pouching device. The revolutionary result was a rubber bag attached to a circular faceplate that was fixed

*Personal communication: Alexander Fleischmann, RN, ET and Klaus Matzel, MD, Ph.D., Surgical Department, University Hospital Erlangen, Germany.
to the skin with rubber-based cement (Fig. 15). This instrument was the first pouching device that could be drained while still in place. Eventually, Koenig recruited H.W. Rutzen, who had also had an ileostomy, to market his invention. The H.W. Rutzen & Son Co. remains in business today.

Another person who had an ostomy, Murle Perry, at the urging of his surgeon, developed a line of stoma management devices. The Perry Model 51, which was introduced in 1951, consisted of a plastic pouch with absorbent papers combined with a close-fitting rubber gasket designed to keep irritating stoma output away from the surrounding skin [61].

Despite these advances, skin irritation continued to be a significant problem, particularly for ileostomy patients. Just as had happened with Alexander Graham Bell and the telephone many years earlier, an accidental discovery led to a great advance in stoma surgery by Rupert Turnbull.

Figure 15  Rutzen bag, 1944. (Courtesy H. W. Rutzen & Sons, Inc., Chicago, IL.)
In 1952, he [Turnbull] was cleaning out the desk of his former chief, Tom Jones, and accidentally knocked over a small canister of Jones dental powder into spilled coffee on the desk. The karaya immediately absorbed the coffee and stuck to Turnbull’s wet hand. He thought the powder might also absorb ileostomy effluent and protect the skin from excoriating effects of the liquid stool. [61]

Thus the use of karaya was introduced. Karaya powder (and later wafers) was a major advance in peristomal skin care.

Another dental product was found to be useful in stoma care. In 1964 Squibb (Princeton, NJ) developed Orahesive paste and powder for use as a paste and dental fixative. E.S.R. Hughes, an Australian surgeon, realized the usefulness of this product in stoma care and conveyed his experiences to Turnbull, a close personal friend. The result was the Stomahesive wafer, introduced in 1972, a product that was particularly useful for patients with watery ileal effluent (which diluted the karaya) or those with an allergy to karaya. Recently, stoma adhesive wafers have been combined with a flange apparatus (Sur-Fit; ConvaTec, Princeton, NJ) to create a two-piece ostomy management system. This system allows for easy stoma access since the pouches can be removed and the faceplate can be left intact. In addition, the pouches can be washed and reused.

CONCLUSION

Over the past 200 years intestinal stomas have developed from “last chance,” lifesaving efforts to well-planned, technically refined artificial anuses. Colostomies can be “trained” to function once every 24 to 48 hr. Ileostomies and urostomies can be made “continent” if the patient so desires. Although stomas formerly were foul-smelling and offensive, today they are rarely noticeable, even to the patient’s closest contacts.

These advances in stoma management are the result of an increased understanding of intestinal physiology, refinements in surgical techniques, advances in ostomy management products, and the development of enterostomal therapy. It is hoped that the overview of these developments provided by this chapter will add perspective to the information found in the following chapters.

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INTRODUCTION

Over a million people in the United States have an intestinal stoma which has been fashioned for a variety of reasons. Patients with properly functioning stomas retain normal physiology except for some well-compensated changes in fluid and electrolyte homeostasis. Furthermore, with modern techniques of stomal construction and proper postoperative care, the metabolic complications from the creation of a stoma have fortunately been minimized. Through a better understanding of normal physiology and the systemic response to fecal diversion, physicians are able to help maintain and improve the lifestyles of their patients with stomas.

CONVENTIONAL ILEOSTOMY

Ileostomy Output

There appear to be three distinct phases of adaptation during the initial postoperative period following stoma construction. Ileostomy effluent during the first 1–3 days is bilious and liquid in nature, and each day the output increases. During the second phase, beginning between days 3 and 5, the output stabilizes or decreases slightly. The third phase is characterized by steadily declining outputs until a steady state is reached 6–8 weeks postoperatively [1]. Subsequently, a relatively constant stool volume ranging from 200–700 mL/day is expected when the ileostomy is well established. This process of small intestinal adaptation allows conservation of the majority of the 1500–2000 mL/day that normally enters the colon from the small intestine. Dietary changes have minimal influence on the ultimate stomal output, and once the ileostomy has “matured,” there is little daily

2
Stoma Physiology

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variation in output volume in a given individual. Hill [2] classified indi-
viduals with ileostomies into two groups; patients with a low stomal effluent
(less than 700 mL/day) and those with outputs exceeding 1000 mL/day. Pa-
tients with Crohn’s disease characteristically have a higher stomal output.
Since the development of eversion and primary maturation as de-
scribed by Brooke in 1952 [3], high ileostomy outputs have become less
common. Prior to this, high stomal outputs were caused by serositis of the
exposed ileostomy, with subsequent localized inflammation and partial
small bowel obstruction at the level of the abdominal wall. The inflamma-
tory obstruction led to proximal partial small intestinal dilation and watery
diarrhea [4]. Today bowel obstruction is caused by local edema, food im-
paction, ileus, or early adhesive complications. Partial obstruction can be
recognized by either scant output or high-volume, thin, bile-stained efflu-
ent: this most often resolves with the use of conservative measures, includ-
ing nasogastric decompression and bowel rest with intravenous hydration.

By 4–6 months postoperatively, the volume of ileostomy effluent var-
ies little from day to day; the consistency is porridge-like, with a yellow-
brown color, and food particles are present. Formed feces are extremely
unusual and generally associated with marked dehydration, since normal
ileostomy effluent is 90% water (Fig. 1). Variations in consistency and
volume are governed by the amount of water in the stool. Hill [5] observed
that body mass had a direct correlation with stomal output, such that a 40-
kg individual might expect outputs of 300–400 mL/day, while an 80-kg
individual could expect outputs of 800 mL/day.

High stoma output in the perioperative period is initially managed
with aggressive rehydration and replacement of depleted electrolytes.
Should the initial recovery phase to a steady state be prolonged, the output
can be decreased by the use of antimotility agents such as loperamide, di-
phenoxyate-atropine, or tincture of opium. Caution must be employed to
ensure these agents are not used if a partial small bowel obstruction is the
underlying cause of high stomal output.

High outputs in a patient with a mature ileostomy are dealt with first
by modifying the diet. Avoiding foods that frequently quicken transit time
(fruit juices, heavily spiced foods, chocolate, and alcoholic beverages) and
the use of stool-thickening foods (breads, pastas, cheeses, bananas, and creamy
peanut butter) will often decrease the output to an acceptable level. Should
dietary measures prove ineffective, the use of antimotility agents can be
initiated and monitored.

**Effects of Oral Intake**

The influence of diet and fluid intake on the consistency and volume of
ileal effluent has been well studied and characterized. Water intake plays
virtually no role in determining ileostomy output except that dehydration is
Figure 1  Intestinal consistency and erosiveness. The stool becomes more solid as it progresses through the gastrointestinal tract. A stoma from the colon rather than the small bowel emits stool that is far less injurious to the skin. (From Keighley MRB. Ostomy Management. In: Pemberton JH, ed. Shackelford’s Surgery of the Alimentary Tract, 5th ed. Vol. IV. Philadelphia: W. B. Saunders Co., 2002:305–333.)

associated with decreased outputs and thicker consistency. Fasting dramatically decreases ileostomy output to between 50 and 100 mL/day. Studies of individual dietary components show that ileostomies respond to the institution of an elemental diet with decreased output and concentration of digestive enzymes and bile acids [6]. Diets with high fat content have been associated with increases of stomal output to 20% above baseline [6,7]. Increases in fiber content in excess of 16 g/day likewise are reported to increase output by 20–25%, [8] and also cause increased stool frequency and flatus. The quantity of sodium in the diet correlates directly with the volume of stomal output without affecting the dry weight of stool. Grape or fruit juices, however, do increase the wet weight of the stool. The vast majority of patients report maintaining or gaining weight after ileostomy construction, with tolerance of most food types.
Nutritional Effects

Normal nutrition is the goal and generally also the rule in patients with established ileostomies. As long as terminal ileal resections are limited (less than 100 cm), there are few nutritional consequences. Normally, nutrients are readily absorbed from the small intestine. When malabsorption does occur though, osmotic diarrhea may result and is suggested by malodorous floating stools. Fat malabsorption, from impaired bile salt absorption or a reduced bile salt pool, is a common cause of osmotic diarrhea. Bile salts may increase outputs either by absorptive inhibition or perhaps by a direct secretory stimulation on the intestinal mucosa [6,9]. Other disorders of nutrient malabsorption occur with carbohydrates (lactase deficiency) and protein (enterokinase deficiency). Body composition is preserved if patients increase their dietary consumption of fluid, nutritious foodstuffs, and minerals. However, fat losses cannot be compensated for by dietary measures if the terminal ileum has been resected.

Malabsorption of vitamin B12 is unusual in patients who have undergone resection of less than the distal third of the ileum [10]. Transient malabsorption of vitamin B12 may be related to a temporary alteration in the ileal microflora, and vitamin B12 supplementation is unnecessary in such patients. However, resection of more than 100 cm of ileum (especially involving the distal ileum and ileocecal valve) and stagnation from distal obstruction or bacterial overgrowth predispose the patient to the need for vitamin B12 supplementation.

Metabolic Effects

In individuals with well-adapted ileostomies, electrolyte, mineral, and vitamin deficiencies are uncommon. Intestinal water absorption is controlled by solute transport across the epithelium, with sodium transport being the major determinant of small bowel water absorption. Kramer [11] observed that variations in dietary Na\(^+\) do not markedly influence the Na\(^+\) content of the stomal effluent. However, chronic systemic water and sodium depletion associated with ileostomy are accompanied by profound changes in urine volume, osmolality, and Na\(^+\) content. These observations are consistent with more recent studies indicating that, after ileostomy, the kidneys promote systemic conservation of salt and water through the release of mineral corticoids and their precursors. Thus, after ileostomy, urine volume and sodium ion concentrations—[Na\(^+\)]—fall, accompanied by increases in [H\(^+\)] and [K\(^+\)] [12–14]. Early on, there may be disturbances in total body water and [K\(^+\)] homeostasis [15]. Subsequently, when the ileostomy is established and the patient has achieved a steady state, the chronic stimulation of endogenous mineral corticoid secretion is sufficient to restore body water and ion composition [12,13,15].
If dietary sodium is decreased, a diuresis with reduced renal sodium excretion and increased ileal potassium losses occurs, which maintains a normal plasma sodium concentration. Importantly, this renal response may lead to hypovolemia in ileostomates who are already at risk for dehydration because of fixed salt and water losses. The mechanism for this response is unknown but may be related to changes in the secretion of arginine vasopressin. However, previous studies have failed to show significant changes arginine vasopressin levels in plasma [16,17]. Sutters et al. [18] have shown that diuresis from sodium restriction in ileostomy patients is blunted with synthetic vasopressin administration without affecting renal sodium losses or the composition of ileal effluents.

The normal amount of sodium lost in the ileostomy effluent is approximately 60 mEq daily, as compared to 2 to 10 mEq lost in the stool daily in a normal individual. Stomal sodium losses average 1 mEq/hr in the fasting state but increase to 3–4 mEq/hr postprandially. However, symptomatic salt depletion in well-established ileostomates is rare. Instead, urine output and sodium excretion are decreased because of enhanced renal conservation of salt and water [19]. Hill [2] showed that, despite adaptation, a decreased amount of total body water and exchangeable sodium exists in ileostomy patients compared to healthy persons. This obligatory ileal sodium loss is normally overcome with a standard diet. Importantly, however, the onset of volume depletion is rapid in patients who develop high ileostomy outputs for any reason.

The terminal ileum is an important region for water and sodium resorption, and the extent of small bowel resection directly effects the ileostomy adaptation process. Ileostomy output is susceptible to the loss of as little as 9 cm of terminal ileum, and salt and water absorption are progressively impaired as the extent of resection increases [20]. In patients who have undergone ileal resection, ileostomy outputs and electrolyte losses are higher early postoperatively as compared with those in patients with preservation of small bowel; furthermore, the volume and electrolyte composition are unchanged by 6 months [21]. In addition, losses of fat and nitrogen are higher following more extensive small bowel resection and can further influence water and electrolyte losses [22].

A proximally located loop ileostomy has an effect comparable to that of extended ileal resection. In performing the ileal pouch–anal anastomosis (IPAA), 50–100 cm of terminal ileum is often excluded from absorption by creating the diverting loop ileostomy. Patients have higher fecal outputs, which are more liquid in nature. Poor weight gain and episodes of dehydration cease once the loop ileostomy is closed.

Total body potassium depletion is rare in a patient with an uncomplicated ileostomy. Normal individuals and ileostomy patients lose about 9 mEq K⁺ each day, regardless of the magnitude of the output of feces or
ileostomy effluent \[23,24\]. A chronic state of salt depletion causes ileal potassium secretion to increase in exchange for maximizing ileal sodium absorption. Excess potassium and total-body nitrogen losses reflect extensive small bowel resection. The mature ileostomy excretes approximately 1.5 g of nitrogen daily. Cooper et al. \[25\] found patients to have a normal body weight, with normal fat and water content, if the ileal resection was limited to 4 cm. This was associated with reduced total body nitrogen and potassium, implying a decreased fat-free body mass. In patients with more than 50 cm of ileum resected, total body weight was reduced due to decreased total fat content.

Losses of calcium and magnesium are unaffected unless extensive ileal resection has been performed. In this instance, malabsorption of dietary calcium is compounded by abnormal bile salt and vitamin D metabolism from terminal ileal resection.

**Intestinal Transit**

Patients with an ileostomy adapt to the loss of their colon by slowing their small bowel transit time. Soper et al. \[26\] studied the orostomal transit time in ileostomy patients (Table 1). Using a dual radioisotope technique, they demonstrated that the gastric emptying of liquids in patients with ileostomies was not altered. However, orostomal transit time was significantly longer in ileostomy patients compared to controls (348 min vs. 243 min, respectively, \(P < 0.01\)). These observations confirmed the conclusion of a previous study, which found that proctocolectomy and ileostomy slowed small bowel transit \[27\]. A recent study by Bruewer et al. \[28\], employing a lactulose breath test, likewise showed that oropouch transit is prolonged following proctocolectomy with IPAA. The authors found that the adapta-

<table>
<thead>
<tr>
<th>Parameter (min)</th>
<th>Control ((n = 8))</th>
<th>Ileostomy ((n = 5))</th>
<th>(p) value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gastric emptying(^a)</td>
<td>120 ± 22</td>
<td>109 ± 10</td>
<td>NS</td>
</tr>
<tr>
<td>Small bowel transit(^b)</td>
<td>243 ± 32</td>
<td>348 ± 12</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

\(^a\)T\(_{3/4}\) of gastric emptying of a liquid marker.

\(^b\)Interval to reaching cecum in controls and ileostomy bag in ileostomy subjects.

tion process takes longer than a year and that the initial oropouch transit times in the early postoperative period were significantly accelerated.

The mechanisms behind this adaptive response of the small bowel following colectomy remain unclear but may be related to epithelial hypertrrophy, resulting in an increased absorptive surface [29,30]. Furthermore, an inverse relationship between electrolyte and nutrient absorption and intestinal transit has been demonstrated [31].

**Bacteriological Environment**

The bacterial flora of the ileum after ileostomy is intermediate in nature between small intestinal and colonic. Gorbach et al. [32] found an 80-fold increase in organisms in the terminal ileum; furthermore, coliforms were 2500 times more common than in normal ileal fluid. Overall, the ileostomy effluent bacterial count was still considerably less than that of normal feces. Staphylococci, streptococci, and fungi were increased in number, while *Bacteroides fragilis* was rarely found in the ileostomy effluent.

**Systemic Effects**

Urinary stone formation is a widely recognized complication of inflammatory bowel diseases, particularly in association with ileal resection. The reported incidence is 3–13% and is related to dehydration and excess sodium losses experienced by patients with ileostomies. The incidence of stone formation in the general population is approximately 4% [33]. Uric acid stones usually make up less than 10% of all stones but 60% of all stones found in patients with ileostomies [34]. Christie et al. [35] found ileostomy and IPAA patients to have a significantly lowered urinary volume and pH, with increased concentrations of calcium and oxalate. Patients with ileostomies were at increased risk for forming uric acid and calcium stones, while those with IPAA showed only a propensity to form uric acid stones. High-output ileostomies and extensive ileal resection predispose patients to stone formation. The etiology is likely related to the reduced urinary volume and pH facilitating stone precipitation. Prophylaxis is directed toward increasing daily fluid intake and urine output.

The association between ileostomy construction and increased gallstone formation is controversial. Well-adapted patients excrete bile acids in amounts similar to those excreted by a person with an intact colon [36,37]. However, with extensive terminal ileal resection or inflammation, the enterohepatic circulation is disrupted. Subsequently, bile acid malabsorption or depletion alters the saturation of bile, promoting precipitation and stone formation. Ritchie [38] found no difference in the number of ileostomy patients who required cholecystectomy compared to those without ileostomies. However, Kurchin et al. [39] urged consideration of prophylactic cho-
lecystectomy in female patients undergoing proctocolectomy or small intestinal resection for inflammatory bowel disease because of a threefold increase in asymptomatic gallstones in women receiving ileostomies. At Mayo, prophylactic cholecystectomy is rarely performed. If, during laparotomy, gallstones are discovered and the remainder of the operation has gone smoothly, cholecystectomy is usually performed.

**KOCK POUCH**

**Continent Ileostomy Output**

The majority of Kock patients appear to have no major long-term physiologic sequelae. The physiological consequences of creating a continent ileostomy have been well described. The initial postoperative fecal output is approximately 1500 mL/day. By 6 months, the volume is between 400 and 600 mL/day. Well-established continent reservoirs and conventional ileostomies have similar stool volumes [40]. However, unlike the conventional ileostomy, the continent reservoir accommodates to increasing intraluminal volume passively, like the rectum. At the time of operation, the reservoir typically can accommodate a volume of 70–100 mL. At a month’s time, the volume is approximately 200 mL, and it increases steadily to a maximum of around 600 mL at 6 months. The fecal volume may increase to over 1000 mL/day if undue small bowel is sacrificed at the time of operation and in the presence of recurrent Crohn’s disease or pouchitis [41].

**Bacteriological Environment**

The ileal reservoir luminal flora changes to resemble colonic bacteria in both quantity and the ratio of anaerobic to aerobic bacteria [40,42]. The contents of the Kock pouch are more fecal than those of the conventional ileostomy. These changes are noted soon after creation of the pouch and presumably occur because of the pouch. Subsequently, increased bacterial flora then competes with the host for nutrients, bile acids, and vitamin B₁₂ for substrate. However, bacterial overgrowth tends not to be a significant clinical problem. Increased anaerobic bacteria in the pouch have been implicated as an etiology of pouchitis because of its common response to metronidazole therapy. Data from this institution have not confirmed a correlation between stomal microbial effluent and pouch dysfunction, although it certainly remains a likely component of a multifactorial etiology [42,43].

The bacterial counts in the proximal small bowel also increase in patients with a continent ileostomy. Qualitatively, the flora is similar to that of the normal jejunum. Kelly et al. [42] postulated that decreased jejunal motility and impaired clearance of swallowed bacteria are plausible explanations for this finding.
Histological Alterations

Histologically, the small intestinal villi in the pouch become blunted and undergo a metaplastic response to resemble colonic epithelium [40,44]. The number of crypt cells and mucosal volume increase while the neuroendocrine cell population is unaltered. These changes occur within the first year of reservoir construction but stabilize by 6–10 years postoperatively [45]. The metaplastic changes are not necessarily permanent and may normalize back to small intestinal villi with time. The etiology of the altered mucosa is unknown but may be related to prolonged exposure to bacterial metabolites and toxins from fecal stasis in the pouch. However, oxidative enzymatic and secretory activities appear unaltered by the morphological changes [45]. Furthermore, structural changes in the ileal mucosa are not correlated with pouch dysfunction [42,43]. The long-term effects of these changes are uncertain, but in isolated cases, progression of pouch dysplasia to invasive carcinoma have been reported in both a Kock pouch and an IPAA [46,47].

Metabolic Effects

The metabolic consequences of constructing a continent ileostomy are minor despite the altered histology and bacterial environment in the pouch. The absorptive pattern of the continent ileostomy is similar to that of the conventional ileostomy. Absorption of fat, water, xylose, and phenylalanine as well as bicarbonate secretion are not different from what is seen with standard ileostomies [48]. Mucosal transport of sodium, chloride, and water within the reservoir is also unaltered despite large concentration gradients [49]. Total body water and urinary excretion of sodium and potassium are also similar. Furthermore, Ojerskog et al. [50] found no evidence of potassium or water depletion in conventional ileostomy patients who underwent conversion to a continent pouch. The pH of the reservoir contents is less than that of the conventional ileostomy, presumably due to increased bacterial fermentation of polysaccharides and production of short-chain fatty acids within the reservoir [51].

Bile acid excretion is not different from that associated with conventional ileostomies (Table 2) [48,52]. Normal daily fecal bile acid loss is approximately 200 mg or 5% of the bile acid pool. Bile acid depletion of up to 20% is balanced by enhanced hepatic synthesis. Hence, disruption of the enterohepatic circulation is uncommon unless bacterial overgrowth or extended ileal resection is present. Hylander et al. [53] reported that bile acid deconjugation may occur in the reservoir; however, this is disputed by others [49,51]. Furthermore, the incidence of cholelithiasis is similar with a continent or conventional stoma [54]. With preservation of the bile acid pool, the ability to absorb fat is retained in most patients with continent ileostomies (Table 3).
Table 2  Daily Fecal Bile Acid Excretion After Proctocolectomy

<table>
<thead>
<tr>
<th>Surgical procedure</th>
<th>n</th>
<th>Acid loss</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brooke ileostomy</td>
<td>16</td>
<td>150–300</td>
<td>Some had ileal resection [19]</td>
</tr>
<tr>
<td>Brooke ileostomy</td>
<td>10</td>
<td>235–1070</td>
<td>Some had ileal resection [20]</td>
</tr>
<tr>
<td>Brooke ileostomy</td>
<td>5</td>
<td>mean 400</td>
<td>mg/kg/day [32]</td>
</tr>
<tr>
<td>Continent ileostomy</td>
<td>5</td>
<td>mean 550</td>
<td>mg/kg/day [32]</td>
</tr>
<tr>
<td>Continent ileostomy</td>
<td>5</td>
<td>mean 1400</td>
<td>With ileal resection [32]</td>
</tr>
<tr>
<td>Health controls</td>
<td></td>
<td>≤500</td>
<td></td>
</tr>
</tbody>
</table>


Abnormal and borderline Schilling tests have been reported in patients with a continent ileostomy [48,49]. However, vitamin B$_{12}$ absorption is generally unimpaired, and any defect in this absorption is often transient. Furthermore, serum plasma levels of vitamin B$_{12}$ tend to be normal. Active absorption of vitamin B$_{12}$ and intrinsic factor has been demonstrated by instillation of the complex into the reservoir of patients with intact ileal segments [49]. Gadacz et al. [49] postulated that the prolonged contact time between the intestinal contents and the ileal mucosa may enhance vitamin B$_{12}$ absorption. Thus construction of a Kock pouch does not predispose the patient to vitamin B$_{12}$ malabsorption unless the terminal ileum has been removed.

Schjonsby et al. [55] found increased concentrations of *Bacteroides* in the continent ileostomy effluent, compared to conventional ileostomy, to be associated with vitamin B$_{12}$ malabsorption. These patients with “stagnant

Table 3  Fecal Weight and Excretion of Fat After Proctocolectomy

<table>
<thead>
<tr>
<th>Surgical procedures</th>
<th>n</th>
<th>Fecal weight (g/24 hr)</th>
<th>Fecal fat (g/24 hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent results</td>
<td>29</td>
<td>616 ± 27</td>
<td>4.6 ± 0.5</td>
</tr>
<tr>
<td>Diarrhea/pouchitis</td>
<td>13</td>
<td>1405 ± 57</td>
<td>9.6 ± 2.1</td>
</tr>
<tr>
<td>Brooke ileostomy [24]</td>
<td>19</td>
<td>651 ± 44</td>
<td>3.4 ± 0.4</td>
</tr>
<tr>
<td>Health</td>
<td></td>
<td>≤250</td>
<td>≤7.0</td>
</tr>
</tbody>
</table>

loop syndrome” received oral lincomycin and had improvement of vitamin 
B$_{12}$ absorption, decreased fecal fat excretion, and decreased concentrations 
of ileal Bacteroides.

** Continent Ileostomy Motility**

Kock designed the continent ileal reservoir in such a way that the motor 
activity within its different parts might offset themselves [56]. Subse-
sequently, patterns of small bowel motility within the pouch have been further 
studied [57]. Small intraluminal pressure waves (amplitude < 10 cmH$_2$O; 
frequency 5–7 min) constituted the basal motor activity; which was similar 
to the normal terminal ileal motor pattern. However, with distention of the 
pouch to > 60% of its maximum capacity, high-pressure waves (HPW; am-
plitude > 25 cmH$_2$O; frequency 1 every 3 min) were superimposed on the 
basal motor pattern. These waves were associated with fullness and discom-
fort. The authors concluded that the ileum is able to accommodate large 
intraluminal volumes with only small incremental increases in intraluminal 
pressure.

** COLOSTOMY**

** General**

Approximately 1500–2000 mL of fluid and 120 mEq of sodium are passed 
daily from the ileum to the colon. The colon secretes little fluid to add to 
this volume; rather, the colon stores the fecal content and slowly propels 
the stool in a caudad direction for eventual evacuation. During the passage 
of stool from the right to the left colon, absorption is so efficient that less 
than 200 mL of water and 25 mEq of sodium are expelled daily in the 
feces. To a lesser extent, the colon absorbs bile acids not absorbed in the 
terminal ileum. However, ileal resection predisposes the patient to exces-
sive colonic bile acids, which promote secretion of water and electrolytes.

When a colostomy first begins to function, the output is liquid. The 
liquid steadily increases in volume and is expelled on an irregular basis. 
After 10–14 days the consistency of the effluent becomes quite viscous. 
Slowly, a pattern of stool evacuation develops and the stool is expelled on 
a more predictable basis.

In general, the diet of a patient with a colostomy should be unrestric-
ted. The patient soon recognizes specific foods that increase stomal output 
or flatulence. As in the case of an ileostomy, high-fiber foods increase fecal 
weight. If sufficient colonic absorptive surface is preserved proximal to the 
colostomy, dehydration and electrolyte disturbances are rarely matters of 
concern.

Medications introduced through the stoma are readily absorbed. The 
exceptions are enteric-coated or time-release formulas, which may be ex-
peled before adequate absorption has occurred. This situation is more of a problem with proximal colostomies, in which excretion is common.

**Proximal Colostomy**

Ileal content that enters the right colon is predominately liquid. The right colon is important for mixing the ileal effluent to facilitate water and electrolyte absorption through uniform exposure of the luminal contents to the mucosal surface. The cecum and the ascending colon store and knead the luminal contents through a series of antiperistaltic annular contractions. The proximal colon is the origin of giant migrating contractions responsible for mass movements of luminal contents distally [58]. Constructing an ascending or proximal transverse colostomy interferes with the storage and mixing of stool and reduces the absorptive capacity of the colon. Hence the output from these stomas is a high-volume liquid effluent with a high sodium concentration. Fecal material is expelled from a right-sided colostomy on a frequent and irregular basis, which allows little or no planned control of stomal output. For these and other reasons, right-sided colostomies should be avoided whenever possible.

**Middle Colostomy**

The midcolon is responsible for transit and absorption of the luminal contents. The motor activity is characterized by annular contractions that divide the fecal mass and propel it distally and proximally in a to-and-fro fashion. The construction of a distal transverse or descending colostomy increases the length of absorptive surface and allows enhanced colonic mixing of the fecal material. Sodium is actively absorbed, thereby generating osmotic gradients that facilitate passive absorption of water. Hence the effluent from distal transverse and descending colostomies is lower in volume and less liquid than that from proximal colostomies (Fig. 1).

**Distal Colostomy**

The distal colon functions primarily as a storage area for fecal material until willful defecation occurs at an appropriate time. Infrequent strong contractions in the distal colon, which are occasionally sensed by the patient, facilitate caudal propagation of fecal material [58]. The consistency of the fecal matter reaching the distal colon is ordinarily semisolid to solid in nature. After construction of an end-sigmoid colostomy, the colonic contents, composed of unabsorbed food products and bacteria, are expelled, usually no more than once or twice a day. Hence regulation of stool elimination from a distal colostomy through the use of irrigation techniques is often possible. Irrigation initiates colonic distention, which stimulates colonic peristalsis and mass contractions and thus facilitates stool evacuation [59].
Fecal volumes in a sigmoid colostomy approximate the losses from an intact colon. Like the small intestine, the colon adapts to increased fluid losses from the gastrointestinal tract via aldosterone-mediated fluid and sodium resorption by the colonic epithelium [60]. Thus fluid and metabolite homeostasis is facilitated by preservation of the colon proximal to the colostomy, with active participation of the colon in the correction of volume and salt depletion.

**CONCLUSION**

The small intestine and colon are critical organs that play a central role in maintaining fluid and electrolyte homeostasis. Nearly all patients adapt to the physiological changes caused by the creation of an intestinal stoma provided that there is sufficient healthy proximal intestine. Metabolic disturbances in patients with stomas are often subtle and develop gradually. Careful attention to fluid and electrolyte balance is therefore necessary to preclude complications related to intestinal diversion. Nonetheless, the metabolic consequences of creating an intestinal stoma are minor and, by themselves, rarely alter the patient’s lifestyle dramatically.

**SUGGESTED READINGS**

Hill GL. Ileostomy: Surgery, Physiology and Management. New York: Grune and Stratton, 1976. This comprehensive review of the original physiological studies of conventional ileostomies is a required reference for stomal physiology.


**REFERENCES**


Preoperative Considerations

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INTRODUCTION

One goal of any surgical procedure is to improve the patient’s quality of life. In cases where the operation will include the creation of an ostomy, the resultant quality of life will depend not only on successful treatment of the underlying disease but also on the patient’s adaptation to the stoma. Such success will be determined in part by the patient’s ability to manage a stoma in a way that will allow a return to the lifestyle the patient enjoyed prior to his or her illness. Factors that will influence this ability include a stoma that is free from leakage and skin problems and can easily be visualized and cared for in an independent manner. The time spent by the surgeon with such a patient in the preoperative period can have a significant impact on the ability to achieve these results and on the ultimate success or failure of the quality-of-life goal.

There are a number of issues that must be recognized as determinants of success or failure. These include an understanding of the patient’s attitude toward an ostomy—including fears, misunderstandings, and actual misinformation; anatomic considerations; and special considerations related to other health problems or physical disabilities.

PATIENT ATTITUDES

It is not inappropriate to assume that most patients have the attitude that “it is better to be dead than to live with a stoma.” Therefore, education and counseling become critical first steps in the process, beginning with listening to the patient to learn what his or her fears and questions may be.

Most patients, unless they have a family member or close friend with a stoma, do not even know what one looks like. Having literature or educational videos available that can demonstrate the appearance of a stoma can
be very helpful. In addition, having a list of ostomy patients who are willing to visit with new patients can go a long way in alleviating fear. In most centers, the United Ostomy Association (www.uoa.org) has volunteers who can fulfill this function. A visit from an ostomy patient of a like age and gender can be particularly reassuring.

Many questions will frequently arise if the physician is interested enough to listen. Does it hurt? What does an appliance look like? How does an appliance stay on and how often will I have to change it? What will I do about sexual relations? How will I be able to swim or shower or take a bath? Will I still be able to participate in sports? Will I have to wear special clothing? These and many other questions are commonplace. While the physician may be able to address many of these questions, time constraints will likely limit his or her ability to do them justice in the eyes of the patient. If at all possible, an enterostomal therapist (ET nurse) or a wound, ostomy, and continence care nurse (WOC) should also play a role. Such specialists will not only be able to answer the patient’s questions but can also show him or her some of the many appliances available and even allow the patient to try them on preoperatively.

The ET or WOC nurse will frequently provide important counseling functions to the patient. He or she can reinforce the surgeon’s discussion of the risks and potential benefits of ostomy surgery. Depending on the indication for the surgery, this may include potentially curative treatment for cancer, protection from infectious processes, or improved quality of life. The nurse can also reinforce the surgeon’s discussion of the risks, so as to ensure complete understanding and an informed consent. Potential complications—including bladder and sexual dysfunction, peristomal skin problems, parastomal herniation, and stomal prolapse—need to be thoroughly understood if true informed consent is to be obtained. Such counseling represents an important step toward ensuring the achievement of quality-of-life goals and decreasing complications following stoma surgery [1,2].

**ANATOMICAL CONSIDERATIONS**

Anatomy becomes important when it is time to select the site for a stoma. The marking of a stoma site is best done in the preoperative period, when the patient is able to change positions and demonstrate his or her ability to visualize and work with the site. A site that cannot be visualized by the patient is doomed to failure if the patient intends to remain independent in stoma care. Careful consideration must be given to all of the usual landmarks, including the costal margins, umbilicus, waistline, and groins. In addition, scars from previous operations and skinfolds must be identified and their potential impact on stoma function recognized.

There are several primary anatomical characteristics that should be identified in selecting the placement of a stoma on the abdominal wall.
Preoperative Considerations

These include a 5- to 7-cm area of skin that remains relatively flat, regardless of patient position, through which the stoma can be placed. In addition, the location of the rectus muscle, especially its lateral border, must be identified. Finally, a site that can be visualized by the patient and, if possible, a site that rests below the belt line should be sought. Generally this site sits within the “ostomy triangle,” which is bordered by the umbilicus, the anterosuperior iliac spine, and the pubic symphysis (Fig. 1).

The process of marking a site should begin with the patient supine. Having the patient raise his or her head and/or cough can help identify the lateral borders of the rectus. When identified, these borders should be marked. The patient should then be asked to sit on the edge of the table. The infraumbilical fat pad should be identified, along with any creases, deep wrinkles, or irregular contours. The patient should then lean over to further accentuate any creases that might interfere with the integrity of the

Figure 1  When a stoma site is being chosen, scars, bony prominences, and the umbilicus must be avoided. (Modified from Corman ML. Colon and Rectal Surgery, 3rd ed. Philadelphia: Lippincott, 1993:939.)
pouching system. A flat space matching the desired area of 5 to 7 cm across should then be sought near the apex of the infraumbilical fat pad. Historically, it has been felt that a site within the marked borders of the rectus muscle should then be selected to reduce the risk of parastomal herniation [3]. However, recent evidence has questioned the value of this surgical dogma, with at least one report suggesting that the rectus abdominis is not protective [4]. Nevertheless, most surgeons will still place a stoma through the rectus and site the stoma no closer than 5 cm to any bony prominence or fold, crease, or scar.

Once such a space is identified, the ability of the patient to view it must be confirmed. The patient should then stand and the examination be repeated to confirm the absence of any creases that could interfere with the appliance’s integrity. The patient should be asked to confirm that he or she can touch and see the site while standing and lying down.

Selecting a site below the belt line allows greater flexibility in clothing selection. Tighter clothing may be worn with confidence and will help to conceal the pouching system. In addition, underclothing can help to support the weight of the appliance. If the stoma ends up being above the belt line, clothing choices may be somewhat more limited. It may be necessary to wear loose clothing to conceal the appliance more fully.

After the site has been chosen and its accessibility confirmed, it is marked. This can be accomplished with an India ink tattoo, and indelible marker, or subcutaneous injection of methylene blue. Once the patient is asleep and in the operating room, the site should be scratched with a needle to make sure that the site will not be lost during the skin preparation process.

**SPECIAL CONSIDERATIONS**

**Physical Disabilities**

Patients who are incapable of caring for their own stomas do not need to have a site that they can visualize or touch. In such cases it is more important to ensure that placement is done to facilitate the caregiver’s needs in managing the stoma. This might mean a higher or lower stoma site than would otherwise be selected.

For patients confined to a wheelchair, it is essential that the selection and marking of a stoma site be done while they are in their chairs. Frequently, these patients will require a higher stoma placement than would otherwise be used in order to better visualize and manage the stoma while the patient is in a sitting position.

Patients with physical conditions that require them to wear a brace or other device for back support or other musculoskeletal problems should have a stoma site selected with the brace in place. This will obviate problems from later impingement of the brace on the stoma, with subsequent risk of stoma injury.
Other Health Problems

Patients with portal hypertension are at increased risk of developing para-stomal varices. Alternatives to stoma surgery should be considered in these patients. Patients with chronic ulcerative colitis and primary sclerosing cholangitis who are scheduled for colectomy should consider an ileoanal pouch or ileorectal anastomosis, since there have not been reports of perianastomotic bleeding in these patients, while over 50% of these patients who have stomas will develop stomal variceal bleeding [5].

With cancer patients who have a history of radiation or who are candidates for radiation, care should be taken to avoid placing stomas within the radiation field. Mucositis and severe skin complications can occur in both the acute and chronic settings. Ostomy sites, which are placed within a radiated field based on standard selection criteria, should be modified to fall out of the radiated field by being placed higher on the abdominal wall.

In severely obese patients, visualization of a stoma located below the umbilicus may not be possible when the patient is standing or lying down. High stoma placement may be necessary in such patients. High placement may be advantageous in these patients for another reason: since the abdominal wall is usually much thinner high above the umbilicus, it may be much easier to deliver a satisfactory length of bowel through the abdominal wall and thus to fashion a stoma with a satisfactory profile.

Some patients require more than one stoma. In cancer patients undergoing pelvic exenteration, both a urostomy and fecal diversion are necessary. Keeping the two stomas at differing levels will avoid potential problems with pouching belts, one of which could cause injury to the complementary stoma. It is generally preferred to have the urostomy as the highest stoma. In addition, the two stomas should be located on opposite sides of the abdomen (Fig. 2).

Although the right and left lower quadrants are the ideal sites for ileostomies and colostomies, respectively, these sites will not always be available. Prior stoma surgery, multiple surgical scars, nonhealing skin lesions, obesity, and other factors may make alternative siting necessary. In these difficult circumstances, preoperative marking becomes even more important. Alternate sites include the left and right upper quadrants, the umbilicus, the midline above and below the umbilicus (particularly useful in infants), and even the left and right lumbar areas (choices of last resort) (Fig. 3).

In selecting an alternate site, the general principles are followed as closely as possible. The stoma should pass through the rectus muscle (or the linea alba in the case of midline stomas). It should be positioned 6 cm away from the costal margin or iliac crest, and it should be placed to avoid prior scars or other stoma sites. Occasionally, a stoma may be brought through the surgical wound, but only when no other viable option exists. Such placement increases the chance of hernia formation and makes appli-
Urostomy and colostomy sited on the abdominal wall. The urostomy is to the right of the midline and slightly higher.

cation of the pouch very difficult. After a stoma site has been selected, the patient should wear an ostomy management system for 24 to 28 hr preoperatively to assess the acceptability of its position.

**Miscellaneous Situations**

A patient’s employment should always be noted. In some instances, modification of the siting may be necessary. For instance, a carpenter may wear a tool belt. Depending on where it is worn in relation to the belt line, it may be necessary to modify the site to above or below the belt line to accommodate the tools and prevent trauma to the stoma. In a similar fashion, a police officer may need to modify a stoma site in order to accommodate a gun holster.

Finally, there is the special situation that will occasionally occur despite our best efforts to avoid it. That is the need to select a stoma site
intraoperatively because unexpected findings are encountered at time of operation. Unfortunately the best one can do in this situation is to follow all of the guidelines previously outlined. These include maintaining a distance of at least 5 cm from any bony prominence or other surface defect, including scars, creases, and wrinkles. The ostomy should be brought through the rectus muscle. Planned open wounds should be kept at least 5 cm from the stoma if at all possible. Identification of the infraumbilical fat pad should be done to the best of one’s ability and the stoma placed slightly cephalad in order to ensure good patient visualization. If no landmarks are available to guide placement in the lower quadrants, it may be best to utilize the upper quadrants.

CONCLUSIONS

The best way to achieve success in maximizing quality of life following stoma surgery is to adequately prepare the patient preoperatively. An appropriate approach to this problem includes counseling patients in realistic expectations, correcting misconceptions and myths, properly siting the stoma to minimize complications related to appliance disruption and leakage, and providing adequate support postoperatively. Proper siting is done in the preoperative setting, taking care to assess the abdominal wall in the supine,
sitting, and standing positions. Proper identification of an adequate area of flat, smooth skin unencumbered by creases, wrinkles, or a bony prominence is critical. The development of the stoma within the confines of the rectus abdominis muscle remains the preference of most surgeons. The few minutes necessary to achieve these goals may prevent years of impaired quality of life and complications often associated with a poorly located stoma.

REFERENCES

INTRODUCTION

Optimum care of a patient with stoma is achieved through active participation of both the surgeon and the enterostomal therapy (ET) nurse. This participation should begin in the preoperative period with physical examination and preoperative preparation of the patient.

The ET nurse who provides ostomy care should determine from the surgeon and staff nurse what information has been communicated to the patient and family and their level of understanding. This knowledge provides the basis for anticipatory care.

In addition, the patient needs counseling and psychological preparation for surgery. The surgeon should not abdicate responsibility in this area, because such preparation can influence the patient’s outcome appreciably.

The most common problems that may occur are related to placement of the stoma and parastomal sepsis. Incorrect placement of the stoma predisposes the patient to problems that cannot be managed conservatively (i.e., with a change in equipment). Although correct siting of the stoma is a fundamental consideration, it is often ignored or forgotten in the myriad of things that need to be accomplished in preparation for surgery. Discussion of the patient’s concerns about activity, odor, diet, employment, and intimacy are topics that are commonly addressed during preoperative preparation.

The objective of stoma construction is to provide an anatomically stable opening allowing placement of an ostomy management system that will maintain a seal of stool and gas for 4–7 days. If every abdomen were flat, muscular, and unscarred, placement of the stoma would not be a major problem. In reality, many patients have a protuberant abdomen and lax musculature. Often they have incision lines that were placed in different directions and have created creases and weak muscles from neurovascular interruption. Under these circumstances the time taken to plan the site for
Siting of the stoma is done with the patient awake. An ostomy management system or a specially prepared disk of the same dimensions as the system is used. The patient is positioned in various ways—supine, sitting, and bending. When the optimum site has been determined, the skin is tattooed with a 27-gauge sterile needle and India ink so that, when the abdomen is opened and the anatomic relationships are distorted, the chosen site will not be mistaken. The stoma must be constructed so that it is visible to the patient (i.e., not located on the inferior surface of the pendulous abdomen) (Fig. 1). The stoma should be located away from the umbilicus, skin creases, scars, and bony prominences. Areas of skin damaged by irradiation or skin grafts also should be avoided.

In the immediate postoperative period, a pectin skin barrier is used for end stomas. A karaya washer is used for loop stomas because, when the karaya reaches body temperature, it molds itself over the rod and creates a seal. A temporary ostomy pouch is used until the rod has been removed. When the rod is removed, the patient is fitted with an ostomy management system and given instructions on care of the stoma and the equipment. The patient must be competent and comfortable with care of the stoma before
hospital discharge, because deficiencies in care can have serious psychological and physical consequences for the patient. Follow-up in the clinic usually takes place 1 month after discharge, so that the situation can be assessed and the stoma can be remeasured as postoperative edema resolves. If necessary, self-care instruction can be continued by a home care ET nurse.

Since construction of a stoma creates an abnormal anatomical situation, complications may occur. However, such complications can be minimized through the surgeon’s understanding of physiology and correct construction of the stoma.

**GASTROINTESTINAL FUNCTION**

**Jejunostomy**

Jejunostomy function usually begins within the first 48 hr after surgery. Initially the effluent is watery, clear, and dark green. Because the volume of output may approach 2400 mL in 24 hr, the patient should be monitored closely for signs of electrolyte imbalance. Absorption capacity depends on the length and functioning of the proximal bowel. Absorption of nutrients, fluids, and electrolytes may be deficient in the patient with a jejunostomy.

**Ileostomy**

An ileostomy generally begins to function within the first 48–72 hr after surgery. The initial effluent is viscous, green, and shiny. An ileostomy created via a laparoscopic approach may begin to function within 24 hr. Such output does not necessarily indicate return of peristalsis; rather, it may represent the elimination of secretions that have collected in the distal small bowel. Once peristalsis has returned, the patient may enter a period of high-volume output known as the adaptation phase. Output during this period exceeds 1000 mL/day and frequently reaches 1500 to 1800 mL/day. The physiological basis for this high-output phase is loss of the colon’s absorptive surface coupled with loss of the ileocecal valve. During this period the patient must be monitored closely for signs and symptoms of fluid and electrolyte imbalance. Replacement therapy, which is necessary at this time, can be managed via the intravenous route or with oral electrolyte replacement solutions, depending on the status of bowel function.

Over a period of days to weeks, the proximal small bowel increases fluid absorption and the bowel adapts; gradually the volume of output decreases and the stool thickens to a toothpaste-like consistency and is light to medium brown. Initially the output from an ileostomy can vary from 500 to 1500 mL in a 24-hr period. After adaptation, the average output decreases to between 500 and 800 mL daily.
Colostomy
The initial output from a colostomy varies, depending on the location of the stoma within the colon. Because the colon absorbs all but approximately 100 mL of the 1000 mL of contents that passes through the ileocecal valve daily, the output from distal colonic stomas has a thicker consistency and smaller volume than that of proximal colonic stomas.

Cecostomy
This stoma usually begins to function by postoperative day 3. The output may be projectile (because of the close proximity of the ileocecal valve) and initially is liquid. A cecostomy can be either at skin level or tubal. The location, output characteristics, and construction combine to make this a difficult stoma to manage. The tube cecostomy poses a particularly difficult management problem because stool tends to flow both through and around the tube. Tube cecostomies also are associated with a greater risk of intra-abdominal spillage.

Transverse Colostomy
A transverse colostomy usually begins to function on postoperative day 3 or 4. Output, which varies from pasty to soft, usually occurs after meals and at intervals throughout the day. In a loop transverse colostomy, a support device (e.g., rod or bridge) placed during surgery is removed 5–7 days later. The alternative is to construct a fascial bridge at the time of surgery, which obviates the need for a stomal support device.

Descending or Sigmoid Colostomy
A descending sigmoid colostomy takes the longest time to regain normal peristalsis and may not begin to function until postoperative day 5. Patients with active bowel sounds who have not passed flatus or stool by postoperative day 5 should be assessed for factors that would contribute to the delay in return of function (e.g., administration of narcotics). To stimulate function, a 20F soft Foley catheter is well lubricated and then gently advanced into the stoma. A warmed solution of 500 mL of normal saline is instilled via gravity drainage and allowed to return. This procedure initiates a reflex contraction, provides relief of gaseous distention, and maintains peristalsis.

Once normal function has returned, the output from a descending or sigmoid colostomy usually is soft-formed stool. Elimination patterns are generally similar to those of the preoperative period.

The amount and consistency of stool from any gastrointestinal stoma is influenced by the amount of bowel resected, the length and condition of the proximal bowel, medications, and diet. Over a period of several months, the remaining bowel increases its absorptive capacity and the effluent decreases in volume and becomes thicker.
POUCHING SYSTEM PROCEDURES

General issues that must be considered in establishing pouching system procedures include the following: organizational matters, timing of pouch change, frequency of pouch change, and sizing of the pouch or barrier opening.

Organization of Materials

It is helpful to organize all the products required for the pouch changing procedure in one area and to assemble all necessary supplies before the procedure is begun. Necessary supplies include a plastic trash bag (for disposing of soiled items), a wet washcloth or disposable wipes, the pouch itself, and any products for skin protection (e.g., skin barrier powder, sealants, or paste). When a cut-to-fit pouch is used, a measuring guide or pattern, pencil, and scissors are also needed. If hair is present in the peristomal area, an electric or disposable razor may be required. When a pouch is to be applied to a urinary stoma or a high-output fecal stoma, it is advisable to have an ample supply of absorbent materials, such as soft paper towels, nonsterile gauze, tampons, or dental wicks.

Timing of Pouch Change

Optimally, the pouch is changed when the stoma is not highly active. A fecal stoma is usually most active within 2 hr of a meal. For a urinary stoma, the best time for a pouch change is usually early in the morning, before fluid consumption. Each patient learns his or her own best time for pouch changes.

Frequency of Pouch Change

There is no “correct” frequency for pouch changes. The goal is to establish a routine schedule that prevents leakage and provides the individual with control. The stoma that is appropriately sited and well constructed can usually be managed with a pouch change frequency of every 4–7 days. With more durable products, some individuals can maintain secure seals for 10 days or even longer. Most clinicians recommend at least a weekly change to inspect the peristomal skin and prevent irritation. In contrast, with a poorly sited or retracted stoma, a twice-weekly pouch change may be required to prevent leakage; occasionally daily or alternate-day changes may be required.

Establishment of the optimum frequency for pouch change requires individual adjustment and experimentation. In the immediate postoperative period, the pouch is changed more frequently than usual to permit stoma assessment and provide instruction in self-care procedures. After discharge, the patient should be encouraged to gradually extend the interval between pouch changes until optimum frequency can be determined. This frequency then becomes the basis for routine pouch changes. The patient is also taught
to recognize the signs of undermining and impending leakage (i.e., itching or burning of the peristomal skin, odor noted when the pouch is closed, or visible “meltdown” of the skin barrier) and to change the pouch promptly whenever any of these signs are present.

### Sizing of Pouch or Barrier Opening

Most manufacturers of ostomy supplies include disposable stoma-measuring guides in each box of pouches. These guides are used to determine the size of a round stoma. An opening that clears the stoma and minimizes exposure of the peristomal skin should be selected. For irregularly shaped stomas, it is necessary to make a pattern that can be used to size the barrier or pouch opening. One simple way to make a pattern is to use a transparent piece of plastic and a felt-tipped marker to trace the contours of the stoma. The pattern is then cut out and altered as necessary until a good fit has been obtained. The pattern should be labeled with arrows indicating “head” and “foot” and “pouch side” and “skin side.”

When a barrier is added to an adhesive pouch, the barrier is sized to fit closely around the stoma without impinging on the bowel mucosa; the pouch is sized to clear the stoma by at least 1/8 in. This method prevents the rigid pouch opening from causing damage to the stoma; in addition, it prevents tunneling of the effluent between the barrier and the pouch (see Table 1).

Because edema decreases during the first 6–8 weeks after surgery, the size of the stoma decreases and the opening of the ostomy device must be resized at each pouch change during this period. Once shrinkage is complete, further resizing is not necessary unless the stoma changes. The condition of a patient who is not able to measure the stoma or who has an irregularly shaped stoma must be followed closely during the first 6–8 weeks after surgery, either by a home care nurse or through follow-up at an outpatient clinic (Fig. 2).

### Use of Pouch with Urinary Stoma

Issues that must be addressed in regard to applying a pouch to a urinary stoma include peristomal skin protection, pouching options, and modifications required for applying a pouch to a stoma with stents in place. Use of an extended-wear barrier will help prevent undermining of the pouch seal and protect the peristomal skin.

### Peristomal Skin Protection

Urine contains no enzymes and is normally slightly acidic. Therefore skin damage from urine is usually caused by pooling of the urine on the peristomal skin, which results in maceration. Alkaline urine can damage the skin and cause encrustations and crystal deposits. Therefore skin protection for
Table 1  Application of One-Piece Fecal Pouch

1. Gather all supplies.
2. Gently remove soiled pouch by pushing down on skin while lifting up on pouch. Discard soiled pouch in odorproof plastic bag. Save tail closure.
3. Clean stoma and peristomal skin with water; pat dry. If indicated, shave or clip peristomal hair.
4. Use stoma-measuring guide or established pattern to determine size of stoma.
   *Presized pouch*: Check to be sure pouch opening is correct size. Order new supplies if indicated. *Cut-to-fit pouch*: Trace correctly sized pattern onto back of barrier or pouch surface and cut stomal opening to match pattern. Once stomal shrinkage is complete, this step may be omitted and preparation of the clean pouch may be completed before the soiled pouch is removed.
5. Apply skin barrier paste around stoma. *(Tip: wet finger to facilitate paste application.)* An alternative approach is to apply skin barrier paste to the aperture in the prepared pouch or barrier. Allow paste to dry. *Optional:* Apply skin sealant to skin that will be covered by tape. Allow to dry.
6. Remove paper backing from pouch or barrier to expose adhesive surface; center pouch opening over stoma and press into place. Attach closure. *Optional:* Apply tape strips to “picture frame” the pouch–skin junction.

*Universal precautions must be followed when this procedure is performed.*


the patient with a urinary diversion focuses on prevention of pooling and maintenance of acidic urine.

Pooling of urine is prevented by maintaining a tight seal between the skin and the pouch, so that urine flows into the pouch and is not trapped under the pouch adhesive. Pouches with antireflux valves prevent or limit backflow of urine toward the peristomal skin. (Most disposable pouches and selected reusable pouches are constructed with antireflux valves.) Skin sealants also reduce the potential for maceration of the peristomal skin, since they help to “waterproof” the skin.

Encrustations and crystal formation are prevented by maintaining an acidic and dilute urine.

**Pouch System Options**

In applying a pouch to a urinary stoma, two approaches can be taken: (1) a pouch with an attached skin barrier can be used (the skin barrier is sized to fit snugly around the stoma) or (2) an adhesive-only system with an antireflux valve can be used. In the latter approach, the pouch opening is sized to adhere to a flat abdominal surface, even if cutting of the pouch
Figure 2 When resizing of the barrier opening is necessary, the choice of a pouching system depends on the condition of the abdomen and the position of the stoma. This flowchart shows the possible choices when the abdomen is firm (A), soft (B), or very soft (C).
opening wide and exposure of the skin are required. Both approaches are
valid because the intent of each is to protect the skin from pooled urine.
Skin barriers are not always required, but their use may increase the wear-
ing time of the pouching system.

Pouches with barriers are sized to fit closely around the stoma because
the barriers are moldable and usually can adapt to peristomal contours. If
the stoma is protruding (budded) and the pouch is equipped with an antire-
flux valve, any barrier that adheres well to the peristomal skin is appro-
priate. For example, karaya and pectin barriers are known to break down
as a result of exposure to urine; however, they may be effective with a
budded stoma if the pouch is equipped with an antireflux valve (because
the urine projects into the pouch and backflow is limited by the antireflux
valve). With a flush or skin-level stoma, however, it is important to select
a barrier that is resistant to breakdown by urine. Urine from a flush stoma
constantly washes over the barrier, and a barrier that is not resistant to urine
quickly deteriorates. When a pouch with a barrier is being changed, the
barrier and the peristomal skin are assessed to ascertain that the barrier is
not absorbing the urine and causing peristomal maceration.

Some patients with urinary stomas obtain longer pouch seals and im-
proved skin protection by using adhesive-only pouching systems with a
“hydrophobic” barrier. In the application of an adhesive-only pouch with
an antireflux valve, the goal is to obtain a good seal between the pouch and
the peristomal skin in order to prevent pooling of urine. Adhesive surfaces
cannot adapt to changing peristomal contours. If they are applied over ir-
regular contours and deep creases, they may become partially detached and
allow pooling. The pouch opening should be sized to permit adherence to
a flat abdominal pouching surface. It must be emphasized that this approach
requires the use of a pouch with an antireflux valve; backflow of urine must
be prevented because the peristomal skin is exposed. The use of sealants or
cements usually is recommended to further protect the skin from macera-
tion (see Table 2).

**Control of Gas and Odor**

The two major sources of intestinal gas are swallowed air and gas formed
through bacterial action on undigested carbohydrates. Swallowed air is ab-
sorbed gradually during its transit throughout the intestinal tract. Therefore
it is more likely to affect the patient with a small bowel stoma, especially
one located in the proximal small bowel. Since swallowed air is increased
by the use of straws, talking while eating, chewing gum, and smoking, the
patient who swallows large amounts of air may benefit from reduction or
elimination of these practices.

Gas formed by bacterial action on undigested carbohydrates is of
greater significance to the patient with a large bowel stoma, because most
Table 2 Application of One-Piece Urinary Pouch

1. Gather all supplies.
2. Gently remove soiled pouch by pushing down on skin while lifting up on pouch. Discard soiled pouch.
3. Use stoma-measuring guide or establish pattern to determine size of stoma. *Presized pouch:* Check to be sure pouch opening is correct size. Order new supplies if indicated. *Cut-to-fit pouch:* Trace correctly sized pattern onto back of pouch and cut stomal opening to match pattern. Once stomal shrinkage is complete, this step may be omitted. If a cut-to-fit pouch is used, pouch may be cut out before soiled pouch is removed.
4. Remove paper backing from pouch, and lay pouch to one side.
5. Clean stoma and peristomal skin with water; pat dry. *If indicated,* shave or clip peristomal hair. *Use wicks against stoma to absorb urine and to keep skin dry for steps 6 and 7.*
6. Optional: Apply skin sealant to skin that will be covered by tape. Allow to dry.
7. Remove paper backing from pouch; center pouch opening over stoma and press pouch into place.
8. Optional: Apply tape strips to “picture frame” the pouch–skin junction.

*Universal precautions must be followed when this procedure is performed.*


intestinal bacteria are located in the colon. Gas-forming foods (e.g., beans, cabbage, broccoli, brussels sprouts, and beer) are identified. The lag time between intake of gas-producing foods and actual flatulence is about 6 hr for the person with a colostomy (based on average transit time from mouth to colon). The individual can decide to omit these foods or to eat them only at times when flatulence will not cause embarrassment. Foods associated with reduced odor include yogurt, parsley, and orange juice. Measures for muffling flatus sounds include applying pressure to the stoma with the hand or elbow. Patients with large amount of flatus but firm stool may benefit from pouches with deodorizing flatus filters. Such filters vent the gas through a charcoal filter, thus eliminating flatus odor while keeping the pouch relatively flat. However, loose stool may seep into the filter, causing odor and leakage.

The most important odor-control measures are the use of odorproof pouches and good hygiene (i.e., keeping the bottom or “tail” of the pouch clean). The patient who is using an odorproof pouch and keeps the pouch spout clean should note fecal odor only when the pouch is emptied or changed. It is often helpful to remind the patient that fecal odor during elimination is normal. Additional options for odor control include pouch
deodorants, room deodorants, and oral deodorizing agents. Agents used as pouch deodorants include commercial deodorants, commercial perineal cleansers, and mouthwashes, all of which contain antibacterial agents. Deodorizing agents for use in the pouch are added to the pouch after it has been emptied. Room deodorant sprays can be used when the pouch is being emptied or changed. They are particularly beneficial when the patient must empty the pouch in a public restroom, and they are available in purse or pocket size. Oral agents commonly used include bismuth subgallate (Devron) and chlorophyllin copper (Derifil) complex. When taken consistently, these over-the-counter agents reduce fecal odor significantly. Again, it must be emphasized that the best odor-control measures are a secure, odorproof pouch and good hygiene. Oral charcoal capsules are available but may interfere with the absorption of fat-soluble vitamins.

**Management of Diarrhea**

The person with a fecal diversion is just as susceptible to episodes of diarrhea as the individual whose bowel is intact. Diarrhea may occur as a result of a viral or bacterial gastroenteritis, antibiotic therapy, radiation therapy, chemotherapy, some medications (e.g., antacids containing magnesium), or food intolerance. Management of diarrhea depends on the location of the stoma within the gastrointestinal tract and the length and function of the proximal bowel. The principles of management are the same for all patients and can be summarized as follows:

1. Eliminate the cause of diarrhea if possible; for example, the patient who is taking antibiotics may benefit from a preparation of *Lactobacillus* to restore normal bowel flora.
2. Maintain a bland, constipating diet. Recommended foods include rice, pasta, cheese, bananas, and applesauce.
3. Replace fluid and electrolytes. The patient is instructed to replace both fluid volume and fluid components (electrolytes). One approach is to drink a glass of replacement fluid each time the pouch is emptied. Suggested replacement fluids include fruit or vegetable juices and broth.
4. Over-the-counter antidiarrheal medications are usually acceptable. One exception is for the patient receiving radiation therapy. Such patients should not take over-the-counter antidiarrheal agents because many of these preparations contain bismuth, which is a metallic agent.

Patients should also be instructed to notify their physician of signs and symptoms of fluid-electrolyte imbalance, such as weakness, lethargy, dry mouth and tongue, reduced urine output and increased urine concentration, abdominal cramps, and dizziness when standing. Notifying the physi-
cian is particularly important for patients with a small bowel or proximal large bowel stoma because these patients are at increased risk for fluid and electrolyte imbalance during episodes of increased fluid loss.

**Recognition and Management of Food Blockage**

Adherence to the guidelines for adding high-fiber foods to the diet usually prevents development of food blockage. The person with an ileostomy, however, should be taught the signs and symptoms of food blockage, appropriate home management, and indications for notifying the physician. Signs and symptoms of food blockage are the same as for any intestinal obstruction and vary depending on the degree of obstruction. A partial obstruction usually causes cramping abdominal pain, watery output with a foul odor, and possible abdominal distention and stoma swelling; nausea and vomiting also may occur. With complete obstruction, stoma output ceases; severe cramping pain, abdominal distension, stomal swelling, nausea, and vomiting usually occur. Patients are taught to notify their physician or ET nurse promptly if signs of complete obstruction do not respond to the use of mild analgesics and cessation of eating or drinking. These patients usually require ileal lavage, as outlined in the discussion of obstruction.

**Prevention and Management of Fluid-Electrolyte Imbalance**

Persons with an ileostomy have lost the absorptive functions provided by the colon. They lose approximately 500–750 mL of fluid daily through the stoma, compared with 100–200 mL lost by the average person with an intact colon. Thus the individual with an ileostomy is at much greater risk for fluid-electrolyte imbalance when increased loss occurs—for example, with gastroenteritis causing diarrhea and vomiting. Self-care instruction for these patients should focus on the importance of vigorous replacement of fluid and electrolytes during periods of increased loss and on the recognition and prompt response to signs and symptoms of fluid-electrolyte imbalance. The importance of notifying the physician promptly if fluid cannot be replaced during period of increased loss also must be stressed.

**FUNDAMENTALS OF PATIENT CARE**

**Special Considerations with Transverse Colostomy**

Issues specific to patients with a transverse colostomy include dietary and fluid modifications and concealment of the stoma. Since transverse colostomies most commonly are performed for temporary diversions, an additional issue for many patients is incorporation of the colostomy into their own lifestyle on a temporary basis.
Dietary and Fluid Modification
Nutrients are digested and absorbed in the small intestine. Since the small intestine is not affected by a transverse colostomy, patients with a transverse colostomy have no absolute restrictions imposed by the colostomy. They do lose additional fluid through the stoma and should be instructed to increase fluid intake to 10 glasses of liquid per day.

Concealment of Stoma
Patients with a transverse colostomy may have a stoma located in the upper abdomen above the beltline. They frequently have concerns related to clothing and concealment of the stoma. Although suggestions must be individualized for the patient, general guidelines include wearing a layer of knit clothing next to the body to keep the pouch secure and smooth and adding a loose outer layer of clothing for concealment. Patients may also find vests, sweaters, scarves, and jackets to be helpful in concealing the stoma.

Prevention and Management of Constipation
The patient’s previous bowel habits—including history of constipation, past management of constipation, and lifestyle factors (e.g., activity level and intake of fiber and fluid affecting bowel function)—must be assessed. It should be explained to the patient that a colostomy does not prevent constipation; specific recommendations must be made for maintenance of healthy bowel function and prevention of constipation. Routine preventive measures include daily exercise and an adequate intake of fluids and fiber. Individual recommendations are made based on usual fluid and fiber intake, past bowel patterns, and activity tolerance. For example, the sedentary patient with a history of constipation and the usual intake of fluid and fiber [limited to six glasses of fluid a day and one serving of fiber (<5g)] may be instructed to begin a simple graduated walking program, add two glasses of fluid a day, and take a bulk laxative twice daily. An alternative suggestion would be to increase dietary intake of bulk or to add bran to the diet.

Colostomy Irrigation
Education for the patient with a descending or sigmoid colostomy may include instruction in colostomy irrigation. The appropriateness of routine irrigation as a method of management is initially assessed, and the patient is then counseled regarding management options. The patient who is determined to be a candidate for routine irritation and elects this management approach is instructed in the procedure.

Criteria for Irrigation
Patients who meet the following criteria are good candidates for management with routine irritation:

1. Descending or sigmoid colostomy. Routine irrigation is a management option only for patients with a descending or sigmoid
colostomy. It is an inappropriate approach for patients with a more proximal stoma, because such stomas produce a more fluid, higher-volume output; since these patients are unable to regulate fecal output with irrigation, routine irrigation may induce fluid-electrolyte imbalance.

2. *Normal bowel function.* Routine irrigation is most appropriate for persons with a history of regular, formed bowel movements. This method is least likely to be effective in individuals with frequent episodes of diarrhea or the irregular bowel pattern of irritable colon.

3. *Ability to learn and perform the procedure.* Patients must be capable of learning and performing the irrigation procedure. In addition, they must have access to adequate toilet facilities, such as running water and indoor plumbing.

4. *Patient preference.* Irrigation is optional; it is not required to maintain normal bowel function. The decision to use this management approach should be made by the patient, not the health care team.

Some conditions and situations that may be regarded as relative contraindications for routine irrigation include the following:

1. *Stoma prolapse or peristomal hernia.* Because of the potential for increased prolapse or bowel perforation, irrigation should be done only with appropriate equipment.

2. *Children and adolescents.* Routine irrigation may not be appropriate for younger patients because of the amount of time required for the procedure and the need to follow a regular schedule.

3. *Pelvic or abdominal radiation.* Irrigation is contraindicated in patients who are receiving pelvic or abdominal radiation. It should not be initiated or resumed until the inflammation has resolved, as indicated by restoration of normal bowel function and healthy stomal mucosa.

4. *Temporary colostomy.* Routine irrigation is usually not recommended for patients with temporary colostomies because of the time required to master the procedure.

5. *Poor prognosis.* Routine irrigation usually is not recommended for patients who have a poor prognosis because of the time and energy required for the procedure. However, candidacy must be determined according to the individual’s status and priorities.

**Principles of Colostomy Irrigation**

The goal of irrigation is to distend the bowel, making it contract and evacuate its contents. Routine irrigation causes the bowel to empty on a regular basis, which reduces the chance of fecal elimination between irrigations.
Scheduling of Irrigation
Most individuals irrigate the colostomy daily or every other day, depending on their preoperative bowel pattern. The time of day is selected on the basis of their individual lifestyles and preferences.

Type and Volume of Solution
Most patients use lukewarm tap water for irrigation. The alternative is saline, which can be made by adding 2 tsp of salt to 1 quart of water. The volume is titrated for the individual. The goal is to use enough irrigant to distend the colon but not enough to cause cramping pain. Most adults use between 600 and 1000 mL of water. The patient is instructed to instil the irrigant at a steady rate until the feeling of fullness has been achieved. Remind patients who are traveling to use potable water for their irrigations.

Equipment
A cone tip rather than a catheter is recommended. The cone tip prevents bowel perforation and also acts as a plug to prevent backflow of the irrigating solution around the device. An irrigation sleeve is snapped onto a two-piece wafer or belted into place around the stoma. Disposable adhesive irrigation sleeves also may be used. The end of the sleeve can be closed with a clip or placed in the toilet to direct the flow of return.

Time Frame
The time frame required for the entire irrigation procedure is usually about 1 hr: approximately 10 min for setup and instillation of irrigant, 30–40 min for evacuation, and 10 min for cleanup. While waiting for evacuation, the individual is free to pursue other activities with the irrigation sleeve in place.

Teaching and Counseling for Self-Care
The initial focus in patient teaching is on self-care skills and daily management issues, such as dietary alternations. Once these basic skills have been mastered, the focus shifts to how to incorporate the ostomy into the person’s lifestyle. With decreasing length of stay in hospital, this is often begun in the hospital and continued at home with a visiting nurse and/or during outpatient visits. Common concerns include bathing and clothing; management of the ostomy at work, during exercise, in recreational activities and travel, and during sexual activity; and disclosure issues.

Bathing
Patients may take a tub bath or shower with the pouch left on or taken off. They are encouraged to bathe with the pouch on unless it is time to change the pouch (routine bathing with the pouch off may result in inadvertent removal of the skin barrier paste or washing of the skin barrier wafer or ring, which in turn contributes to premature disruption of the pouch seal). The patient may choose to “picture frame” the edges of the pouch with
waterproof tape to increase the resistance; the alternative is to pat the taped edges dry or to dry them with a hair dryer on a low setting.

**Clothing**

Snug undergarments over the pouch help conceal the presence of the stoma. Pouch covers protect the skin from the plastic of the pouch and also serve to conceal the pouch contents. For patients with a flush or slightly protruding stoma located in the lower abdominal quadrants, these measures are usually sufficient to conceal the stoma and allow preoperative clothing to be worn. Clothing modifications usually are minimal for these patients; for example, patients may wear slacks or skirts that have front pleats or are loose-fitting. Women are instructed that pantyhose and stretch panty girdles are permissible. Regular girdles may also be worn provided that the stays do not cross the stoma. Bathing suits are available that effectively conceal the stoma; women are advised to look for patterned suits with shirring or draping. Patients should also be made aware of specialty underclothing designed for the person with an ostomy.

**Fecal Diversions**

When the distal bowel segment remains intact—as with a loop stoma, a double-barrel stoma, or an end stoma with Hartmann’s pouch—the patient must be prepared for temporary output of stool per rectum once peristalsis returns. The distal bowel continues to produce mucus, and the patient may periodically feel rectal fullness and the need to evacuate the accumulated mucus. Patients who sense rectal distention but are unable to expel the mucus may benefit from a low-volume rectal enema to flush out the mucus.

The patient who has a double-barrel ostomy must be taught how to manage the nonfunctioning “mucous fistula” stoma. If the distal mucous fistula stoma is immediately adjacent to the proximal functioning stoma, it should be included in the pouch. If the nonfunctioning stoma is located at a distance from the proximal stoma, it can be managed with a light dressing, changed by the patient either daily or as needed, or with a stoma cap or cover.

**Discharge Planning**

Discharge planning is critical for the patient with an ostomy. As the length of stay after ostomy surgery has shortened, the time available for teaching and counseling has also decreased. The teaching focus during the postoperative phase must be survival skills—that is, pouch emptying and pouch changing procedures. Much additional teaching and counseling are required to support integration of the ostomy into the patient’s lifestyle. All patients should have access to outpatient follow-up on a regular basis. In addition to such follow-up, many patients need home health care after discharge. The home care nurse can provide reinforcement and support for self-care and additional instruction regarding ostomy management and counseling.
regarding psychosocial issues. The ET nurse who provides instruction should evaluate the ostomy patient’s potential need for home care follow-up and should initiate or contribute to the referral. It is frequently beneficial to contact the home care nurse and provide that professional with additional information regarding the patient’s care.

Support Groups
Many patients and families benefit from support groups such as the United Ostomy Association, Crohn’s and Colitis Foundation of America, and the American Cancer Society. Advice, information, and support from people living the experience can be invaluable to patients (see Appendix).

COMPLICATIONS
Metabolic Problems
The normal output from an ileostomy is approximately 800 mL/day. In the immediate postoperative period, the volume may be much higher because of partial obstruction caused by edema of the stoma. In the established stoma a bacterial or viral gastroenteritis commonly increases the output and may require intravenous fluid replacement until the volume of output diminishes. Chronic losses of electrolytes may alter the ratio of chemicals and predispose the patient to the precipitation of stones in the kidneys and gallbladder. If resection of an appreciable length of distal ileum has occurred, the possibility of a vitamin B_{12} deficiency must be considered.

Necrosis occurs because the terminal portion of the bowel has been deprived of an adequate blood supply. In the construction of an end ileostomy, the mesentery may be detached from the bowel for 5 cm without causing ischemia. The blood supply to the terminal ileum is transmitted through the submucosa (Fig. 3). In a patient with a thin abdominal wall, 5 cm is sufficient to construct a viable stoma and allow eversion of the bowel for nipple construction. Ischemia is readily recognized. In the postoperative period, if there is any doubt about whether a dusky color change is congestion or ischemia, a pinprick will clarify the issue. If the stoma is ischemic, it will have to be revised at laparotomy. If the level of ischemia is above the level of the fascia, the revision can be done at a convenient time. However, if there is no identifiable level of demarcation superficial to the fascia, laparotomy should promptly be performed.

In obese patients, even moderately obese ones, construction of an end ileostomy may result in compromising viability and/or having the nipple protrude above skin level. Construction of a loop end ileostomy as described by Turnbull and Weakley [1] allows the creation of a viable stoma with a nipple valve that looks and functions as an end ileostomy. In extremely obese individuals, fashioning even a loop end ileostomy may be difficult. The small intestine must be mobilized and a generous incision (8–10 cm)
made in the rectus muscle to allow the stoma to be delivered through the skin aperture. When the surgeon is satisfied with the length of the stoma support by a rod, the defect in the muscle and fascia is closed cephalad and caudal to the bowel with interrupted nonabsorbable sutures. Closing the defect reduces or delays the development of a parastomal hernia.

**Parastomal Abscess, Ulcer, and Fistula**

In the early postoperative period, considering the local environment, parastomal abscesses are uncommon. When they do occur, they are related to revision or reconstruction of a stoma at the same site. An abscess, which is the result of an infected hematoma or a misplaced suture during maturation, requires surgical drainage. When an abscess develops at a mature stoma, it is usually the result of folliculitis or recurrent Crohn’s disease in an ileostomy. At a colostomy, an abscess usually results from perforation of the intestine with an enema tip during attempted irrigation. A parastomal abscess must be drained if it has not drained spontaneously. An ileoscopy or stoma injection is performed to investigate the cause of the abscess and to determine whether a fistula is present. If no fistula is present, the cause is invariably folliculitis. The abscess may be drained, but it will not heal unless the cavity is unroofed by excising the undermined skin. Re-epithelialization then will occur. If the unroofed area is small (≤2 cm in diameter), the ulcer is managed with a small piece of nonadhesive dressing placed under the conventional ostomy management system and changed daily until it heals. If the ulcer is larger, healing is better if a Perry Model 51 ostomy
management system (Perry Co., Minneapolis, MN) (or a modification of it) is used. The Perry system is kept in place with a belt rather than adhesive. This system allows changes of the nonadhesive dressing on the ulcer three to four times a day without damaging the skin, which would occur with such frequent removal of an adhesive type appliance. The dressing used is an absorbent paper pad (Micropad 3M; 3M Health Care, St. Paul, MN) moistened with aluminium acetate solution (Domeboro).

After an abscess has been drained, whether or not a fistula is present will become evident. Enteric content will be seen issuing from the drain site or under the ostomy management system and will create skin excoriation. A fistula in an ileostomy is invariably the result of prestomal Crohn’s disease. Treatment requires resection of the prestomal disease and construction of a new stoma. It is preferable to relocate the stoma if a suitable site exists so as to avoid the infection present at the old site. This problem is the reason that a midline abdominal incision is advised in surgery for inflammatory bowel disease. A midline incision preserves all quadrants of the abdomen in the event that relocation of a stoma becomes necessary.

A parastomal abscess resulting from a perforated colon is a more serious and urgent problem since the perforation and abscess are usually within the parastomal hernia that precipitated the injury. This situation involves the potential for contamination of the peritoneal cavity. The abscess must be drained and laparotomy must be performed to resect the perforation. If possible, the stoma is relocated and the hernia repaired. This procedure may be staged, depending on the patient’s toxicity.

Pyroderma gangrenosum around a stoma may mimic a parastomal ulcer. This condition is best managed locally with the Perry ostomy management system and conventional medical treatment of the pyoderma. Treatment consists of local applications of a 10–20% solution of benzyl peroxide, which kills bacteria and fungus. A high dose of tetracycline (100–200 g/day) is given orally. In some instances dapsone and colchicine are used. Since dapsone may produce anemia, the initial dose is 25 mg, and this dose is increased to 100 mg over several months. In addition, patients should be given vitamin E, which has a beneficial effect on erythrocytes. Methotrexate or azathioprine and antibiotics can be used sparingly, and corticosteroids can be used systemically (Table 3).

Parastomal Hernia

Parastomal hernias are relatively uncommon with ileostomies; the reported incidence varies between 0.7 and 2.6% [2–4]. These hernias are more common with colostomies, with occurrences reported as between 3 and 10% of patients [5,6]. Predisposing conditions are obesity, a large abdominal wall aperture, placement of the stoma lateral to the rectus sheath, and weakness of the abdominal wall from age or multiple incisions. Parastomal hernias
<table>
<thead>
<tr>
<th>Condition</th>
<th>Cause</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allergic</td>
<td>Sensitivity to skin barriers, adhesives, tapes</td>
<td>Use patch test to determine what patient can tolerate.</td>
</tr>
<tr>
<td>Bacterial</td>
<td>Folliculitis</td>
<td>Trim peristomal hair with scissors or electric razor.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Use adhesive remover to ease release of adhesives.</td>
</tr>
<tr>
<td>Fungal</td>
<td><em>Candida albicans</em></td>
<td>Nystatin topical powder is applied with each pouch change.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Excess powder must be dusted off to allow appliance to seal.</td>
</tr>
<tr>
<td>Chemical</td>
<td>Leakage of effluent under pouching system</td>
<td>Determine cause of leakage.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check for peristomal fistula.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Refit into proper pouching system.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dust skin with skin barrier power prior to pouching.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Severe hyperplasia may require surgical debridement and use of nonadherent system until re-epithelialization occurs.</td>
</tr>
<tr>
<td>Mechanical</td>
<td>Skin stripping from adhesive removal</td>
<td>Gently pull skin away from adhesive with warm, moist gauze square or adhesive remover.</td>
</tr>
<tr>
<td></td>
<td>Laceration of stoma from pouching system due to shifting, improper sizing, or improper application</td>
<td>Remeasure stoma.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Observe pouching system while patient is sitting, supine, and standing.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Observe patient applying pouching.</td>
</tr>
<tr>
<td>Other peristomal abscess</td>
<td>Commonly caused by recurrent Crohn’s disease</td>
<td>Unroof ulcer:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>If ulcer is &lt; 2 cm, cover with nonadherent gauze or hydrocolloid, apply pouch as usual, and change every 2–3 days.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>If ulcer is &gt; 2 cm, apply nonadherent pouching system.</td>
</tr>
</tbody>
</table>
generally enlarge and may cause an unsightly bulge under clothing. If untreated, these hernias may enlarge and make it difficult to keep an ostomy management system attached. If a rigid face plate is used, pressure necrosis may result from tightening the belt to keep the system attached. Less rigid ostomy management systems, such as those with a pectin-based skin barrier, make this complication less likely. Smaller, asymptomatic hernias can be managed by using a Velcro binding with an opening cut for the pouching system. The indications for surgery are difficulty with pouch application or with irrigation of the colostomy.

Surgery is most satisfactorily done by relocating the stoma, usually to the contralateral side. As a practical consideration, certain sites for relocating the stoma are less than optimal, and local repair may be preferable. Local repair is done at laparotomy. The orifice through the abdominal wall is closed with interrupted nonabsorbable sutures. In a survey of patients at the Cleveland Clinic, the cumulative probability of recurrence was 46% after 6 years. Obesity was the only clinical factor investigated that significantly predisposed patients to recurrence of the hernia.

**Stricture**

It is still thought by some individuals that stomas need to be dilated after construction to prevent stricture formation. This idea originated when stomas were not matured primarily. When stomas are constructed correctly and matured primarily, there is no reason for “dilatation” of the stoma. This practice is not only uncomfortable and unnecessary but can also cause strictures from the scarring that develops as a result of the repeated trauma caused by the dilatation.

If a stricture develops as a result of ischemia or recurrent prestomal Crohn’s disease, revision is necessary. Such revision may be done locally, but recurrent Crohn’s disease usually requires laparotomy and resection of the terminal ileum.

**Volvulus**

Volvulus around an ileostomy is prevented by suturing the cut edge of the mesentery of the small bowel to the anterior abdominal wall (Fig. 4). This method closes the mesenteric defect, preventing the small bowel from rotating on the axis of the mesentery of the stoma. A volvulus may occur around a loop ileostomy where the mesentery is not divided; however, such an occurrence is uncommon, and it is not practical to attempt to close the mesenteric defect. We have seen three instances of volvulus around loop ileostomies during the latter half of pregnancy, possibly related to a change in the location of the small intestine.

Volvulus is manifest as an obstruction involving congestion of the stoma. Laparotomy is indicated to alleviate this condition.
Figure 4  Suturing the cut edge of the mesentery of the small bowel to the posterior rectus sheath obliterates the mesenteric defect through which the bowel may rotate.

Caput Medusae

Caput medusae is a circumferential burgundy halo around a stoma that blanches with pressure. It is the result of a portosystemic collateral circulation from portal hypertension. The underlying cause is cirrhosis caused by sclerosing cholangitis. Bleeding, the resulting complication, occurs at the mucocutaneous junction and may be profuse. Immediate control of the bleeding can be obtained by applying pressure precisely to the bleeding point. The bleeding will stop if there is no coagulopathy, as may occur with cirrhosis. Repeated episodes of bleeding should prompt surgical treatment. Such treatment involves interrupting the portosystemic circulation by separating the mucocutaneous junction [7]. The collateral circulation is located at this level. It is not necessary to mobilize the stoma completely down into the peritoneal cavity. Some of the vessels to be interrupted have a large caliber and require individual ligation. Blood loss may be more than expected if the portal pressure is high. Because of the pathophysiology of the caput medusae, recurrence is inevitable. Portosystemic shunting surgically or via transjugular intrahepatic portosystemic shunt (TIPS) may be indicated. Sclerotherapy has been proposed as a treatment method, but those reported cases in which it was done required multiple injections and the effect was short-lived.

Obstruction

In the early postoperative period, obstruction is caused by edema at the level of the new stoma. The obstruction may result in some abdominal
cramping and liquid output caused by the excessive secretion of succus entericus. As the time from operation increases and the edema settles, so do the symptoms.

In a well-established ileostomy, an adhesive bowel obstruction may occur (as after any abdominal operation). In specific relation to the stoma, obstruction caused by a food bolus needs to be considered. Direct questioning of the patient regarding recent ingestion of food with a high fiber content will give an indication of the probability of such obstruction. If the patient has been indiscreet and has eaten a large volume of high-fiber foods, it is likely that a bolus of undigested food is the cause of the obstruction. The point of obstruction occurs at the fascia level of the abdominal wall. Management involves ileostomy lavage. The lavage is performed by inserting a 22 or 24F Foley catheter into the distal bowel and irrigating it with several 100-mL aliquots of saline. A two-piece pouching system or irrigation sleeve can be applied to manage the flow. If the catheter can be inserted into the stoma for several inches and irrigation with several aliquots does not produce a return of fluid containing particulate matter of undigested food, the obstruction should be considered more proximal, probably an adhesive bowel obstruction. Further attempts to relieve the obstruction by irrigation should be stopped. If the irrigation produces a volume of undigested fibrous material, the procedure is continued until the bolus is broken up and there is some evidence of spontaneous evacuation. Treatment of a bolus obstruction by lavage usually does not require admission to the hospital.

**Mucosal Implants**

Mucosal implants are islands of mucosa that have lodged along suture tracts; they are avoided by using appropriate technique during stoma construction. During maturation of the stoma, the mucocutaneous sutures are placed through the dermal layers of the skin without entering the epidermis (Fig. 5). If mucosal implants create a problem, it is from the mucus that they secrete under the ostomy management system. The mucus reduces the adhesion of the pouch and causes leakage. It is not common for implants to cause a major problem, but if the implants are extensive, relocation of the stoma may be necessary. Precise destruction at skin level with a needle electrocautery will give temporary relief.

**Trauma**

Trauma to the stoma may occur in body-contact sports, but this is uncommon because most patients with stomas avoid this type of activity. When the aperture in the pouching system is too small or misplaced, vigorous physical activity may result in a cut or a circumferential ulcer and bleeding. If the cut is
During maturation of the stoma, sutures are placed through the full thickness of the bowel and dermis of the skin. Deeper, a fistula or complete transection of the stoma can occur. In less severe cases modification of the pouching system will allow healing of the ulcer.

At the Cleveland Clinic, McLeod et al. [8] conducted a survey of patients with conventional ileostomies to determine which factors affected the health and quality of life of these individuals. It was found that the only significant item that had any effect on quality of life was the function of the ileostomy.

The most common reasons for stoma revision are technical errors and recurrent disease. Surgeons, in concert with ET nurses, must approach the construction of stomas with care and make every effort to minimize potential problems, both physical and psychosocial.

**SUGGESTED READINGS**


**REFERENCES**

5

Quality of Life with a Stoma

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INTRODUCTION

There is increasing recognition that quality of life is an important outcome in clinical medicine. The World Health Organization definition of health, that is, “health is a state of complete physical, mental and social well-being and not merely the absence of disease,” has been used to define quality of life [1]. However, investigators realize the limitations of this definition. Generally, it is felt that quality of life is multidimensional, encompassing at least the domains of physical, social, and emotional well being. As well, quality of life should be measured from the patient’s perspective and consider the fact that cultural differences may impact on quality of life and quality of life may change over time [2].

Recent interest in quality of life probably reflects the changing patterns of surgical diseases and the evolution of surgical procedures. In the early part of the last century, operative morbidity and mortality for most abdominal procedures tended to be high. As a result, surgery was considered only as a last resort, where there was little else to offer the patient. Thus, immediate and long-term survival were the important variables in assessing the success of the operation. However, with improvements in anesthetic techniques, the discovery of antibiotics, advances in nutrition and perioperative care, both mortality and morbidity have been significantly reduced. As a result, surgery tends to be performed earlier and for a wider range of indications including failure of medical therapy. Consequently, the success of surgery must be evaluated by other parameters.

Assessment of quality of life is particularly important in patients who require surgery that will leave them with a permanent stoma. Not surprisingly, many patients faced with this possibility may be reluctant to undergo surgery for fear that they may be more disabled postoperatively than they were preoperatively. In deciding whether to agree to surgery and in choosing a specific operative procedure, the patient often considers quality of life
to be a major determinant. This factor is especially important for patients with ulcerative colitis, who may choose from several surgical options, each with its advantages and disadvantages and varying complication rates. It may also be significant for selected patients with rectal cancer who have the option of local therapy or radiation therapy versus radical surgery with a colostomy. Such patients, in deciding on treatment, may have to weigh the quality of life against a higher risk of tumor recurrence.

METHODS FOR ASSESSING QUALITY OF LIFE

Clinicians have always made an assessment of quality of life of their individual patients when they ask “How are you doing?” Although this inquiry may have some validity in assessing individual patients, it lacks both the necessary validity (i.e., the degree to which a measurement measures what it purports to measure), reliability (i.e., reproducibility), and comprehensiveness necessary to evaluate the outcome of groups of patients or compare treatment alternatives. Outcome has also been assessed with surveys or unvalidated questionnaires. Although these studies have some merit, their value is limited because the reliability and validity of the surveys have usually not been established and the results cannot be compiled into a summary statistic, so statistical analysis is not possible and it is not possible to make comparisons between groups.

In general, two types of instruments are used to measure quality of life: psychometrically and utility-based measures [3]. There are advantages and disadvantages to both. Psychometrically based measures of quality of life attempt to quantify this phenomenon using a range of questions from the various domains being assessed. The ratings or scores of the individual items are usually summated to give an overall measure of quality of life. Items can be weighted equally or differentially in accordance with the importance of each item. There are two types of measures. Generic measures have been designed to be applicable to individuals with a broad range of diseases and impairments undergoing a range of treatments. Their usefulness is that they are applicable to a wide range of groups: therefore quality of life can be compared among these groups. The disadvantage is that they may lack the sensitivity to detect small but clinically important differences in a particular group of patients. Other advantages of the generic instruments are that they have often been used extensively, so their validity and reliability have been well established in many different populations. As well, they can detect and measure unexpected treatment effects. Some examples of generic instruments are the Medical Outcomes Trust SF-36, the Sickness Impact Profile, and the Nottingham Health Profile [4–6].

Disease-specific instruments have been designed to measure areas of quality of life that are important to specific patient populations. Usually these
instruments contain items of importance to this population, so they may be more responsive to small but clinically important changes and may better discriminate between individuals within the population. They may also appear more relevant to clinicians and patients. However, they tend to have less established reliability and validity than generic measures and cannot be used to compare populations to whom the disease-specific instrument is not applicable. Several disease-specific instruments have been developed for assessing patients with inflammatory bowel disease, including the Inflammatory Bowel Disease Questionnaire, developed by Irvine and colleagues [7,8], and the Rating Form of Inflammatory Bowel Disease Patient Concerns (RFIPC), developed by Drossman and colleagues [9]. There are also instruments developed specifically for measure quality of life in cancer patients, including the Karnofsky Performance Scale [10], the European Organization for Research and Treatment of Cancer (EORTC) Quality of Life Questionnaire [11,12], and the Functional Assessment of Cancer Therapy Scale (FACT) [13].

The alternative to measuring quality of life psychometrically is to use utility-based measures [14]. Utilities represent an individual’s preference for a given state relative to death or perfect health. Complete wellness is given a utility of 1.0 and death a utility of 0. A health state less than “completely well” is given a value between 0 and 1.0. Utilities may be assigned using either a decomposed or a holistic approach. With the decomposed method, an individual is asked to rate his or her functioning in a number of health domains or attributes. For each specific category score, a utility value has previously been generated from a defined population, and these values can then be combined. With the holistic approach, individuals assign a utility to health-related quality of life (HRQL), taking into consideration all aspects of quality of life. Utilities may be generated using either the standard gamble method or time trade-off technique. With the standard gamble, a utility is calculated based on how much risk the patient would be willing to take to have normal health rather than his or her present health state. With the time trade-off technique, the utility is calculated based on how many years of life the patient would be willing to give up. Utility assessments tend to be less sensitive for detecting differences or changes than psychometrically based measures. Moreover, if the holistic approach is used to generate utilities, it is not possible to discern which domain or aspect of health is affected. The main use of these instruments has been in the field of health economics and policymaking in performing cost utility studies.

LIFE WITH AN ILEOSTOMY

Most patients who require a permanent ileostomy have ulcerative colitis; a smaller proportion have Crohn’s disease or familial adenomatous polyposis.
Although patients with ulcerative colitis and familial polyposis have several surgical alternatives from which to choose, including the continent ileostomy (Kock pouch) or an ileal pouch–anal procedure, the conventional ileostomy is still considered by most surgeons to be the standard against which other procedures are compared.

Although patients may be reluctant preoperatively to accept a permanent ileostomy, most adapt well to it and achieve a very high quality of life. Of 273 ileostomy patients who underwent follow-up at the Cleveland Clinic, 72% considered that they led normal lives without restriction, 24% stated that they had minor restrictions or difficulties adjusting to an ileostomy, and only 4% said that they regretted having had the surgery [15]. Roy et al. from the Mayo Clinic reported that 92% of their patients were satisfied with their postoperative status [16]. Awad and colleagues reported that 93% of their cohort of patients were happy with an ileostomy and appeared to have adapted to a normal life with it. Interestingly, 87% stated they preferred the ileostomy to an ileoanal pouch. More recently [17], Camilleri-Brennan and Steele studied a cohort of 49 patients who had a total proctocolectomy and permanent ileostomy performed for ulcerative colitis at three hospitals in the United Kingdom [18]. Compared with the normal population, there were no significant differences in the scores of any of the eight subscales of the SF-36 measured a mean of 29 months postoperatively. The major reason for this appears to be that most patients regain their normal physical well-being following surgery. Several surveys have shown that between 80 and 90% of ileostomates consider their physical health to be good or excellent [15,16,19,20].

Despite the good overall rating of quality of life, restrictions are encountered by individuals with an ileostomy (Table 1). Approximately 10% of individuals in the Cleveland Clinic survey stated they had severe restrictions, and 40–50% had moderate restrictions postoperatively in their diet, ability to participate in sports and hobbies, travel, and clothing selection.

Table 1  Restrictions with Conventional Ileostomy in Daily Activities Before and After Surgery (%)

<table>
<thead>
<tr>
<th></th>
<th>None Before</th>
<th>None After</th>
<th>Moderate Before</th>
<th>Moderate After</th>
<th>Great Before</th>
<th>Great After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diet</td>
<td>24</td>
<td>39</td>
<td>45</td>
<td>48</td>
<td>30</td>
<td>12</td>
</tr>
<tr>
<td>Sports</td>
<td>37</td>
<td>42</td>
<td>31</td>
<td>44</td>
<td>27</td>
<td>10</td>
</tr>
<tr>
<td>Hobbies</td>
<td>35</td>
<td>51</td>
<td>43</td>
<td>39</td>
<td>19</td>
<td>8</td>
</tr>
<tr>
<td>Travel</td>
<td>34</td>
<td>57</td>
<td>39</td>
<td>34</td>
<td>24</td>
<td>8</td>
</tr>
<tr>
<td>Clothing selection</td>
<td>54</td>
<td>34</td>
<td>30</td>
<td>53</td>
<td>10</td>
<td>9</td>
</tr>
</tbody>
</table>

Source: From Ref. 57.
However, these patients had often been restricted in their activities of daily living preoperatively and, with the exception of clothing selection, were generally less restricted postoperatively. In other surveys, over 90% of patients stated that they were able to return to work and were unrestricted by the ileostomy [21,22].

Problems encountered by patients with an ileostomy who were surveyed at the Cleveland Clinic included skin irritation (49%), offensive odor and noise (42%), and detection of the ostomy device by others (17%) [23]. Twenty-nine percent stated that they had difficulties in maintaining the ostomy management system. On the whole, however, all these problems were less troublesome than expected, and 90% of the patients stated that they devoted less than 1 hr per day to care of the ileostomy. Roy et al. reported that 85% of patients felt that caring for the ileostomy was not difficult [16]. With respect to psychological concerns, there is some variability in the literature. Approximately 80% of ostomates at the Cleveland Clinic reported that their emotional health was good or excellent and a similar proportion felt that they had a positive body image. Only 10% experienced negative feelings from employers, friends, or family. Morowitz and Kirsner also reported that only 12% of patients with an ileostomy had some emotional problems related to the ileostomy [19]. A survey by Burnham et al. revealed that only 12% patients believed that their marriages were adversely affected by the ileostomy [24]. Rolstad et al. reported that 30–40% of patients with an ileostomy felt that intercourse was more difficult physically or psychologically because of the ileostomy [25]. Some 50–60% of the same group felt less desirable sexually.

In predicting outcome, Morowitz and Kirsner reported that the length of time patients had the disease before surgery was a significant variable [19]. Of the 36 patients, 10 (28%) who felt that their health had deteriorated postoperatively had symptoms of ulcerative colitis for less than 1 year before they underwent surgery. In the Cleveland Clinic study, stoma function was predictive of outcome. Seventeen percent of patients with a poorly constructed stoma were dissatisfied with their quality of life, whereas only 2% of those with a well-constructed stoma were dissatisfied [15].

KOCK POUCH

The continent ileostomy was developed by Professor Nils Kock in the late 1960s for those patients who were dissatisfied with the conventional ileostomy. A pouch that acts as a reservoir for stool and a nipple valve that maintains continence are constructed from the terminal ileum. Although the patient still has a stoma, it is flush with the skin and an appliance is unnecessary. To empty the pouch, a catheter is inserted into the reservoir several times per day.
One of the major advantages of the continent ileostomy is that patients feel that they experience fewer restrictions. In a survey of 71 patients with continent ileostomies constructed at the Cleveland Clinic, only 10% noted having restrictions in activities related to work or leisure activities [26]. This response was markedly different from the responses of the 36 patients who had conventional ileostomies prior to conversion to continent ileostomies: Some 49–93% of these patients noted some restrictions in sports, work, hobbies, travel, or clothing selection. The most striking differences were with regard to clothing selection and sports activities. Only 15% of patients with continent ileostomies were limited in these areas, whereas approximately 90% of patients with conventional ileostomies complained of restrictions in these categories. The major restriction that individuals with a continent ileostomy did experience related to food intake. However, restrictions in diet were similar in frequency and severity to those experienced by patients with a conventional ileostomy. For persons who have difficulty adapting to the conventional ileostomy for psychological reasons, the continent ileostomy may be considered as a superior alternative. Nilsson et al. reported that 98% of their patients had felt embarrassed or inhibited by the conventional ileostomy, but only 24% had these feelings following conversion to a continent ileostomy [27]. Eighty percent thought that their sexual lives were disturbed by the conventional ileostomy, but none of them felt inhibited by the continent ileostomy. Ojerskog et al. reported that the most common reason for patients requesting a continent ileostomy was to achieve a better sex life [28]. They also noted that 64% of patients felt that their overall sexual satisfaction was improved following construction of the continent ileostomy. Many of these patients also reported an improvement in body image and self-esteem. In the Cleveland Clinic survey, 80% of the patients noted that their body image was improved following conversion of their conventional ileostomy to a continent ileostomy [26]. All patients stated that retrospectively they would have chosen to have a continent ileostomy; 96% found the result to be as good as or better than their preoperative expectations, and 97% stated that they would undergo revisional surgery rather than have removal of the continent ileostomy.

ILEOANAL POUCH PROCEDURE

The ileoanal pouch procedure or restorative proctocolectomy was introduced in the 1970s as another alternative for patients requiring surgery for ulcerative colitis. In this procedure, a near total proctocolectomy is performed with preservation of the anal musculature. A reservoir is constructed from small bowel and is anastomosed, either by hand or with a stapler, to the upper anal canal. The major advantage is that patients do not have a permanent stoma, and they evacuate via the normal route. Neither
catheters nor ostomy management systems are necessary. Even in the early years, when complication rates were high, IPAA was enthusiastically endorsed by most patients. It is now the preferred option for most patients.

In a survey of our patients who have had this procedure, over 95% stated that their physical health was normal [29], and 80% said that they had a good appetite and energy level. Approximately 50% of patients avoided some foods, particularly vegetables or gas-producing foods, or restricted the times at which they ate. However, only 15% stated that their bowel function interfered with their work or daily activities. Overall, 77% felt that they had an excellent result, 14% a good one, 5% a fair one, and only 4% a poor result. Similarly, Pezim and Nicholls surveyed 55 patients who had undergone the ileal pouch procedure at St. Mark’s Hospital in London [30]. All these patients had a temporary ileostomy constructed at the time of surgery; 87% preferred the reservoir to the ileostomy. A similar proportion felt more confident, had a better self-image, and felt that they were less restricted in their social and sports activities and work. A total of 67% said that there was no significant disadvantage associated with the reservoir, whereas 20% saw the long convalescent period and 18% the requirement for catheterization as drawbacks to the procedure.

Weinryb et al. studied 48 patients who had a pelvic pouch procedure [31]. These patients were studied after colectomy but before closure of the ileostomy and again 1 year after closure of the ileostomy. Functional results were assessed by the patient, psychiatrist, psychologist and surgeon. As well, the Psychosocial Adjustment to Illness Scale, Global Assessment of Function, and Well-Being Profile were administered. The functional outcome correlated significantly with most of the assessments of quality of life performed by the three independent evaluators. Furthermore, quality of life did not improve after the ileostomy was closed, suggesting that surgery itself was responsible for most of the change.

Tiainen and Maitikainen administered a modified version of the SF-36 to 72 respondents among 136 patients who had a IPAA performed at their institution over a 10 year period [32]. The median number of BMs per 24 hr was six, and 44% of patients were totally continent. Despite more frequent bowel movements, there were no significant differences in the scores of the SF-36 of patients with IPAA and the normal Finnish population. Follow-up time, age, and sex did not alter outcome. However, there was a significant correlation between quality-of-life scores and functional results, with patients having more than 10 BMs per day having below-average scores.

Fazio and colleagues recently reported quality of life in a sample of 977 patients who had IPAA performed at the Cleveland Clinic [33]. Two instruments, the SF-36 and the Cleveland Clinic Global Quality of Life (CCGQL) instrument, were used to evaluate quality of life. The latter instrument was developed by this group and includes three items (quality of
life, quality of health, and energy) each rated on a scale of 0–10. They found high mean SF-36 scores similar to those of the U.S. normal population. As well, there was a high correlation between the CCGQL and the SF-36. Quality of life was shown to increase during the first 2 years after surgery and thereafter did not deteriorate. Factors affecting quality of life included number of stools per 24 hr, urgency, incontinence, and age at the time of surgery. Others have also documented the impact of bowel function on quality of life [34–36].

Lastly, Dunker and colleagues compared outcome of 16 patients who had a laparoscopic-assisted IPAA to 32 patients who had an open procedure using the SF-36 and Gastrointestinal Quality of Life Index (GIQL) [37]. No differences in mean scores were found between the two groups. The only difference between the two groups was a difference in body image score based on the results of the Body Image Questionnaire.

COMPARISON OF QUALITY OF LIFE

Several studies have attempted to compare the quality of life of patients following the various procedures. Unfortunately, these studies are not randomized controlled trials, which would not be ethical or feasible to perform, so there may be inherent differences in the patient samples that may limit the findings of the studies. In addition, many of the comparative studies have been performed using invalidated instruments.

Kohler and colleagues from the Mayo Clinic surveyed 406 patients who had a conventional ileostomy, 403 who had a Kock pouch and 300 who had an ileal pouch for ulcerative colitis or familial adenomatous polyposis between 1960 and 1980 [20]. They reported that more than 90% of patients in all three groups were satisfied with their current status, although 33% of patients with a conventional ileostomy, 11% with a Kock pouch, and 3% with a pelvic pouch would like to have a change. More than 90% in all three groups had returned to work or school, and more than 60% reported that their attitude had improved since surgery. They assessed performance in seven categories: social activity, sports, housework, recreation, family relationships, sexual activity, and travel. There were no significant differences with the exception that patients with an ileal pouch scored higher in the areas of sports and sexual activities compared to the other two groups. Patients with Kock pouches were more restricted in food intake and their ability to travel.

In an attempt to quantitate quality of life following these procedures, our group used two techniques, the time trade-off technique and the direct questioning of objectives to derive utilities for patients’ perceived health status [38]. As mentioned previously, a utility of 1.0 signifies perfect health and death is assigned a utility of 0. Three cohorts of patients were interviewed: 28 patients with conventional ileostomies, 28 with continent ileos-
tomies, and 37 with pelvic pouches. All the patients had had surgery at least 1 year previously and were selected at random from patients followed in our practices. Attempts were made to include patients who were thought to have good and poor results as judged by the attending surgeon. The mean utilities, using both techniques, were similar for all three groups of patients, with utilities ranging from 0.87–0.97. Thus, not only did this study suggest that quality of life is close to that of normal but there appeared to be little difference in quality of life with the different procedures. With subgroup analysis we did find that the mean utilities were significantly different between those judged to have “failed” pouches and those with good results.

In a similar study, Jimmo and Hyman administered a modified IBDQ to 50 patients who had a IPAA and 12 who had a permanent ileostomy following total proctocolectomy [39]. There was no difference in the mean IBDQ scores between the two groups. Similarly, 95% of the IPAA patients compared with 100% of the ileostomy patients were very satisfied or satisfied with the surgical procedure and none, in retrospect, would have chosen the other procedure.

These studies indicate that quality of life is high for most patients postoperatively irrespective of the procedure performed. These results appear to contradict what occurs in clinical practice: that is, that most patients, given the option, choose a pelvic pouch. There may be several reasons to explain the discrepancy. First, the patients were not randomly allocated to which procedure they had; therefore it is likely that there are inherent differences in the groups. Second, the most important determinant of quality of life may be physical well-being, which is excellent in most patients irrespective of the procedure. Third, there may be an aspect of patients accepting their current health status and rationalizing that it is superior to other alternatives. The findings from these studies, however, should not discourage surgeons from performing the various alternative procedures. Rather, surgery should be viewed as an effective treatment for patients with ulcerative colitis, and patients should play a role in choosing the best procedure for them based on their expectations and lifestyle. Finally, it points out the need for further research into the area of quality-of-life assessment and patient decision making in this group of patients.

COMPARISON OF QUALITY OF LIFE OF MEDICALLY VS. SURGICALLY TREATED PATIENTS WITH ULCERATIVE COLITIS

Recently several studies have compared outcome in patients treated medically to that in patients treated surgically. It is interesting that these studies have resulted in conflicting results and conclusions. One explanation is that there may be differences in the patients studied and the study design. For
example, the natural history of patients with ulcerative colitis is often variable. Thus, if quality of life were assessed when the disease was quiescent, one could predict that the quality of life would be high. On the other hand, if these same patients were assessed preoperatively when the disease was active, their quality of life would probably be low. For patients who have had surgery, the health status is usually much more stable except for the early convalescence period. Thus quality of life soon after surgery would probably be lower than if it were assessed at a later date. Another issue that might result in incorrect conclusions is that the “right thing” may not be measured. For instance, stool frequency is an important indicator of disease activity in ulcerative colitis and thus of the quality of life of patients being treated medically. On the other hand, stool frequency seems to have less impact on the quality of life of patients with pelvic pouches (and is totally irrelevant in patients with conventional ileostomies or Kock pouches). Thus patients who have a pelvic pouch and have an excellent quality of life routinely have five or six bowel movements per day. The same number of bowel movements in a patient being treated medically may indicate active disease, and with it impaired quality of life. If an instrument such as the IBDQ, where stool frequency is an item, were used to assess quality of life, the surgical patient might appear to have a poorer quality of life than he or she really has.

It also seems that investigator bias may account for differences in the results. Surgeons have tended to report a high quality of life following surgery whereas the opposite conclusion has been drawn by gastroenterologists. Does this difference appear because the patients being studied differ, or is there an expectation bias, with patients wanting to "please" their physicians? These questions are unanswered and emphasize the need for further well-designed studies. There is also a lack of information about what the important determinants are that affect quality of life in both medically and surgically treated patients. This issue is also important to address.

Sagar and colleagues surveyed 100 medically treated patients who had ulcerative colitis for more than 1 year and 110 patients who had the pelvic pouch procedure [40]. The ulcerative colitis patients were those who attended an outpatient gastroenterology clinic and were in remission at the time of the survey. Both groups were given a self-administered questionnaire developed in conjunction with an enterostomal therapist and psychologist. They also completed the Hospital Anxiety and Depression (HAD) test. Functional scores were based on a modified scoring system developed by Oresland et al. [41] for assessing functional results with a pelvic pouch. These authors found that surgical patients had significantly more bowel movements (5 per 24 hr vs. 2 per 24 hr) and nocturnal stools (1 vs. 0), and a higher proportion of the surgical patients used antidiarrheal agents (52 vs. 3%). On the other hand, significantly fewer surgical patients had urgency (12 vs. 73%) or social limitations (21 vs. 46%), and they had significantly
better functional scores, HAD anxiety scores, and HAD depression scores. Thus patients who had had surgery seemed to have a better outcome at least in some domains than those even with quiescent disease.

Martin and colleagues studied two cohorts of patients: 29 patients who had surgery and another 57 who had ulcerative colitis treated medically [42]. A validated 29-item, self-administered questionnaire was completed. Patients who had been treated surgically had better scores than those with severe ulcerative colitis but similar scores to those with mild disease or those in remission.

Provenzale and colleagues compared the outcome of 22 patients who had had a pelvic pouch at Duke University Medical Center to a national sample of IBD patients who were members of the Crohn’s and Colitis Foundation of America [43]. Patients with a pelvic pouch scored significantly better on Sickness Impact Profile (SIP) as well as the Reporting form of Inflammatory Bowel Disease Patient Concerns (RFIPC). The limitation of this study is that the control and surgery groups were drawn from different populations. Moreover, the disease status of the patients in the control group is unknown. In a follow-up study, this group assessed 20 patients having an IPAA preoperatively and at intervals up to 1 year after using the SF-36, RFIPC, and the time trade-off technique [44]. Seven of the eight subscales of the SF-36 revealed improved quality of life. Similarly, there was a significant reduction in patient concerns. The mean utility increased from 0.59 +/- 0.28–0.93 postoperatively. The improvement in outcome occurred as early as 1 month and was sustained over the study duration of 12 months.

Our group assessed quality of life of a cohort of 20 patients immediately before and 1 year after surgery [38]. The time trade-off technique and direct questioning technique of objectives were used to assign utilities. Not surprisingly, quality of life was significantly higher postoperatively, with mean utilities of 0.58 preoperatively versus 0.98 postoperatively using the time trade-off technique and 0.38 and 0.88, respectively, using the direct questioning of objectives. Preoperative quality of life also correlated with disease activity. Two other studies demonstrated improved quality of life, as assessed by the SF-36, RFIPC, in cohorts of patients assessed pre- and postoperatively [45,46].

Cohen and colleagues compared the quality of life of 7 patients who had been treated with cyclosporine for ulcerative colitis to 22 patients who had failed cyclosporine therapy and had surgery and a pelvic pouch [47]. They found that the cyclosporine patients had significantly better emotional function, ability to sleep through the night, fewer bowel movements, and less abdominal pain. Their conclusion was that “the choice of cyclosporine is supported by a superior quality of life.” Weiss and colleagues from Mount Sinai Hospital in New York also compared the quality of life of patients treated with cyclosporine or surgery for ulcerative colitis and came to a similar conclusion [48]. A total of 28 patients who had a pelvic pouch
procedure were compared to 39 patients who had received cyclosporine for acute ulcerative colitis. Quality of life was significantly better as assessed by a disease-specific instrument, the IBDQ (181 ± 33 vs. 163 ± 39; \( p = 0.04 \)), but there was no difference when a generic measure, the SF-36, was used (MCS 47 ± 11 vs. 44 ± 12, \( p = 0.3 \); and PCS 49 ± 11 vs. 40 ± 10, \( p = 0.65 \)). The mean utilities, as determined by the time trade-off technique, also revealed a higher quality of life in the cyclosporine group (mean 0.95 ± 0.08 vs. 0.85 ± 0.18). What is not readily apparent in this study is why the mean utility for the surgery group was lower than that observed in two other studies where utilities were assessed [38,43]. It may be due to a selection bias, as only 28 of 62 patients who underwent surgery were included in this study.

A final study did not measure quality of life per se but compared 20 medically treated and 20 surgically treated patients followed at the Cleveland Clinic in Florida [49]. Patients were matched for age and duration and severity of disease. Cost, number of hospital admissions, and length of stay were recorded over a 5-year period. Sher and colleagues reported that morbidity—defined as the need for further medical therapy—was significantly higher in the medically treated patients.

QUALITY OF LIFE FOLLOWING SURGERY COMPARED TO THE NORMAL POPULATION

Surgeons have often thought that because patients can be cured of their disease, the postoperative quality of life of patients who had surgery for ulcerative colitis was similar to that of the normal population. In fact, two studies have demonstrated that this appears to be the case.

Provenzale and colleagues compared the outcome of 22 patients with a pelvic pouch performed at Duke University Medical School to a normal population using the SF-36 test [43]. No significant differences were detected. They also reported that the median utility for this cohort, as determined using the time trade-off technique, was 1.0.

Kohler compared the outcome in a cohort of patients who had a pelvic pouch procedure to a cohort who had cholecystectomy [50]. Although they found that the pelvic pouch patients had increased stool frequency (6 vs. 1 BM/day, took more medication (40 vs. 12%), and had a higher proportion of fecal spotting (68 vs. 13%) and concern about bowel habits (28 vs. 18%), the quality of life of the two cohorts was similar. Similar proportions reported that they had good health (76 vs. 79%), slept well (75 vs. 82%), and experienced no abdominal pain (77 vs. 70%). Furthermore, similar proportions participated in sports and recreational activities (90 vs. 88%), social activities (95 vs. 89%), family relationships (95 vs. 98%), and sexual activity (84 vs. 82%).
LIFE WITH A COLOSTOMY

There is less written in the literature about the quality of life of patients with a colostomy than for those with an ileostomy. Most often, patients have a colostomy following abdominoperineal resection for cancer of the rectum. In recent years, since the introduction of stapling devices, restorative procedures are being performed more frequently, even for cancers occurring in the lower third of the rectum. With this, there has been an increased interest in assessing outcome and quality of life in patients having restorative procedures compared with abdominoperineal resection and colostomy.

Although this issue requires study, like comparisons in patients with ileostomates, one must be cautious in interpreting the results since patients are not randomly allocated. Patients who have restorative procedures tend to be younger and have more favorable tumors than those having abdominoperineal resections. Secondly, bowel function and quality of life may vary depending on the level of the anastomosis following anterior resection. Outcome tends to be poorer following a low anastomosis, which would be the alternative to a colostomy. Radiation has been shown to affect functional results following restorative procedures and may confound the results.

Sprangers and colleagues reviewed the literature and found 17 studies published between 1969 and 1992 which compared quality of life of patients with a colostomy to those who had a reconstructive procedure [51]. These studies were all cross-sectional in design. The studies tended to be small (60–420 patients), and the time elapsed since surgery varied widely, ranging from 1–10 years. Most used unvalidated instruments. There was great heterogeneity among the studies, but the major finding of the review was that both patients with a colostomy and those with intact sphincters experienced limitations in all four areas of quality of life (physical, psychological, social, and sexual functioning). Approximately three-quarters of the patients surveyed considered their general state of health good. However, a large proportion complained of bowel problems, including constipation in ostomates and frequency and control problems in patients who had restorative procedures. Psychological problems such as low self-esteem, depression, loneliness, suicidal thoughts, and feelings of stigma were seen in both groups but were more common in ostomates (10–54%) compared with the nonstoma patients (3–43%). Both groups of patients were restricted in their social activities. However, the findings suggested that having a colostomy is associated with reduced interest and participation in outside activities, although in-house activities were less affected because of feelings of being a nuisance or embarrassment. With respect to sexual functioning, 66–100% of male ostomates reported some sexual dysfunction, whereas the frequency was 30–75% in those who had had reconstructive procedures. Much less has been written about sexual function in women, but dyspareunia, dimin-
ished orgasm, and less frequent intercourse were reported more commonly in females with a colostomy. Thus, the conclusion was that ostomates have more psychological, social, and sexual dysfunction, but the authors pointed out the limitations of the studies and that caution is required in drawing conclusions.

While it has been accepted by surgeons that a sphincter-sparing procedure is preferable to an abdominoperineal resection, two recent studies have suggested that quality of life, in fact, may be better in patients who had an abdominoperineal resection and permanent colostomy [52,53]. These studies are limited by not being randomized controlled trials. However, these are interesting observations. The findings may be due at least in part to patient expectations. Most patients preoperatively are loath to even consider a colostomy but often accept it quite well postoperatively. On the other hand, patients having a reconstructive procedure may be unprepared for the change in bowel function that often occurs following a very low anterior resection.

Grumann and colleagues prospectively studied 73 patients who had cancers of the rectum: 50 patients were treated with anterior resection and 23 patients with abdominoperineal resection. The EORTC QLQ C30 and CR38 modules were administered preoperatively, at 6–9 months and at 12–15 months [52]. In most subscales, there was no significant difference in the results between the two groups, although there tended to be a trend in favor of the patients having abdominoperineal resection. On multivariate analysis, patients having a low anterior resection had particularly poor total quality-of-life scores, role function, social function, body image, and future perspective. As well, they had more gastrointestinal and defecation–related symptoms than patients undergoing high anterior resection. These findings are particularly interesting in that it is accepted that elderly patients having a low anterior resection or those having a coloanal anastomosis may have poor functional results. However, in this study, the mean age of the patients was approximately 60 years, and 70% of the patients in the anterior resection group had an anastomosis above 5 cm.

Another study by Allal and colleagues reported similar findings [53]. Quality of life was assessed in 29 patients who had had an abdominoperineal resection and 23 who had had a low anterior resection. All patients had received preoperative radiation therapy with or without concomitant 5-fluorouracil. For all scales of the EORTC QLQ-C30 and EORTC QLQ-CR38, there were no significant differences in the median scores between the two surgical groups. However, patients who had had an abdominoperineal resection had lower body image scores and reported a higher rate of sexual dysfunction in male patients. On the other hand, these patients reported better physical function, future perspective, and global quality of life than those who had sphincter-sparing surgery.

Three studies have assessed quality of life in patients having temporary stomas following low anterior resection. Quality of life appeared to be
decreased while patients had a stoma [54]. This is plausible in that many patients do not accept a stoma well when it is temporary. There seemed to be no difference in quality of life whether the patient had a loop ileostomy or a transverse colostomy [55,56]. However, outcome was directly related to the number of stoma problems or complications that were encountered [56].

**SUMMARY**

Quality of life is becoming an increasingly important outcome for both surgeons and patients. As patients become better informed, they demand more information about both the surgical procedure and their long-term outlook. It therefore behooves the surgeon to consider quality of life and to measure it objectively with instruments that are sensitive, reliable, accurate, and valid. The development of instruments to measure quality of life is also important, so that modifications of techniques and new procedures can be evaluated adequately.

Despite the limitations of studies assessing quality of life, it appears that quality of life is good in most patients with an ileostomy or a colostomy. Although some restrictions may be encountered, most patients are able to lead a normal life.

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End Sigmoid/Descending Colostomy

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INTRODUCTION

The ability to create a healthy, well-functioning, easily manageable colostomy is essential for all abdominal surgeons. Colostomy creation was one of the first abdominal operations performed historically. It is a frequent part of emergent colonic surgery, and almost any abdominal procedure carries some risk of requiring a colostomy or ileostomy. Historically, in the case of emergent colonic surgery, a transverse colostomy was created for proximal diversion. Currently, end sigmoid colostomies are the most frequent diversions in the case of sigmoid perforation. This itself is diminishing with the increasing frequency of single-stage resection for acute diverticulitis. If a distal anastomosis or surgical site requires proximal fecal diversion, a loop or end-loop ileostomy is growing in popularity.

An ostomy is simply an anastomosis between an endothelially lined organ (e.g., intestine, trachea) and the skin. However, a properly constructed stoma should be free of complications such as retraction, stricture, and prolapse. Although often meant to be temporary, many colostomies are in place for months to years. Every colostomy should be created as if it were to be the patient’s only mode of defecation for life. As in all intestinal surgery, the principles of tension-free construction with adequate blood supply and minimal tissue manipulation result in the best functional outcome.

A colostomy will frequently be a significantly life-altering event, even if only temporary. Whenever possible, it is best to have the patient and family well educated prior to surgery. When available, the preoperative evaluation and marking by a qualified enterostomal therapist results in greatly improved patient satisfaction and functional result [1,2].
INDICATIONS

Colostomies are created to be permanent or temporary; they are created electively, emergently, or incidentally due to an unexpected event in surgery. An elective, permanent end sigmoid colostomy is created as part of an abdominoperineal distal rectal resection for cancer. Alternatively, one creates the same stoma for improved hygiene in a paraplegic or an individual with permanent fecal incontinence. Here, a laparoscopic approach is frequently employed. An elective but temporary sigmoid colostomy is indicated in a patient with a near obstructing rectal cancer who is undergoing preoperative radiation therapy prior to curative resection. A sigmoid colostomy may be indicated in association with complex sphincter/perineal procedures. However, many surgeons prefer an ileostomy for elective temporary fecal diversion.

End sigmoid colostomies are frequently created as part of emergent colonic surgery for obstruction, perforation, or trauma. After resection of a diseased rectosigmoid, the remaining colon or the local environment may not be suitable for immediate reconstruction. The classic example is Hartmann’s two-stage procedure for acute and/or perforated diverticulitis. Lastly, one may need to create a rapid colostomy even if the tissue is adequate in order to complete a procedure expeditiously in an unstable patient.

There are no contraindications to end colostomy creation per se other than complete resection of the colon. Certainly bowel that is of questionable viability or overly manipulated should not be used to create a colostomy. There is little documented evidence in the literature to support the avoidance of stoma creation in an individual with portal hypertension. However, portosystemic shunting will frequently occur, creating a peristomal caput medusae. This can result in gastrointestinal hemorrhage that is difficult to control. Surgical judgment will dictate whether the risks associated with an anastomosis outweigh the potential for anastomatic complications. Consideration should be given to the patient’s ability to care for the colostomy, especially when the location is being chosen. Examples include but are not limited to visual impairment and severe arthritis.

OPERATIVE TECHNIQUE

Mobilization and Preparation of the Colon

The necessity of a colostomy should not alter the technique or extent of resection. Once oncologic or infection control requirements are met, the remaining colon is prepared for colostomy creation. It is my preference to fully mobilize and prepare the colon prior to creation of the trephine. In this way there will be adequate time for any compromise of the distal bowel to present itself prior to maturation. Use of a liner stapler for proximal
division of the colon is helpful in limiting contamination and provides a closed end of bowel that is easy to manipulate through the abdominal wall. At this point, the sigmoid attachments to the pelvis should be divided if not already done. Frequently the left lateral peritoneal reflection of Toldt must be incised as well. The posterior retroperitoneal plane is dissected to free up the left colon and sigmoid mesenteries. Care should be taken to avoid injury to the left ureter and gonadal vessels, as is done during all dissection in this area. Dissection and mobilization should be limited to only that which is necessary to bring the end of the colon 3–4 cm past the skin without tension. Excessive mobilization may compromise blood supply or contribute to stomal prolapse. In the event of complete sigmoid resection, splenic flexure take-down will frequently be required. It may be necessary to divide the to provide length. In this case the artery should be divided as close to the aorta as is feasible so as to preserve blood flow through the proximal arcade. If there is significant fat surrounding the end of the colon, it is helpful to clear it at this time. A distance of up to 4 cm of serosa can be cleared circumferentially without vascular compromise.

Siting the Colostomy

If at all possible, the site of the colostomy on the anterior abdominal wall should be chosen preoperatively and marked by an enterostomal therapist. In the case of an emergent or unplanned colostomy, the following is a helpful rule in patients of almost any body habitus (Fig. 1). A triangle is defined from the symphasis pubis to the umbilicus to the anterosuperior iliac spine (ASIS). This triangle is bisected by a transverse line at the ASIS. Choose the location at or slightly above the center of the upper triangle. Alternatively, in a significantly obese patient, a stoma may be sited superiorly to the umbilicus through the rectus abdominis. This is only a rough guide. If an ET nurse is not available to site the stoma, the surgeon should mark the patient preoperatively. Beginning with the technique above, an appliance is then placed on the patient. The patient is then evaluated sitting and standing as well as supine. If the proposed site overlies a skinfold or falls out of sight, the mark should be adjusted appropriately.

Creating the Trephine

Centered on the spot chosen, using knife or electrocautery a circular disk of skin is removed approximately the size of a quarter. Although this may seem small, the hole will enlarge once the disk is removed. I prefer not to excise a core of subcutaneous fat. Because skin does not stretch equally in all directions, holding the skin aloft and cutting with a scalpel parallel to the floor will often produce an oval opening. This should be avoided. With the skin disk excised, a longitudinal incision is made down to and through
When a site for ileostomy location is being chosen, scars, bony prominences, and the umbilicus must be avoided. (Modified from Corman ML. Colon and Rectal Surgery, 3d ed. Philadelphia: JB Lippincott, 1993, p. 939.)

the anterior rectus sheath. It is critical to keep the midline skin incision aligned with the midline fascial incision. A helpful trick is to grasp the fascia and the dermis with Oschner clamps. Holding the two clamps together will avoid placing the opening in the fascia too close to the midline fascial closure (Fig. 2). With a 2- to 3-cm incision made in the anterior sheath, the rectus muscle is split bluntly down to the posterior sheath/peritoneum. A reliable instrument for this is straight Mayo scissors. With the scissors held closed and aligned in the direction of the rectus fibers, the scissors are bluntly insinuated through the muscle to the posterior sheath. Placing a folded lap pad under the abdominal wall and pressing upward will protect the bowel and allow easy cautery dissection into the peritoneal cavity. The scissors are rotated 90 degrees and opened, separating the muscle evenly and allowing Army-Navy retractors to be placed through the muscle to the posterior sheath. Once the abdomen is entered, the muscular and fascial opening should be enlarged to allow easy passage of the bowel.
Figure 2  Construction of end colostomy. A. Incision of abdominal wall at stoma site to create a circular skin opening. B. Rectus sheath has been incised in a vertical direction, and rectus muscle is split.

By holding the index and second digits of both hands together crosswise through the defect one has a good rule of thumb.

With the trephine completed, a Babcock clamp is passed inward through the hole and can be used as a retractor, lifting the jaws to inspect for bleeding form the peritoneal side. Grasping the stapled end of the bowel with the Babcock, the end of the colon is brought through the abdominal wall and held at least 3–4 cm beyond the skin surface. If there is adequate length of colon, more distance above the skin is preferred.
With the distal aspect of the colon held outside the abdominal wall; one should reinspect for adequate blood supply, hemostasis, and lack of tension. Some surgeons choose to employ methods designed to prevent parastomal herniation and prolapse. These methods include raising peritoneal flaps and tacking the mesentery to the abdominal wall. My personal preference is to avoid these steps. They take time, run the risk of their own complications, and are of questionable value.

Maturing the Stoma

The abdominal wall and skin are closed prior to maturation of the colostomy. Delayed maturation of the colostomy is mentioned only to be condemned. There is no reason in the twenty-first century other than hemodynamic instability not to mature the colostomy during the initial operation.

With the midline incision protected, the distal aspect of the colon is opened. Full-thickness sutures are taken at the cut edge of the colon. The suture is brought down to a seromuscular bite 3–4 cm proximally and then to a dermal bite. The suture should be taken in this order in order to avoid implanting mucosal cells in the dermis (Fig. 3). Care should be taken not to include a full-thickness bite of the skin. My preference is to place four initial sutures—superiorly, inferiorly, medially, and laterally. Any absorbable suture material may be used, such as 3-0 or 4-0 Vicryl or Monocryl. The sutures are placed without tying. With all four in place, the stoma is then everted and inspected. At the surgeon’s discretion, one or two sutures are placed between each of the other four (eight to twelve total). These sutures may simply be from the full-thickness end of colon to the dermis, as the bowel is already everted. When completed, the os, or opening of the stoma, should be in the center. If not, the patient may have significant problems with pouching or leaking under the appliance.

Figure 3  Colostomy maturation. Sutures are placed from the bowel (full thickness) to the deep dermal layer of the skin.
COMPLICATIONS AND PITFALLS

End sigmoid colostomies are easier to manage, with fewer complications than other stomas. Complications are divided into early and late. Early complications are frequently technical in nature and may require immediate intervention. Frequently, observation alone is adequate. Late complications may be the result of early complications but more often are part of the natural history of colostomy. Surgical intervention is frequently required, but enterostomal therapists provide much of the care. Risk factors are the same as for most of abdominal surgery: advanced age, obesity, poor wound healing secondary to diabetes, and poor nutrition. Disease process is not an independent risk factor, but the creation of an emergency colostomy is associated with a higher complication rate [3–5].

By the time one is ready to mature the colostomy, the blood supply should have been unchanged for several minutes. Any demarcation or compromise from inadequate blood flow should be more than evident. Despite this, some type of colostomy necrosis occurs in 2–17% of cases [4]. The mucosa is more sensitive to arterial compromise, and this may become more apparent when the colon is opened. At this point, transillumination is a simple technique to establish adequacy. If the mucosa transmits light well, it will most likely continue to be fine. If blood flow was adequate prior to maturation or before passing the colon through the trephination, ischemia may be due to compromise at the fascial level. An effort can be made to enlarge the fascial opening slightly. If the patient or the colon is cold, arterial spasm may make the mucosa appear marginal. Holding the colostomy in a lap sponge soaked in warmed saline may improve its appearance. Small needle pricks may also demonstrate adequate arterial supply. More commonly, and far less concerning, the venous outflow of the colostomy may be compromised. This usually will not become apparent for many hours after completion of the case. The colostomy appears dark and swollen, often with a purplish hue. Transillumination again is helpful. Despite a dark color, colon with adequate arterial inflow and compromised outflow will still transilluminate well. A colostomy with significant venous congestion may slough its mucosa and appear nearly necrotic but in the end may heal to a viable, well-functioning colostomy. If questions remain as to the colostomy’s viability or if a return to the operating room is considered for revision, bedside endoscopy of the colostomy may be performed. This simple and most rapid technique is performed with a phlebotomist’s test tube and a penlight. After removing the stopper top, a well-lubricated tube is passed through the colostomy. If the stoma is viable, shining the penlight down the tube should demonstrate healthy pink mucosa.

A grossly ischemic or infarcted colostomy calls for a return to the operating room for revision. If the vascular compromise goes below the fascia, repeat laparotomy is in order. If the ischemia is limited to the distal-
most aspect of the bowel, it may be observed and allowed to demarcate. Eventually a skin-level revision should be performed if there is full thickness necrosis. This involves division of the sutures, debridement of the compromised tissue, and rematuration of the stoma. Circumferential ischemia left untended may result in stricture of the colostomy.

Clinically, colostomy retraction is less consequential than ileostomy retraction. A flat colostomy may be well tolerated by many patients. Still, a rise of ½ in. is preferred. Retraction of the colostomy is approached similarly to ischemia. If the colostomy retraction approaches the fascia, relaparotomy is called for. Retraction below the skin level will frequently require surgical attention at some point to avoid stricture and hygiene problems.

Prolapse of an end sigmoid colostomy is a late complication and is less frequent than with loop sigmoid or loop transverse colostomies [2]. Surgical intervention is usually for psychological reasons or pouching difficulties. Rarely, prolapse may result in obstruction or vascular compromise. Simple skin-level revision is adequate in uncomplicated cases. For patients with permanent colostomies, the most common complication is a paracolostomy hernia. Reports vary from 1% to over 60% [5]. The most common complaint is of pain. Incarceration and strangulation are rare complications.

Mucocutaneous separation may occur secondary to ischemia or retraction. In their absence, however, separation is due to improper technique or inadequate closure. Partial separation will be self-limited with time and wound contraction. Complete separation can easily be managed by debridement and revision. Occasionally but surprisingly rarely, contamination or infection of a hematoma or seroma results in an infection or abscess within the trephine. If the infection is limited to the subcutaneous tissue, simple drainage by dividing the maturation stitches will be adequate. A subcutaneous abscess with evidence of cellulitis requires systemic antibiotics. Signs and symptoms of sepsis should prompt a search for an interabdominal source. Recurrent infections indicate a fistula. This may be the result of a full-thickness evertting stitch or an amputated diverticulum. Once established, colostomy fistulas require stomal revision.

Mortality obviously can occur in association with colostomy creation. In one review of 126 patients with 130 end colostomies, there were 7 mortalities. In all cases, deaths were related to emergent operations or comorbid, nonsurgical disease [6].

POSTOPERATIVE CARE AND CONSIDERATIONS
Enterostomal Therapy

If the patient has not had the opportunity to be evaluated preoperatively by the ET nurse, consultation should be obtained as soon as the first postoperative day. The ET nurse is a resource for the floor nurses for stomal evalua-
tion and care. For the patient, the ET nurse is the main source of education and adaptation to this new life change. Often a patient may not be discharged from the hospital until cleared by the ET nurse.

**Irrigation Techniques**

For some patients with a long-standing end colostomy and with stable bowel habits, an end sigmoid colostomy can be “trained” to defecate “on schedule” with routine irrigation. This reduces embarrassment and fears associated with unscheduled or public functioning of the colostomy. In addition to simply washing out the distal colon, irrigation stimulates the more proximal colon to peristalsis and empties the more proximal colon. When done on a regular basis, the results may be quite reliable. Irrigation is performed as a simple retrograde enema administered via a cone-tipped catheter held against the stoma. This reduces stomal trauma and leakage around the catheter. A number of commercial products are available to maintain cleanliness and facilitate emptying into a toilet. The enema is often administered with 500–1000 mL of warm tap water. Fluid is instilled slowly until a sense of fullness occurs. The stoma is allowed to drain and, for approximately the next half-hour, the colon will continue to evacuate.

**SUMMARY**

Although the creation of a colostomy is not particularly difficult, its nuances should not be overlooked. A well-functioning colostomy is taken for granted at its creation. A poorly created colostomy can truly be a life-ending catastrophe. “Temporary” colostomies will frequently turn out to be permanent. If all the principles of surgical anastomoses—such as blood supply and freedom from tension—are observed, stoma creation will remain nearly intuitive.

**ACKNOWLEDGMENTS**

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**REFERENCES**


INTRODUCTION

The construction of diverting stomas is an integral part of many operations for colorectal tumors, trauma, and inflammatory bowel disease. These stomas are formed by exteriorizing and maturing a segment of small bowel or colon in which the continuity of the intestinal wall or mesentery is preserved, most often resulting in a loop or end-loop configuration. Traditionally they are used in clinical situations in which proximal fecal diversion must be performed expeditiously and usually on a temporary basis, such as to protect a low anastomosis, decompress obstructed bowel, or prevent fecal material from further contaminating an inflammatory mass. The advantages of diverting stomas include technical ease of construction and, more important, ease of closure (because a formal laparotomy is seldom required). For these reasons diverting stomas, particularly the loop variety, have become the most frequently used type of ostomy in surgical practice.

Several fundamental questions commonly arise during a discussion of diverting stomas. Perhaps the most common one is: Do diverting stomas completely defunctionalize the bowel? The corollary to that question is: Are diverting stomas necessary? Another important and frequently overlooked issue is: How often are diverting stomas temporary? In addition, there has been considerable discussion about which type of diverting stoma—ileostomy or colostomy—is superior with respect to ease of construction, function, and complications. Finally, what is the role of laparoscopy in creation and closure of diverting stomas? The aim of this chapter...
is to answer these questions and to review the indications, operative techniques, and complications associated with the construction of diverting stomas.

INDICATIONS

Over the past several years, many of the previously absolute indications for diverting stomas have been challenged. A loop or end-loop ileostomy was often created to protect an ileal pouch anal anastomosis in a patient with chronic ulcerative colitis or familial adenomatous polyposis coli. However, some centers have recently described comparable results of ileal pouch anal anastomosis procedures with or without diversion [1–2]. Many surgeons now take a selective approach to this issue, tailoring the use of an ileostomy to the individual patient, taking into account body habitus (pelvic shape and length, mesenteric thickness, or total length of remaining bowel), steroid use, and anastomotic tension. Diverting ileostomy has also been used as a temporizing measure in patients with fulminant inflammatory bowel disease, although most surgeons would probably opt for a more definitive procedure if the patient’s condition permits.

A diverting colostomy is used most frequently to provide proximal fecal diversion in patients with a large bowel obstruction or pelvic sepsis when a malignant tumor, diverticulitis, colorectal trauma, radiation injury, or a complication of inflammatory bowel disease is present. Recently, such a colostomy has been used to protect a coloanal anastomosis as part of a sphincter-saving procedure for midrectal cancer, radiation-induced stricture, or fistulas. Fecal diversion for colon trauma was initially recognized for high-velocity military-related penetrating trauma. This was extrapolated to civilian penetrating colon injuries. Since then, there has been a progressive trend away from diverting stomas for low-velocity civilian penetrating colon injuries to the point that some surgeons do not divert even left-sided colon trauma [3].

We would caution against performing a “blind” transverse loop colostomy in cases of large bowel obstruction without manually exploring the abdomen to ascertain the site and resectability of the obstructing lesion. This type of diverting stoma has no value in relieving an obstruction at the ileocecal region or an obstruction due to a sigmoid volvulus.

A tube cecostomy has often been recommended as a convenient and rapid method of decompressing obstructed large bowel. However, regardless of the diameter of the tube’s lumen, a tube cecostomy is relatively ineffective in diverting the fecal stream. It is also prone to leakage of liquid stool from around the tube, which may result in wound complications or intra-abdominal sepsis.
OPERATIVE PLANNING AND TECHNIQUE

Whenever possible, an enterostomal therapist should be involved in the preoperative planning of a stoma, both to provide information about stoma function and care and to offer support and reassurance to the patient and family. Proper selection and marking of the ostomy site is an important consideration in preoperative stoma planning, because many complications of ostomies are related to improper siting of the stoma. For example, if an ostomy is brought out too close to a bony prominence, such as the costal margin or the iliac crest or within skinfolds, scars, or drain sites, it is usually not possible to obtain an adequate skin seal around the stoma. This situation will invariably lead to leakage of liquid stool around the ill-fitting ostomy pouch, which often results in skin irritation.

The patient should be evaluated in the supine, sitting, and (when possible) standing positions to determine optimal ostomy placement. In emergency situations, the stoma should be brought out through the rectus muscle in a location surrounded by 2–3 in. of flat skin to allow adequate adherence of a pouch. In obese individuals, lower abdominal sites should be avoided because of numerous skinfolds created by the protruding abdomen. Many obese patients will be unable to manage or even see their stoma in these locations.

Diverting ileostomies are usually formed in the right lower quadrant, whereas diverting colostomies are brought out along the course of the transverse or sigmoid colon, depending on the site of injury or obstruction. In a survey of technical considerations in the construction of intestinal stomas, 28% of surgeons responded that they routinely bring a loop colostomy through the main laparotomy incision. We believe that this practice makes it difficult to obtain a leak-free seal around the stoma pouch and produces a generally unattractive result.

It is always preferable to mature a loop stoma in the operating room, even in cases of large bowel obstruction. In the past, it was feared that this procedure would lead to an unacceptable incidence of sepsis, because it was theorized that stool would re-enter the peritoneal cavity around the stoma at the mucocutaneous junction. If the distended bowel is carefully decompressed with a needle attached to the suction tubing to minimize fecal spillage prior to opening the loop, this fear is unwarranted. The advantages of primary maturation of the loop stoma in the operating room setting far outweigh the risks of attempting to mature a stoma at the patient’s bedside on postoperative day 2 or 3, with suboptimal lighting, equipment, and anesthesia.

A laparoscopically or endoscopically assisted approach may be considered for elective or semielective situations where a diverting stoma is needed. The details of the techniques for laparoscopic ileostomy or colostomy...
tomy are described in detail elsewhere in this text. A minimum number of ports are needed; some have even described loop diverting stomas through a single port site [4].

Loop Ileostomy

Construction of a loop ileostomy is technically more demanding than construction of most other types of intestinal stomas. In contrast to colonic content, ileal effluent is liquid and rich in skin irritants, such as bile salts and proteolytic enzymes. In order to avoid complications, such as ileostomy dysfunction and skin irritation, the end of the ileum and its mesentery must be mobilized far enough to form a properly everted protruding ileostomy without compromising its blood supply.

A circular skin incision about 2 cm in diameter is made at the designated point and continued through the subcutaneous fat down to the anterior rectus sheath (Fig. 1). The space created by removing this cylinder of fat in continuity with the overlying skin provides room for the bowel mesentery in order to minimize vascular compromise. A cruciate incision is made in the anterior rectus fascia with each limb extending about 3 cm. A curved hemostat is used to spread the rectus muscle in the direction of its fibers and to expose the posterior rectus sheath or transversalis fascia. Then a short transverse incision is made through this layer and the peritoneum. It is important to ensure that the opening in the rectus muscle is not oblique, and care should be taken to avoid injury to the inferior epigastric vessels. As a general rule, the opening in the abdominal wall should admit two fingers.

When fashioning a traditional loop ileostomy, the surgeon should mobilize the designated loop enough to reach the stoma site on the surface of the abdominal wall without creating undue tension (Fig. 2). A small opening is made in the mesentery of the loop adjacent to the ileal wall, through which a small rubber drain or umbilical tape is passed. The ends of the drain are grasped with a hemostat, and the loop is gently drawn through the stomal aperture. A small rod or similar device is passed through the mesenteric opening of the loop in place of the drain; it is sutured in place to support the ileum on the abdominal wall. In contrast to the situation with a permanent end ileostomy, the mesentery does not need to be fixed intraperitoneally. It is useful to mark the distal portion of the loop with a silk suture at this point to prevent maturing the incorrect or distal end of the stoma. After the abdominal incision has been closed, the loop is opened transversely for about two-thirds of its circumference. This incision should be directed toward the distal end of the loop to ensure enough length to form a properly everted protruding ileostomy. The ileostomy and the defunctionalized ileal limb are sutured to the dermis with absorbable sutures to create a nipple and eversion of the functioning end. Skin protection,
Figure 1  Unplanned loop ileostomy. A. The incision should be placed within the triangle formed by the anterosuperior iliac spine, the umbilicus, and the pubis overlapping the rectus sheath. B. A circular skin incision approximately 2 cm in diameter is made. C. A cruciate incision is made in the anterior rectus sheath. A clamp is used to spread the rectus muscle in the direction of its fibers. D. A transverse incision is made in the posterior rectus sheath or the transversalis fascia. E. The opening in the abdominal wall should admit two average-size fingers. (After Pearl.) (From Ref. 17.)
Figure 2  Traditional loop ileostomy. A. A rubber drain is passed through a small hole in the mesentery of the segment of ileum to be exteriorized as a loop ileostomy. B. A plastic rod is placed through the mesenteric opening to support the loop on the skin and is sutured in place. The loop is opened transversely for about two thirds of its circumference toward the distal end. The longer proximal length of ileum is everted with interrupted absorbable sutures to form a protruding ileostomy. C. Completed loop ileostomy. Note the disparity in size and configuration between the proximal and distal lumens. (After Pearl.) (From Ref. 17.)

usually in the form of a properly fitted methylcellulose wafer [Stomahesive, ConvaTec (Bristol-Meyers Squibb), Princeton, NJ] and an ostomy device are then applied before the patient leaves the operating room. The rod can usually be removed in 7–10 days. In instances where the stoma has been created without tension, the ostomy rod may be omitted.

Loop Colostomy

In many ways the construction of a loop colostomy and a loop ileostomy are similar (Fig. 3). However, because the colon is larger in diameter than the small bowel, it is sometimes necessary to partially divide some of the
Figure 3  Loop colostomy. A. A transverse incision is made in the right upper quadrant. B. The rectus muscle is often partially divided to allow for more complete eversion of the stoma. A transverse incision is made in the posterior rectus sheath. C. A supporting rod is placed and then sutured into position. D. The exteriorized loop of colon is opened transversely for about two-thirds of its circumference. E. The loop colostomy is matured primarily with interrupted absorbable sutures. (After Pearl.) (From Ref. 17.)
rectus muscle at the ostomy site to allow for complete eversion of the stoma. The greater omentum should be dissected from the colon around the point of partial transection to facilitate maturation. As with a loop ileostomy, a rod is placed through the mesentery of the colon to support the loop on the surface of the abdomen; the rod is usually left in place for 7–10 days. Separate fascioseromuscular tacking sutures are not only unnecessary but may, in fact, interfere with the closure. The loop is opened in a transverse fashion for about two-thirds of its circumference. The full thickness of the bowel wall of each limb is everted and sutured to the surrounding skin with interrupted absorbable sutures, so that the bowel wall is nearly flush with the abdominal wall, and a colostomy management system is applied. Again, if appropriate, the ostomy support rod may be avoided.

**End-Loop Stomas**

The rodless end-loop stoma described by Prasad et al. (see Suggested Readings) is a simple modification of a loop stoma with several important advantages. First, it is technically easy to construct. Second, it does not require a supporting rod or a separate opening in the abdominal wall for a mucous fistula. These advantages facilitate stoma care because a single circular ostomy device readily covers the openings of both the proximal and distal limbs without the interference of a rod. End-loop stomas are also easy to close. A formal laparotomy is not required because of the proximity of the two limbs. This fact is a distinct advantage of the end-loop ileocolostomy over the more traditional approach of dealing with the divided ends of the ileum and the transverse colon in cases where immediate ileocolic anastomosis is inadvisable after right hemicolectomy (e.g., right-lower-quadrant end ileostomy and left-upper-quadrant end transverse mucous fistula after penetrating trauma to the right colon). The technical details of the three variations of end-loop stomas are presented in Figs. 4 through 6.

**POSTOPERATIVE CARE AND CLOSURE**

A sterile transparent ostomy pouch should be applied in the operating room so that the stoma can be inspected regularly in the postoperative period. If the margin of the stoma becomes dusky or edematous during the first 24 to 72 hr, it is usually not necessary to revise the stoma. However, a completely dark or black stoma must be evaluated for extension of the necrosis to beneath the fascia, in which case the stoma should be reconstructed on an emergency basis.

As a general guideline, closure of a diverting stoma should not be performed within 8 weeks of its formation. In addition, it is important to make sure that no distal obstruction or evidence of active inflammatory
**Figure 4** End-loop colostomy. A. After abdominal exploration through a midline incision, a circle of skin is excised and an opening is made through the rectus muscle as for an end colostomy. B. The colon is divided with a linear-cutting stapler at a point where both the proximal and the distal limbs of the colon can be brought through the opening in the abdominal wall without tension. C. The entire divided edge of the proximal limb and the antimesenteric corner of the distal limb are gently drawn through the opening in the abdominal wall. After the abdomen has been closed, the staple line of proximal limb is excised completely and only the antimesenteric corner of the distal staple line is removed. D. The proximal limb is matured flush with the skin by suturing full-thickness skin to full-thickness colon with absorbably sutures. Two transition sutures are placed to help mature the mucus fistula, which has the appearance of a “ministoma.” E. Sagittal view of the completed end-loop colostomy. Note the position of the distal staple line in the subcutaneous tissue. (After Pearl.) (From Ref. 17.)

disease that might compromise the anastomosis is present. Endoscopic examination or a high-quality contrast study of the distal limb is usually performed to assess the integrity of the suture or staple line. A standard mechanical and antibiotic bowel preparation is used and may be supplemented with one to two perioperative doses of a cephalosporin administered parenterally. There is evidence that there is no difference between sutured or stapled closure of an ostomy [5]. Furthermore, some surgeons use laparoscopic techniques for closure of diverting stomas.

An elliptical incision is made adjacent to the mucocutaneous junction of a loop or end-loop stoma and is continued downward along the serosal
surfaces of both ends or the bowel until they are fully mobilized (Fig. 7). The skin and the fibrous tissue adherent to the edges of the bowel are excised and a hand-sewn anastomosis is formed between the two ends. With many of the end-loop stomas, a side-to-side stapled anastomosis can be accomplished readily. The reconnected bowel is then returned into the peritoneal cavity and the rectus sheath is closed. The skin may be left open to heal by secondary intention or, in selected cases, may be approximated loosely. The use of intraperitoneal drains is not recommended.

Figure 4  Continued.
Figure 5   End-loop ileocolostomy. A. Severe trauma to the right side of the colon, necessitating right hemicolectomy. The distal ileum and the right transverse colon have been divided with the linear-cutting stapler. B. Both limbs of the end-loop ileocolostomy are brought out through the rectus muscle in the right upper quadrant. C. The end of the distal ileum and the antimesenteric corner of the right transverse colon are gently drawn through the circular opening in the abdominal wall. The mesenteric defect created after removal of the right colon must be closed. The ileostomy is matured in the everted fashion. D. Sagittal view of the completed end-loop ileocolostomy. E. Two transition sutures are placed to help mature the mucous fistula. (After Pearl.) (From Ref. 17.)
COMPLICATIONS

The formation and closure of diverting stomas is associated with an appreciable morbidity. The most important preventive measure is recognizing the magnitude of the potential problems that can develop and, with these in mind, paying strict attention to technical detail. When a complication does arise, it should be recognized promptly and dealt with in an appropriate manner.

Metabolic complications are more common with the formation of a loop ileostomy than with a loop colostomy. The volume of fluid lost from an established ileostomy averages 500 mL/day, including about 60 mEq of sodium. In cases of ileostomy dysfunction, significant sodium and water
Figure 6  End-loop ileostomy. A. The ileostomy incision is placed in the right lower quadrant overlying the rectus muscle. B. The ileum is divided with the linear-cutting stapler at a point where the proximal and distal limbs can be drawn through the abdominal wall without tension. C. The divided end of the proximal ileum and the antimesenteric corner of the distal ileum are gently drawn through the opening in the rectus muscle. The mesenteric defect is closed. D. Sagittal view of the completed end-loop ileostomy. E. Two transition sutures are placed to help mature the distal “ministoma.” (After Pearl.) (From Ref. 17.)
losses can occur and can lead to rapid dehydration. In one study, 23 of 117 patients with loop ileostomies (20%) required hospital admission because of dysfunction. Another metabolic complication of ileostomy is the formation of urinary calculi. This complication occurs in 3–13% of patients and is related to chronic dehydration and sodium depletion. To avoid dehydration, patients with an ileostomy should be encouraged to drink several glasses of water daily.

Cholelithiasis occurs in up to 30% of patients with ileostomies. Gallstones form in these individuals because resection or inflammation of the terminal ileum interrupts the enterohepatic circulation, resulting in malab-
Figure 7  Closure of a diverting stoma. A. An elliptical skin incision is made around both limbs of the ileum. B. After both limbs have been completely mobilized, the ends of the ileum and surrounding scar tissue are excised and a side-to-side stapled anastomosis is made. Care must be taken to avoid injury to the ileal mesentery. C. Closure of the loop is facilitated with a linear stapler. (After Pearl.) (From Ref. 17.)
sorption or depletion of bile acids—conditions that favor the precipitation of cholesterol stones.

One of the most common problems associated with the formation of a loop ileostomy is local irritation and breakdown of peristomal skin, which occurs in about 15% of patients. This complication usually results from improper location of the stoma or other technical problems associated with stoma construction. In a prospective study comparing complications of loop ileostomy with those of loop transverse colostomy, the incidence of skin irritation was greater (30 vs. 13%) in those patients with loop colostomies [6]. The authors explain that, although the median daily effluent of the ileostomy group was nearly twice that of the colostomy group (438 vs. 265 mL), the spout of the ileostomy made collection of the effluent more efficient, thus minimizing leakage around the stoma.

Small bowel obstruction occurs in approximately 10% of patients with loop ileostomies yet is noted much less frequently with loop colostomies. This situation is probably so because the intact transverse or sigmoid mesocolon walls off the small bowel and prevents it from twisting. In contrast, a segment of small intestine can rotate around the base of a loop ileostomy at the point of fixation to the anterior abdominal wall, resulting in obstruction.

Retraction of loop stomas has been reported in 4–13% of patients. Such retraction usually results from inadequate mobilization of the mesentery of the bowel to be exteriorized at the time of stoma creation. The special significance of retraction in loop stomas is that it has been considered a cause of incomplete fecal diversion. The use of fascioseromuscular “tacking” sutures will not alleviate retraction of a loop stoma if the mesentery is under tension. In obese individuals, it may be necessary to make one or more “relaxing” incisions in the peritoneum of the bowel mesentery in order to gain adequate length to properly exteriorize a loop stoma.

Prolapse of a loop stoma, another complication associated with incomplete fecal diversion, occurs in 5–10% of cases. Most frequently it involves the distal limb of a transverse loop colostomy, particularly when this procedure is performed on a patient with a distended colon. Treatment consists of closure of the stoma. In those patients in whom the loop stoma becomes permanent, local excision of the prolapsed segment can be performed and the functioning proximal component reconstructed.

In our experience with 229 patients with end-loop stomas, a total of 30 patients (13.1%) developed complications. Skin excoriation and retraction were most common, each having an incidence of 3.5%. Prolapse was observed in only one patient, probably because the tiny aperture of the mucous fistula prevents the distal bowel from prolapsing through it.

Loop stoma closure is associated with a morbidity reported to be between 10 and 50% and a mortality of 0 to 4%. Wound infections and anastomotic leaks are among the most common complications related to loop
colostomy closure. In a large series of patients with loop ileostomies, 14% developed bowel obstructions within 30 days of closure, whereas anastomotic leaks and wound infections each developed in only 2.5% [7]. One group of authors analyzed data from 93 consecutive colostomy closures in order to compare morbidity and mortality of loop and end colostomies [6]. They concluded that loop colostomy closure is not associated with fewer complications than closure of end colostomy, even though the latter procedure takes longer and is more difficult.

Wound infections necessitate adequate drainage and aggressive local care. Small localized anastomotic leaks may be treated conservatively with parenteral nutrition or a low-residue diet that is high in protein and calories. If the patient begins to show signs of systemic sepsis or complete anastomotic disruption, proximal diversion and drainage or exteriorization of the anastomosis is indicated.

**DISCUSSION**

The indications for fecal diversion and the techniques for stoma creation and reversal have changed over time. Currently, some civilian trauma centers primarily repair penetrating colon injuries, even those injuries to the descending or sigmoid colon. In fact, even in cases of severe penetrating colon injuries requiring resection, the American Association for the Surgery of Trauma (AAST) prospective multicenter trial has shown that primary repair without diversion is equivalent in terms of abdominal complications to diversion [3]. Most centers, however, still divert the fecal stream for rectal trauma.

The use of diverting stomas as an integral part of the restorative ileal pouch anal anastomosis has also changed. While some surgeons still temporarily divert all pouch anal anastomoses, there is some evidence that overall morbidity is comparable when various stoma complications are included. When complications arise in the early postoperative period after formation of an nondiverted ileal pouch anal anastomosis, a loop ileostomy can be placed at a second operation without long-term problems [2].

Perhaps the most compelling question regarding diverting stomas is: Do they completely divert the fecal stream? Several reports have addressed this issue (Table 1). The method of study involved either feeding the patients a barium meal or a radiolabeled tracer (chromium 51) and following the course of the marker through the intestinal tract with sequential abdominal radiographs or nuclear scans. As Table 1 shows, loop stomas diverted the fecal stream effectively in almost every instance, regardless of the consistency of the stool (liquid vs. solid) or a dependent location of the distal limb on the abdominal wall. The only significant factors that led to incomplete diversion were stomal retraction, revision of which reestablished effective diversion, and the presence of a loop stoma for longer than 3 months.
Table 1  Effectiveness of Loop Stomas in Diverting Fecal Stream

<table>
<thead>
<tr>
<th>Series</th>
<th>Year</th>
<th>Type</th>
<th>Method</th>
<th>No. of patients with complete diversion (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rombeau et al. [10]</td>
<td>1978</td>
<td>Colostomy</td>
<td>Barium</td>
<td>25/25 (100)</td>
</tr>
<tr>
<td>Schofield et al. [11]</td>
<td>1980</td>
<td>Colostomy</td>
<td>Chromium 51</td>
<td>10/10 (100)</td>
</tr>
<tr>
<td>Williams et al. [8]</td>
<td>1986</td>
<td>Ileostomy/colostomy</td>
<td>Chromium 51</td>
<td>10/10 (100)</td>
</tr>
<tr>
<td>Fontes et al. [12]</td>
<td>1988</td>
<td>Colostomy</td>
<td>Barium</td>
<td>53/62 (85)</td>
</tr>
<tr>
<td>Winslet et al. [13]</td>
<td>1991</td>
<td>Ileostomy</td>
<td>Chromium 51</td>
<td>22/26 (85)</td>
</tr>
</tbody>
</table>

*When retracted stomas were revised, defunctioning efficiency approached 100%.

Another important but frequently overlooked question is: How often are diverting stomas actually temporary? Table 2 summarizes the results of studies concluding that nearly half of all diverting stomas that were intended to be temporary remain permanent. The usual causes for this change to permanency include patient preference and overall medical condition, nonresectability of the primary tumor, and limited life expectancy. These observations underscore the importance of careful preoperative planning and attention to technical detail in creating a “temporary” loop ostomy in order to minimize long-term morbidity.

Once the decision has been made to create a diverting stoma, the question arises about which type of loop stoma is best, colostomy or ileostomy. The most common method used to defunction the distal colon and rectum is the construction of a transverse loop colostomy. Although this type of stoma is relatively easy to fashion, it has several disadvantages. First, a traditional right-upper-quadrant transverse loop colostomy is often difficult to cover properly with an ostomy device because of its relative bulk and location. Second, the liquid consistency and corrosive nature of the effluent often lead to skin irritation in a relatively flush loop colostomy. Third, the

| Table 2  Change of Loop Stoma from Temporary to Permanent State |
|----------|-------------------|-------------------|
| Series   | Year              | Patients with permanent loop stomas (%) |
| Rutegard and Dahlgren [16] | 1987 | 35/56 (62)        |
offensive odor of colostomy output is a frequent patient complaint. Finally, closure of a transverse loop colostomy is associated with an overall complication rate of between 10 and 50%, with most complications secondary to wound infections and anastomotic leaks.

In contrast, a properly everted loop ileostomy is a better choice for a diverting stoma because it circumvents most of the problems noted here. In a prospective controlled trial comparing loop ileostomy with loop transverse colostomy, ileostomy was associated with significantly less odor, a lower frequency of ostomy device changes, fewer complications of stoma management, and a lower wound infection rate following ostomy closure [8]. A retrospective case-matched study from the Mayo Clinic [9] identified no difference in morbidity or mortality from the operations to form or reverse the respective ostomies. However, patients with loop colostomies did have a statistically significant higher risk of skin irritation and leakage of the stoma appliance. Surgeon preference is likely the overriding influence in many of these cases; however, careful evaluation of the current literature reveals loop ileostomies to be a better alternative for both the surgeon and the patient.

With the advance of technology and increasing experience, the use of laparoscopy has allowed for safe creation and closure of diverting stomas, both ileostomy and colostomy.

CONCLUSION

In summary, the construction of a diverting stoma should be considered a major part of the overall operative procedure. It should be performed by a surgeon who is not only technically skilled but also understands the potential complications associated with an ileostomy or a colostomy. In the majority of cases, loop stomas do seem to effectively divert the fecal stream. Almost half of all temporary loop stomas become permanent, a fact that underscores the importance of placing them in an optimal location on the abdominal wall and paying strict attention to technical detail. Finally, loop ileostomy should be considered a potentially superior alternative to transverse loop colostomy following various colorectal surgical procedures.

SUGGESTED READINGS


REFERENCES

INTRODUCTION

Pillore performed the first right inguinal cecostomy in 1776 to provide decompression for an obstructing rectal carcinoma [1,2]. This technique was not popularized until the 1950s, when cecostomy was advocated for several clinical conditions: (1) distal colonic obstruction, (2) proximal diversion to protect a distal anastomosis, (3) cecal volvulus, (4) decompression of toxic megacolon, and (5) intestinal pseudo-obstruction [3,4]. It should be recalled that cecostomy allowed for satisfactory colonic decompression with minimal anesthetic requirements at a time when large bowel obstruction carried a mortality of 12–56% [5–8]. Two other factors that increased the frequency with which this diversion procedure was performed were the reliance on three-stage resections for complicated diverticular disease and obstructing neoplasms and the perceived need to protect distal colonic anastomoses.

The use of cecostomy as an initial decompressive procedure for distal colonic obstruction has been very successful for decompression of the colon and subsequent preparation of the colon for definitive surgery [9]. However, in most series the mortality rate following decompressive cecostomy was alarmingly high (21.5%) [2–9]. This situation is more a reflection on differences in perioperative care of the patient with large bowel obstruction rather than a specific disadvantage of cecostomy. At the time of cecostomy placement, as many as 10% of patients in these series had cecal perforations that would have been unnoticed if a blind transverse loop colostomy had been chosen as the diversion procedure [9]. Conversely, complementary cecostomy placement performed to protect a difficult distal colonic anastomosis has been associated with few complications. However, it is disconcerting that leakage, with subsequent mortality, occurred as frequently (2%) at the cecostomy site and at the distal anastomosis. Such leakage is a factor that discourages wide application of this form of proximal diversion [1].
The treatment of nongangrenous cecal volvulus has included cecal resection, cecopexy, detorsion alone, and cecostomy with or without cecopexy [10–14]. A preference for nonresectional therapy with viable bowel has been noted, and the lowest recurrence rate appears to be associated with cecopexy and cecostomy tube placement [10]. In such cases cecostomy is most readily achieved through the appendicular stump unless the stump was previously resected. Overall, an approach involving cecostomy and cecopexy is highly successful and is associated with lower operative mobility and mortality than resectional therapy [15].

The use of surgical cecostomy for intestinal pseudo-obstruction had been associated with operative mortality ranging from 25–44%, even with adequate decompression [16–18]. Mortality increases significantly with delay in diagnosis and associated full-thickness necrosis of the bowel wall, usually in the face of significant associated medical illnesses [20,21]. However, the morbidity rates associated with endoscopic decompression are minimal compared to those of surgical cecostomy.

**TUBE PLACEMENT**

Throughout the years a number of techniques and tubes have been advocated for cecostomy. The two most frequently recommended techniques are exteriorization and blind tube cecostomy [9,22–26]. Typically the tube placement procedure is performed through a right-lower-quadrant incision, although Hughes [27] has advocated a formal laparotomy with placement of the cecostomy through a separate stab incision.

The procedure can be performed with the patient under local infiltrative anesthesia, although general anesthesia and regional blocks have been used, depending on the patient’s medical condition. A transverse (McBurney) incision is made in the right lower quadrant to allow access to the peritoneal cavity (Fig. 1A). On entry to the peritoneal cavity, the distended cecum should be readily identifiable. The cecum is carefully and gently inspected for perforations or serosal tears, which can occur in as many as 3% of patients with cecal distention greater than 10 cm [2]. If the surgeon encounters a collapsed cecum, bloody peritoneal fluid, or purulent exudate, the procedure should be terminated in favor of a formal laparotomy, which allows for clearer identification of the pathological condition and definitive treatment. After the cecum has been identified, the cecotomy can be performed by exteriorization or the blind tube technique (Fig. 1B). When exteriorization is used, the cecal pouch is allowed to protrude from the abdominal cavity to skin level. A row of seromuscular sutures is placed prior to opening the cecum to prevent spillage of cecal contents into the peritoneal cavity. A cecotomy is made, and the cecum is sewn to the skin circumferentially with seromuscular sutures (Fig. 1B and C), completing the cecotomy.
Cecostomy

Figure 1  A. A transverse (McBurney) incision is made in the right lower quadrant to expose the distended cecum, which is brought out to skin level through this incision. The peritoneal cavity is then closed circumferentially with seromuscular interrupted sutures. B. After the peritoneum has been approximated circumferentially, a cecotomy is performed. C. The cecotomy is matured by circumferential placement of full-thickness sutures through the cecum to the dermis.

When tube cecotomy is chosen, the cecum is initially sutured to the peritoneum circumferentially to prevent peritoneal soiling. Two concentric purse-string sutures of 2-0 silk are then placed in the cecum (Fig. 2A). A small colotomy is made in the center of the inside purse string, with suction readily available to aspirate the effluent. An important technical point is to place the suction tip at the opening of the colostomy rather than to insert it into the cecum, because collapse of the cecum through suction may prevent adequate removal of the more distal contents. Once the effluent has been controlled, a 22 or 24F soft rubber catheter is inserted through the cecotomy and both purse strings are tied securely. A variety of catheters can be employed, including a de Pezzer catheter, Foley catheter, endotracheal tube, or even a soft rubber chest tube [9–28]. A water-filled balloon catheter has the advantage of being more readily interchangeable, if a change should become necessary, than the de Pezzer catheter. In addition, the water balloon catheter offers a security advantage over a non–balloon-type catheter.
Figure 2  The cecum is exteriorized through a right-lower-quadrant incision. The peritoneum may or may not be approximated to the seromuscular layer, according to the surgeon’s preference. Prior to performing a cecotomy, a double row of seromuscular purse-string sutures is placed around the proposed tube site for the cecostomy. A 24F Foley catheter should be used as the cecostomy tube. First the inner purse-string sutures and then the outer ones are tied securely to hold the cecotomy around the tube and keep it firmly in position B. The skin is closed around the tube. The tube should also be secured at skin level with a separate stay suture. In that the balloon tends to retard accidental dislodgment. After the tube has been secured, the fascial skin layers are closed loosely around the catheter and a light dressing is applied (Fig. 2B).

In recent years, percutaneous cecostomy guided by computed tomography (CT) has been described [29,30]. For this technique, the patient is rolled to the left lateral decubitus position. Only local infiltrative anesthesia is required at the site of tube insertion. A small incision is made, and, under CT guidance, a needle is placed through the retroperitoneum into the cecal lumen. The track can then be gently dilated via the Seldinger technique to allow catheter placement for decompression. Although most reports have involved a relatively small group of patients, the technique has resulted in successful rapid decompression of the cecum. Such decompression usually
Cecostomy is achieved with the use of a 12F catheter. In addition to the significant advantage of requiring only a local anesthetic, there have been no reported cases of major morbidity or procedure-related mortality with this approach [29,31,32]. Subsequently, Morrison et al. [33] have described a transperitoneal approach that excludes the need for CT guidance. This technique requires only fluoroscopy, thereby making the procedure readily available at most institutions. In addition, there are limitations associated with the retroperitoneal approach via CT guidance: (1) what appears to be an extraperitoneal cecum actually may be intraperitoneal because of a thin veil of peritoneal reflection that encircles the cecum and (2) the posterior approach via CT guidance presents difficulties when the cecum is tremendously dilated or when it has twisted anteromedially on its mesentery [16,34]. When the transperitoneal approach is used, the dilated cecum is located fluoroscopically and an area central to the cecum is identified. A 2-in. square of skin and abdominal wall is anesthetized with a local infiltrative anesthetic agent. A specially designed 18-gauge introducer needle loaded with a plastic T fastener is carefully inserted into the cecal lumen. The T fastener is launched from the introducer and used to secure the cecum against the anterior abdominal wall. This step is repeated at each of the four corners of the selected site for tube insertion. After the cecum has been attached to the abdominal wall, the transcutaneous needle track to the cecal lumen is progressively dilated via the Seldinger technique to allow a 24–34F tube to be placed at the initial setting. This technique has been advocated primarily for patients with cecal volvulus or those with distal colonic obstruction. In a small group of patients, the technique has been very successful, with no procedure-related morbidity or mortality reported [33].

For the first 12–24 hr after placement of a cecostomy tube, the tube should be gently irrigated with 30 mL of normal saline every 2 hr. Use of larger volumes may disrupt the seal between the cecum and the abdominal wall, increasing the chance of peritoneal contamination. During ensuing days, the irrigation solution can be increased steadily to 500–1000 mL [9]. As the volume is increased, turning the patient in different positions can allow adequate preparation even as far distally as the descending colon. Between irrigation intervals, the tube must be carefully inspected to ensure that no obstruction has occurred as a result of accumulation of stool or kinking. If unrecognized obstruction occurs, the cecum may burst [9].

**TUBE MANAGEMENT**

Tube management depends on the indication for placement of the tube. When the cecostomy is placed as protection for distal anastomosis, it should be left for 7–10 days. After this time, adequate integrity of the colonic anastomosis should be ensured and the tube can be removed readily. In
most cases, the cecal cutaneous fistula will close spontaneously. Westdahl and Russell [2] have advocated the use of a pressure dressing with a rubber sponge placed over the stoma site to speed closure of the defect. If the cecostomy was placed for initial decompression, it is obviously used for the entire time the decompression is required and should be maintained as a protective measure for the ensuing distal anastomosis. If performed to protect a distal anastomosis and anastomotic integrity has been ensured, the tube can be removed as previously described.

The incidence of complications associated with the cecostomy is generally related to the indications for performance of the procedure, with the highest rates occurring with acute colon obstruction. Specific complications directly related to cecostomy include wound contamination, leakage around the tube, and failure of spontaneous closure [9]. Local wound inflammation occurs in virtually all patients after the tube cecostomy; however, major subcutaneous infections occur in only 3.3–7.5% of cases [2,9]. In most instances, wound inflammation is secondary to reflux of cecal contents around the tube. Such reflux tends to be more severe when the cecostomy has been placed for decompression rather than for simple protection of a distal anastomosis [2]. If leakage occurs around the tube, the tube should be replaced with one of a smaller caliber. Inserting a larger tube simply increases the size of the defect and worsens the situation. In several days, the stoma should retract around the smaller tube, allowing replacement of the original tube and control of the fistula [9]. The most troublesome complication following cecostomy is failure of closure of the cecal cutaneous fistula, which occurs in 15–33% of cases [2,9]. In most instances, this complication occurred when the tube initially inserted was larger than a 30F catheter or when formal exteriorization and maturation of the cecostomy with skin sutures were involved [1,2,9]. Operative closure of the cecostomy is required and a laparotomy is recommended, so that the cecum can be mobilized adequately and closed without producing undue tension or injury to the cecum [2].

**SUMMARY**

Cecostomy was originally employed as a means of colonic decompression for distal obstruction requiring minimal surgical insult. In most cases, the procedure can be performed with the patient under local anesthesia to achieve prompt decompression of the colon. In fact, the fluoroscope-guided percutaneous technique may be the most efficient, least morbid approach to achieving cecostomy tube placement. Although—as perioperative medical management has improved and reliance on staged procedures diminished—the need for cecostomy as a diverting procedure has decreased significantly in recent years, it is still useful for the surgeon to be familiar with the technique.
REFERENCES

I. INTRODUCTION

The end ileostomy remains an important option in the definitive management of many diseases encountered in the colon and rectum despite the availability of restorative options that have diminished its role. A properly constructed end ileostomy continues to afford countless patients an outstanding quality of life [1,2], often at lower risk than its more complex reconstructive counterparts.

II. INDICATIONS

End ileostomy remains a viable alternative to ileal pouch–anal anastomosis for patients undergoing proctocolectomy for ulcerative colitis. It is often preferable in cases of concomitant rectal cancer, in patients with compromised sphincter function, in cases of indeterminate colitis with a high clinical suspicion of Crohn’s disease [3], or in patients whose medical comorbidities preclude a more extensive procedure. Alternatively, the patient simply may not wish to be exposed to the pouch-specific complications (e.g., pouchitis) or multiple surgical procedures that may be required with ileal pouch–anal anastomosis [4]. Similarly, end ileostomy is an alternative to pelvic pouch surgery in patients with familial adenomatous polyposis.

Total proctocolectomy with end ileostomy remains the procedure of choice for patients with Crohn’s colitis whose rectum is unsuitable for anastomosis and in many patients with multiple large bowel carcinomas, particularly if there is a synchronous rectal cancer. An end ileostomy is required in a wide variety of circumstances in which urgent ileal and/or colonic resection is required and an anastomosis is deemed unsafe. A common scenario would be subtotal colectomy for toxic megacolon or refractory colitis (e.g., Crohn’s colitis, ulcerative colitis, pseudomembranous or other infectious colitis) or ileocolic resection for mesenteric ischemia. Disease-specific
factors (e.g., perforation, ischemia, or residual diseased bowel) and patient-specific factors (e.g., malnutrition, hemodynamic instability) must be carefully assessed in determining whether an end ileostomy is the preferred or safest option. Reconstruction may be best performed at a later date under more favorable circumstances.

Several points bear emphasis in this situation:

1. Many such stomas will turn out to be permanent and must therefore be carefully constructed.
2. The distal bowel should be exteriorized by creation of an end-loop stoma [5] (see Chap. 7) or mucous fistula or otherwise positioned to facilitate easy identification and closure at a later date, when possible without the need for a major laparotomy. This relatively simple maneuver may ultimately determine whether the patient will be able to undergo subsequent stoma closure, since some patients who would otherwise be unable or unwilling to undergo a major intraperitoneal procedure will be suitable for a skin level stoma closure.
3. Unnecessary dissection, removal, or division of bowel may compromise later reconstructive efforts.

III. PREOPERATIVE PREPARATION

Appropriate preoperative counseling and preparation by both the surgeon and an enterostomal therapist are crucial components of the preparation for surgery. A thorough discussion of surgical alternatives and life with a stoma can greatly enhance the patient’s and family’s adjustment to an end ileostomy. Preoperative discussions with the enterostomal therapist and willing ostomates can be invaluable in allaying anxiety about a wide variety of pragmatic quality-of-life issues and potentially prevent the social isolation that some patients will experience, particularly in the early postoperative period.

IV. SITE SELECTION

There is probably no more important technical issue affecting quality of life after ileostomy than proper site selection and construction. A face plate should be placed on the proposed site with the patient in both the supine and sitting positions (Fig. 1) to demonstrate skin creases that would interfere with a good seal. For similar reasons, the faceplate should not impinge upon bony prominences and be kept away from surgical scars or damaged skin. The patient’s usual choice of clothing and belt line also need to be considered.
Figure 1  Ostomy siting with patient sitting using a faceplate.

Figure 2  Site marked with indelible pen.
Although the right lower quadrant is typically selected as the site for an end ileostomy, this is not always the best choice. A previous right-lower-quadrant stoma or right paramedian incision may not allow a sufficiently flat surface for a secure appliance. Obese patients often benefit from a stoma in the upper abdomen, where they can more readily see the stoma and care for it. Further, many such patients have considerably less subcutaneous fat in the upper abdomen, facilitating creation of a tension-free stoma.

The site may be indicated with an indelible pen and then more aggressively marked with a needle or the tip of a scalpel blade after induction of anesthesia but prior to preparation of the abdomen. If there will be a delay between stoma marking and surgery, an indelible tattoo may be left for subsequent identification (Fig. 2).

V. OPERATIVE TECHNIQUE

A midline incision is generally preferred. Paramedian incisions may interfere with future stoma sites should the patient require reoperative surgery owing to stoma complications or, for example, recurrent Crohn’s disease.

![Ileum transected with linear stapler](image)
After the diseased bowel is resected, the ileum is transected with a linear cutting stapler (Fig. 3). Unless the terminal ileum requires resection, it is our practice to divide the ileum just proximal to the ileocecal valve. The antimesenteric fatty fold routinely found on the terminal ileum is dissected off and reflected toward the cecum (Fig. 4). The entire ileum may thereby be preserved, which may be of particular importance if the patient later undergoes an ileal pouch–anal anastomosis.

Experience with pelvic pouch surgery has demonstrated that the historical admonitions mandating resection of 5–10 cm of ileum after division of the ileocolic vessels is generally unfounded. As such, we prefer to divide the ileocolic vessels at the level of the mesenteric window that exists almost universally on either side of these vessels (Fig. 5). The small branches remaining in the mesentery are divided up to the level of the divided ileum (Fig. 6). The retroileal fold may then be divided, if needed, to provide for more length. It is crucial that careful mesenteric division and mobilization be performed to facilitate construction of a properly everted ileostomy.

Figure 4 Reflecting fatty fold on ileum.
**Figure 5**  Mesenteric vessels divided at ileum.

**Figure 6**  Branches of ileocolic vessels divided in mesentery.
The preoperatively marked stoma site is grasped with a Kocher clamp. Using the cutting cautery or scalpel, a disk of skin approximately 2 cm in diameter is excised (Fig. 7). Pulling up on the skin with the Kocher clamp makes it simpler to make the circular incision. A second Kocher clamp is placed on the midline fascia to keep all layers of the abdominal wall in alignment. A longitudinal incision is made through Scarpa’s fascia and the remaining subcutaneous tissue bluntly retracted to expose the anterior rectus sheath. A longitudinal incision is then made in the anterior sheath, with small horizontal crosshatches, thereby creating a cruciate incision (Fig. 8). Upward pressure with the nondominant hand inside the abdomen provides for better exposure. The rectus muscle is gently separated with a Kelly clamp (Fig. 9) and the retractors repositioned, exposing the posterior rectus sheath. With continued upward traction from a laparotomy pad over the

Figure 7  Disc of skin excised at stoma site.
Figure 8  Cruciate incision in anterior fascia.

Figure 9  Rectus muscle fibers separated.
intra-abdominal hand, the posterior sheath is incised (Fig. 10). The resulting defect should be approximately two finger breadths in diameter (Fig. 11).

A large Kelly clamp may be placed through the stoma site and lifted upward, providing for excellent visualization of the stoma aperture should bleeding be encountered. A Babcock clamp is placed through the hole and the ileum is gently delivered for subsequent maturation, taking care to ensure that the bowel and its mesentery have not been twisted (Fig. 12). The mesentery should be angled in a cephalad direction. Absorbable sutures may then be placed to affix the mesentery to the anterior abdominal wall from the level of the stoma to the falciform ligament, although this step is probably unnecessary (Fig. 13).

The midline incision, including the skin, is then closed and a towel placed over it for protection. With the stoma site quarantined by surrounding towels or drapes, the staple line is excised. Four absorbable sutures of 3.0 or 4.0 are then placed 90 degrees apart to create an everted stoma (Fig. 14). The suture is first passed through the full thickness of the cut edge of the bowel, then placed seromuscularly approximately 3–4 cm below the cut edge, and then through the subcuticular layer of the skin (Fig. 15). The

Figure 10  Posterior sheath incised.
suture should not be placed through the epidermis, since this can create mucosal islands or dense scar that may ultimately impair pouching of the stoma (Fig. 16).

These four sutures are clamped, rather than tied, to facilitate placement of additional four sutures: one between each of the corner sutures (Fig. 15). These need not include a seromuscular bite and may be tied as they are placed, utilizing the four corner sutures to evert the stoma and take the tension off the sutures as they are tied. The four corner sutures are then tied and a postoperative appliance is affixed (Fig. 16).

VI. COMPLICATIONS

Many stoma complications can be prevented by careful technique and attention to detail. Nonetheless, even a well-constructed end ileostomy may be associated with a technical complication, or a problem may arise related to the patient’s intrinsic disease (e.g., Crohn’s disease). These stoma-specific complications are covered in later chapters.
VII. FOLLOW-UP

Patients undergoing an end ileostomy need to be properly followed and supported after surgery. The initial follow-up appointment should be several weeks after hospital discharge and should include the enterostomal therapist. Much of the initial postoperative edema will have resolved and the appliance will often need to be “downsized” for proper skin protection. Careful early follow-up is often of particular importance to the new ostomate, who may feel isolated owing to new physical and emotional challenges. Each new season in the first year brings forth somewhat different issues (e.g., clothing, diet) that may require experienced assistance. Thereafter, follow-up may be individualized.
Figure 13  Suture of mesentery to anterior abdominal wall.

Figure 14  Everting the stoma.
End Ileostomy

Figure 15  Intervening sutures placed.

Figure 16  Completed stoma.
REFERENCES


INTRODUCTION

The achievement of continence, the ability to control the time and place of evacuation of intestinal waste, is one of the earliest developmental milestones in nearly all human societies. Until relatively recently, surgical creation of any kind of intestinal stoma was virtually certain to result in the loss of this most basic function. Over the past 30 years considerable effort has been devoted to the development of means by which continence can be re-established for the person with an intestinal stoma.

CONTINENT ILEOSTOMY

Early work in the field of stomal continence was performed in the 1960s by Professor Nils G. Kock at Sahlgren’s Hospital in Goteborg, Sweden [1]. Kock found that a double-folded ileal pouch provided a low-pressure reservoir capable of “storing” the intestinal effluent [2]. Early clinical results using this technique were encouraging, but not all patients achieved satisfactory continence. Reliable stomal continence was realized in 1972 with the addition of a “nipple valve,” formed by intussusception of the intestinal segment distal to the reservoir [3].

The Kock pouch was enthusiastically embraced by patients who would otherwise have required a permanent Brooke ileostomy. Most continent ileostomies were performed for young adults suffering from chronic mucosal ulcerative colitis. The majority of these patients felt that the reservoir ileostomy significantly improved the quality of their lives. Many were quite willing to undergo multiple revisional procedures rather than return to an external ostomy device.

Initial enthusiasm for the Kock pouch was tempered by numerous early failures. Many surgeons found that the procedure was technically de-
manding and difficult to master. These obstacles placed this operation out of the reach of all but the most dedicated and interested surgeons. Even technical mastery did not guarantee good functional results. The intussuscepted nipple valve proved to be an unreliable closing mechanism. Incontinence caused by slippage or desusception of the valve was reported in nearly 50% of early cases [4–7].

Despite early failures, growing patient demand for a reliable continent ileostomy stimulated the pursuit of improved long-term results and decreased morbidity. Novel experimental and clinical techniques were conceived with these goals in mind. For example, continence was achieved in nonreservoir ileostomies by intestinal intussusception [8] and indwelling catheter occlusion [9]. Although both techniques provided continence, neither approach gained widespread acceptance.

Most investigators concentrated on improving the valve mechanism of the reservoir ileostomy. Many believed that the intussuscepted nipple valve was basically a sound concept and that improved long-term stability could be achieved by modifying the construction techniques. Others reasoned that the intestinal valve was intrinsically flawed and that its replacement by a prosthetic occlusive device would be a better option. The middle ground was taken by those who felt that supporting the intussuscepted nipple with a prosthetic or natural girdle would offer a better solution.

Steps to improve the reliability of the original Kock nipple valve were undertaken early in the evolution of the procedure. Stripping the serosa from the intussuscepted segment, staple fixation of the valve, and application of a special “rotational suture” proved to be useful and effective adjuncts [1]. Prolonged postoperative pouch intubation also helped to reduce valve complications [10].

Complete replacement of the valve by various prosthetic mechanisms was also investigated. The Mayo Clinic group found that a cuffed Silastic catheter, similar to an endotracheal tube, restored continence in “failed” Kock ileostomies [11] (Fig. 1) Fendel and Fazio [12] replaced the nipple valve by a porcine aortic valve in an experimental model. A mucosal “flap” valve was created in another experimental setting [13]. Magnetic closing caps were implanted successfully in two patients [14]. Although the devices subjected to clinical trials were able to maintain continence, various complications and limited patient acceptance prevented widespread adoption of these techniques.

A different approach was taken by Fazio, Cohen, Barnett, and others. They found that the intussuscepted nipple valve was more stable when it was mechanically supported at its function with the pouch and the outflow tract. A strip of fascia [15], Marlex, or Prolene [16] and, later, an ileal limb [17] was used to buttress the valve. Short-term results were promising. A dramatic decrease in the rate of valve desusception was reported. However,
an equally dramatic rise in the rate of late fistula formation was associated with use of the various plastic materials [18,19].

Despite improved functional results, interest in the continent ileostomy faded during the 1980s with the revival of a procedure abandoned three decades previously. In 1977 Martin et al. [20] reported successful preservation of continence after total colectomy by mucosal proctectomy and ileoanal anastomosis. In 1978, Sir Alan Parks combined abdominal colecotomy and mucosal proctectomy with an ileal pouch and pouch-anal anastomosis [21]. This new procedure completely eliminated the need for a permanent abdominal stoma. Use of the anal sphincter as the pouch closing mechanism effectively solved the valve problem. Although the new procedure had its own complications, enthusiasm for restorative proctocolectomy by ileal pouch—anal anastomosis grew quickly among patients and surgeons. By the late 1980s, call for the continent ileostomy had virtually cease [22].
Indications and Patient Selection

Continent ileostomy remains a therapeutic option open to selected patients who would otherwise require a permanent end ileostomy. Most candidates for this procedure have chronic mucosal ulcerative colitis or familial adenomatous polyposis. Some of these patients will choose the continent stoma as a primary or secondary procedure because of personal lifestyle considerations. For others, reservoir ileostomy may be the only continence-preserving alternative when the anal sphincter is unsuitable because of weakness, disease, surgical extirpation, or failure of a previous ileoanal procedure [23].

Selection of appropriate candidates for reservoir ileostomy is of the utmost importance. The risk of complication is significantly greater in certain patient populations. Long-term management of the stoma requires both cognitive and manual skill. All candidates must demonstrate the physical and emotional maturity needed to cope with ordinary and occasionally extraordinary stomal maintenance.

Patient education is equal in importance to patient selection. The mechanics of the reservoir ileostomy, as well as its potential risks and benefits, must be clearly, completely, and honestly explained to all suitable candidates. Candidates must become familiar with the concept of the reservoir and the valve. They must accept the possibility that the procedure may be abandoned intraoperatively because of unexpected findings or circumstances. The risk that repeated revisional surgery may become necessary must be clearly understood. We find it helpful to have a candidate for surgery speak to a patient who has undergone the procedure.

Continent ileostomy is not recommended in patients with Crohn’s disease, suboptimal nutritional or immunological status, or short bowel syndrome [22,24,25]. These conditions raise the risk of complication to an unacceptably high level. Emergency surgery, extremes of youth or age, obesity, and inability to intubate the pouch because of mental or physical impairment are also considered contraindications to a reservoir ileostomy [22,24,25].

Operative Technique

Preoperative preparation includes standard mechanical and antibiotic bowel preparation and enterostomal counseling. With the patient under general anesthesia, the abdomen is entered through a midline incision. When indicated, proctocolectomy, proctectomy, or take-down of a standard ileostomy is performed in the standard fashion. In all cases, every effort is made to preserve the ileal blood supply and conserve maximal ileal length.

The complete continent ileostomy is constructed from the terminal 45 cm of ileum. The nipple valve, outflow segment, and stoma are created from the most distal 15 cm. The reservoir is made from the proximally adjacent 30 cm of intestine.
The pouch is created first. The antimesenteric border of the ileum is grasped with a Babcock clamp 30 cm from the cut end. This distance should be accurately measured with a marked scalpel handle or sterile ruler. The bowel is then folded upon itself with the 30-cm point resting at the apex of the loop.

The antimesenteric borders of the ileal loop are approximated with either staples or sutures. When sutures are used, a running layer of 3-0, long-term absorbable suture is used to approximate the antimesenteric borders of the opposed limbs. This suture line runs for a distance of 15 cm from the loop’s apex (Fig. 2). The approximated ileal limbs are opened with electrocautery parallel to the suture line. The incision in the afferent limb is continued proximally 2–3 cm beyond the distal termination of the incision in the efferent limb. This method will allow the afferent and efferent limbs to be separated when the pouch is closed. Both enterotomies are continued to the tip of the loop, where they meet. A second layer of running, 3-0, long-term absorbable suture joins the two cut edges, leaving a U-shaped pouch of small bowel open toward the inflow and outflow tracts (Fig. 3).

Alternatively, a 90-mm linear stapler can be used to fashion the pouch. In this case, the bowel is opened with electrocautery along the antimesenteric borders of both of the opposed ileal limbs for a distance of 15 cm.

**Figure 2** Construction of continent ileostomy from distal 45 cm of ileum. Most distal 15 cm is used to form the valve and the outflow tract. Adjacent 30 cm of small bowel is folded on itself to form the pouch. Running 3-0 absorbable sutures approximate the antimesenteric borders. Both limbs are then opened parallel to the suture line (dashed line). Note that incision in proximal limb extends 2 to 3 cm beyond the end of the suture line.
from the apex. The cut edges of the adjacent limbs are stapled with two applications of the 90-mm stapler. The incision in the afferent limb is continued proximally 2 to 3 cm beyond the end of the staple line.

The nipple valve is constructed from the 10 cm of distal ileum adjacent to the reservoir. The intussuscepted valve will be about 5 cm long. Multiple techniques are employed to promote permanent fixation of the valve in the intussuscepted position. These include thinning of the valve mesentery, scarification of the intestinal surface, and placement of sutures and staples.

Preparation of the ileal segment for intussusception begins by reducing its mesenteric bulk. This reduction is accomplished by excising the fat between the blood vessels (Fig. 4). Exceptional care must be exercised during this maneuver so that injury to the segment’s blood supply is avoided. The serosa is then abraded with a fine rasp and scored with electrocautery. Scattered subserosal injections of a concentrated tetracycline solution are also helpful in promoting adhesion between the opposing surfaces.

Three 3-0 silk seromuscular sutures are placed on both sides of the mesenteric border, equidistant from the point of intussusception (Fig. 5). When tied, these sutures will help to maintain the intussusception. Rotation of the valve is not necessary. A Babcock clamp is passed from the pouch into the distal ileal segment and the wall is grasped 5 cm from its junction with the reservoir. Gentle traction applied in the direction of the pouch lumen will cause intussusception of the segment. The previously placed silk
Figure 4  Mesenteric fat between blood vessels is excised in preparation for valve intussusception.

Figure 5  Serosal surface of the valve segment is abraded. Silk seromuscular sutures are placed on both sides of the mesentery.
seromuscular sutures are sequentially tied as the segment is intussuscepted (Fig. 6A and B).

The valve is further stabilized by three rows of staples, one placed on either side of the mesentery and the third on the antimesenteric border (Fig. 7). These staples are most easily placed with a bladeless linear stapler-cutter. In addition, six to eight 3-0 silk sutures are passed through all layers of the valve. To minimize the risk of nipple fistula, these sutures should enclose only a small bridge of tissue and should not be tied so tightly as to strangulate the encircled bowel. Lastly, a row of interrupted 3-0 silk sutures fixes the base of the valve to the surrounding pouch wall at its point of exit (Fig. 8).

The pouch is closed by bringing the apex of the U to the base of the valve (Fig. 9A). A double layer of running 3-0 long-term absorbable sutures is used to close the enterotomy (Fig. 9B). Alternatively, two applications of the 90-mm stapler can be used to close the pouch. When the reservoir is complete, competence of the valve is tested. The inflow tract is occluded with an intestinal clamp. A bullet-nosed catheter is passed into the pouch through the outflow tract and valve. Air is insufflated and the catheter removed. The pouch should remain distended.

Barnett recommends encirclement of the outflow tract with an ileal “collar,” thereby creating a “Barnett continent intestinal reservoir” (BCIR) [26]. In Barnett’s modification, the U-shaped pouch and intussuscepted valve are made as previously described. The ileal segment in continuity with the proximal bowel is transected 10 cm from the pouch. The 10-cm segment of ileum that remains connected to the pouch will be fashioned
Figure 7  Valve is secured with three rows of staple or silk sutures. Staples are placed with a bladeless instrument.

Figure 8  Interrupted silk sutures are used to secure the base of the valve to the outflow tract.
Figure 9  a. Pouch is closed by folding the apex of the U to the base of the valve. b. Pouch is completed by placing running absorbable sutures from the corners to the apex.
Figure 10  Continuity between the pouch and the terminal part of the ileum established with EEA (U.S. Surgical Corp.) instrument.

into a collar supporting the valve. After the inflow segment is transected and prior to closure of the anterior pouch wall, the apex of the pouch is stapled to the cut end of the distal ileum (Fig. 10).

The collar is created as follows:

A defect in the mesentery at the base of the valve [is] created, and the end of the distal segment of intestine [is] drawn through and sewed around the base of the valve to form a collar (Fig. 11a,b). Cotton sutures

Figure 11  a. Access segment mesenteric defect has been created. b. The intestinal segment is passed through the mesenteric defect at the base of the valve.
[are] used to fix the collar to the access segment above and to the pouch below. The end of the collar [is] sutured to its origin to form a complete circle. A snug fit of the collar should be accomplished and additional sutures [are] placed if necessary. The optimal level of collar constriction [is] achieved by placing the index finger through the access segment and palpating each degree of incremental tightening [26] (Fig. 12).

The flush stoma is created from the pouch outflow segment. The position of the stoma on the abdominal wall is determined after placing the reservoir in the pelvis. The outflow tract should traverse the midportion of the right rectus muscle without angulation or redundancy. In most cases, the stoma will lie just above the pubic hairline. The stomal defect in the anterior abdominal wall is made by excising a 2-cm disk of skin. The subcutaneous fat is retracted and the fascia opened by a cruciate incision. The fibers of the rectus muscle are split and the peritoneum is incised. The defect should easily admit two fingers.

Before bringing the outflow tract through the abdominal wall, the pouch is rendered heart-shaped by pushing the lateral “ears” into the leaves of the mesentery. Four 3-0 silk anchoring sutures are passed from the pouch to the peritoneum surrounding the stomal site (Fig. 13). The outflow tract is passed through the abdominal wall defect and the anchoring sutures are tied. A closed suction drain is placed in the right gutter, lateral to the pouch. The end of the drain is brought out through a separate abdominal wall stab wound.

The stoma is matured before the abdominal wound is closed. The exteriorized ileum is trimmed until the cut edge is flush with the skin. The

![Figure 12](image-url)  
**Figure 12** Collar stoma allows free communication with the pouch.
ileal edge is anchored to the dermis with interrupted 3-0 long-term absorbable sutures. An ileostomy catheter introduced through the stoma should enter the pouch without difficulty.

A crosspiece is fashioned from a 3-in. segment of 32F rubber tubing by cutting 1-cm holes in the middle of the opposing walls. The crosspiece is used to anchor the ileostomy catheter to the abdominal skin. The ileostomy catheter is passed through the holes in the crosspiece and then inserted into the pouch. The catheter’s position within the pouch is ascertained by palpation. The catheter is held in this position and the crosspiece is brought to skin level. The crosspiece is then sutured to the abdominal wall skin. The abdominal wound is closed and dressed in standard fashion (Fig. 14). The ileostomy catheter is attached to gravity drainage.

**Postoperative Management**

The pouch is irrigated with 20 mL of normal saline instilled through the catheter every 4 hr for the first 24 hr after surgery. Continuous gravity drainage is maintained between irrigations. On the second day, the frequency of irrigation is reduced to every 8 hr. This irrigation schedule is continued for the remainder of the hospital stay. In the early postoperative
period, it is imperative that the ileostomy tube remain within the reservoir. If the catheter slips out, edema of the nipple valve will make reinsertion difficult. Therefore, utmost care must be exercised during dressing changes and irrigations to prevent catheter dislodgement.

Bowel function usually returns by the fourth or fifth postoperative day. Progressive refeeding begins at that time. The diet should exclude indigestible fruits, nuts, and vegetable material so that plugging of the catheter is avoided.

In the early 1980s patients were kept in the hospital 3 weeks or more following Kock pouch surgery. This is no longer feasible or necessary. Most patients with uncomplicated courses can be discharged by the fifth to seventh postoperative day. Discharged patients go home with the ileostomy catheter in place. The catheter is occluded with a plastic button beginning on the fifth or six postoperative day. Evacuation of the pouch by “uncorking” the catheter is performed every hour during the daytime. Gentle pouch irrigation with a small quantity of saline is performed with each evacuation to ensure catheter patency. The patient should be cautioned to avoid straining or pushing to speed evacuation of the reservoir.

At home, the catheter is returned to gravity drainage at night. The interval between pouch evacuations is progressively lengthened by 15 min per day over the 2 weeks following discharge. The maximal interval between evacuations should not exceed 2 hr during this period. A follow-up appointment is arranged for 2 weeks after discharge. The patient is instructed to avoid high-fiber foods until the first postoperative visit.

At the first postoperative visit, usually 3 weeks from surgery, the wound and stoma are inspected. The catheter is removed from the pouch

Figure 14 Procedure is complete. Stoma, matured flush to skin level, is just above the pubic hairline. A No. 28 ileostomy catheter has been placed in the pouch and fixed firmly in place with a rubber collar sutured to the skin.
and the patient is taught the technique of pouch intubation. Most patients master this technique quickly. The catheter should pass into the pouch without difficulty, encountering only minimal resistance at the level of the valve. Patients are instructed to intubate the pouch every 2 hr while awake and once during the hours of sleep. This regimen is continued for another 2 weeks. The diet is liberalized to include fruits, nuts, and vegetables in limited quantities. Another visit is scheduled for 2 weeks later.

At the second postoperative visit 5 weeks from surgery, most patients report that continence is perfect for feces and gas and that intubations are uncomplicated. If all is proceeding smoothly, the patient is instructed to omit the nighttime evacuation. Fiber can gradually be reintroduced into the diet. The interval between evacuations in increased by ½-hr increments every 2–3 weeks. The maximum time between intubations should not exceed 5 hr. The patient is reminded not to strain while emptying the pouch and that continuous intubation is recommended during periods of prolonged coughing or sneezing for the first 6 months.

**Functional Results**

The vast majority of patients are satisfied with the outcome of their surgery [27–32]. Although surgical revision of the nipple valve may be required, ultimately more than 90% of patients are perfectly continent or do not require the use of an appliance [6,24,25,28,32–34]. Most patients evacuate the pouch three or four times daily. The stoma is covered with a small dressing between intubations. The flush stoma does not interfere with clothing or physical activities [27–32]. Full-term pregnancy and uncomplicated vaginal delivery are possible in women with continent stomas [35]. Patients whose standard ileostomies were converted to reservoir ileostomies viewed their quality of life as substantially better [30,31].

Long-term outcome data for patients who had undergone continent ileostomy surgery have been collected [28,36]. At a mean interval of 11.4 years (range 1–21 years) from surgery, 60% of patients still had functioning reservoir ileostomies, whereas 36% had had their pouches removed with conversion to standard ileostomies. The indications for pouch removal included valve dysfunction (42%), refractory pouchitis (23%), multiple fistulas (26%), Crohn’s disease (6%), and “other” indications (16%) (four patients had two indications). Although in approximately one-third of patients the pouch had to be removed, 97% of the remaining two-thirds had a good to excellent outcome [36].

**Complications**

Creation of a continent ileostomy is associated with a variety of early and late complications [4,6,24,25,32–34]. Some problems, such as adhesive
small bowel obstruction, are not unique to the complex stoma but are common to all major intra-abdominal procedures. Others are specific to the reservoir and valve of the continent ileostomy. Specific complications can be divided into those occurring in the early postoperative period. Hemorrhage, pouch leakage, and ischemia of the outflow tract or valve tend to occur during this time. Most late complications particular to the continent ileostomy involve the nipple valve. These include valve slippage, fistula, and prolapse. The reservoir itself is prone to a form of mucosal ileitis termed pouchitis [4,6,24,25,32–34].

Most authors have reported a lowered complication rate as experience with the procedure and technical modifications have evolved. However, an overall reoperation rate of 12–66% has been reported in large series [6,24,33,34]. In more recent studies, the incidence of reoperation is approximately 15%. This rate is compared to a reported reoperation rate of 18–23% for large series of standard ileostomies [37,38].

**Early Complications**

**Hemorrhage** Hemorrhage from the reservoir is usually noted at approximately the seventh postoperative day [25]. The indwelling catheter returns bloody fluid spontaneously or after irrigation. Bleeding is occasionally brisk, and transfusion may be required. The site of bleeding is most often one or more of the pouch suture lines.

This complication can usually be managed nonoperatively in the hemodynamically stable patient. Bleeding will often cease spontaneously if the pouch can be maintained free of old blood. This state is best achieved by frequent saline irrigations. The addition of norepinephrine to the irrigation fluid is helpful. Systemic vasopressin has been used successfully in extreme cases [10,25]. Fiberoptic or rigid ileoscopy should be avoided because of the risk of perforation. Surgical exploration to control hemorrhage is almost never required. When laparotomy is necessary, excision of the pouch and creation of a standard ileostomy is recommended by some [25].

**Suture Line Dehiscence** Suture-line dehiscence is rare and can usually be avoided by scrupulous operative technique and careful postoperative management. This complication occurs in about 2% of cases [6,33]. It presents with the symptoms and signs of localized or free visceral perforation.

Fluid resuscitation and systemic antibiotics are virtually always indicated [25]. Leakage during the first postoperative week is often poorly contained and frequently leads to generalized peritonitis. In this situation, re-exploration for drainage and proximal diversion is necessary. Excision of the reservoir is almost never indicated. Between the second and fourth weeks, localized abscess and pouch–cutaneous fistula are more common [25]. This complication usually can be managed without laparotomy.

**Fistula** The reservoir ileostomy is prone to two distinct types of fistula: internal and external. External fistulas cause an abnormal communica-
tion between the pouch and the skin (Fig. 15). Internal fistulas traverse both limbs of the intussuscepted valve, causing communication between the lumen of the pouch and the lumen of the valve (Fig. 16). Either type of fistula can appear as an early or late complication.

Early postoperative fistula formation occurs in about 2% of cases [6,33]. Pouch-cutaneous or external fistulas are somewhat less common than fistulas involving the nipple valve. An early external fistula tends to arise from the region of the confluence of the reservoir suture lines near the base of the nipple valve. Typically it is manifest during the second or third postoperative week as either a localized peristomal abscess or cellulitis. Spontaneous or surgical drainage leads to an enterocutaneous fistula.

This complication is usually managed without laparotomy. Systemic antibiotics and sump drainage of the reservoir are indicated [25]. A collection, if present, is drained by incision or percutaneous catheter. In most
instances healing is complete within 2–3 weeks. Total parenteral nutrition and octreotide are useful therapeutic adjuncts that can speed fistula closure.

Early nipple-valve or internal fistulas also present during the second or third postoperative week. These fistulas appear to be caused by pressure necrosis of the tissue under one of the silk sutures placed through the full thickness of both segments of the intussuscepted valve [25]. Leakage of intestinal contents around the ileostomy catheter is the common presentation. The magnitude of leakage will depend on the size of the fistulous tract and its proximity to the base of the valve. Larger tracts nearer the base of the nipple will cause a greater volume of leakage.

This complication is managed nonoperatively in the immediate postoperative period. An initial trial of antibiotics and continuous sump drainage of the reservoir are warranted. Drainage of intestinal contents around the catheter is controlled by placing a standard ileostomy appliance around the intubated stoma. A small percentage of cases of early nipple fistulas will heal completely within 1–2 weeks without further intervention. Others, especially those located near the tip of the valve, may shrink to a point at which continence is only minimally affected when the catheter is removed. These valve fistulas are best left alone unless the patient is intolerant of the volume of leakage.

Fistulas that result in symptomatic incontinence and do not close by 4–6 weeks from the initial surgery will usually require operative repair. These fistulas are then managed in the same fashion as late nipple fistulas.

Ischemia Compromise of the blood supply to the distal portion of the ileum causes ischemia of the outflow tract, the valve, or both. Compression or disruption of the intussuscepted mesentery of the nipple valve is usually the cause. A valve longer than 5 cm, excessive fattiness of the valve mesentery, and overvigorous suturing or stapling of the valve at its mesenteric borders predispose to ischemia by compression [25]. Direct damage to the vasculature of the valve may occur during removal of mesenteric fat.

Ischemia usually becomes manifest within 48 hr of surgery. Dusky discoloration of the stoma, bleeding around the catheter, and bloody returns with irrigation are the hallmarks of poor distal vascularity. Fever and pain are common, especially with tissue necrosis. Frequent irrigation of the ileostomy catheter, administration of systemic antibiotics, and close observation are the best early treatments [25]. Ischemia caused by mesenteric edema may resolve without additional therapy. Progression of the ischemic process can result in necrosis of the outflow tract, the valve, or both.

Outflow Tract Problems Chronic ischemia of the outflow tract leads to stenosis of the stomal segment, usually at skin level. Continence is almost always maintained. The problem becomes manifest when the patient begins intubation of the pouch. Progressively increasing difficulty with catheter insertion is the common presentation. This complication is best
managed by a 1- to 2-month trial of continuous pouch intubation. The catheter is capped with a plastic button and the reservoir emptied intermittently. If the problem persists after this period, elective operative repair by double Z-plasty is recommended.

Ischemic necrosis of the outflow tract causes separation at the mucocutaneous junction and ileal “retraction” by dissolution of the distal bowel. The subcutaneous tissues at the stoma site are exposed, usually resulting in peristomal cellulitis. Sump suction of the reservoir and administration of systemic antibiotics are indicated for early management [25]. Healing will usually occur without immediate surgery, although stricture is almost certain to follow. Continence is maintained unless the valve is also affected.

Stomal revision can be delayed until the pouch has completely healed, usually 2–3 months after the initial surgery. The patient can maintain patency at skin level either by continuous intubation or with an infant pacifier placed in the stoma site between intubations [25]. Stomal revision by double Z-plasty is recommended.

Valve Necrosis Further progression of outflow tract ischemia results in valve loss by ischemic necrosis. This complication occurs in less than 2% of cases [6,33,34]. The patient will usually experience pain and fever. Blood clots, necrotic debris, and sutures or staples may return with reservoir irrigation. Leakage of intestinal contents around the catheter will occur as tissue loss results in valve shortening. When valve necrosis is identified, sump suction of the reservoir and systemic antibiotics should be instituted. Immediate operation is rarely indicated, as healing, albeit with incontinence, usually occurs spontaneously [25].

Revisional surgery can often be delayed until the pouch has healed completely [25]. The ileostomy catheter is left in the reservoir throughout the hospital period and for the 2–3 months following discharge. Leakage is controlled by the addition of a standard ostomy device fitted around the intubated stoma. Later, 2–3 months after the initial surgery, the patient is readmitted to hospital for revision. Creation of a new valve involves “turning the pouch” [39].

Late Complications
Valve Slippage The most common late postoperative complication of the Kock ileostomy is desusception or slippage of the nipple valve [4,6,24–28, 33,34]. Early experiences with the procedure were complicated by valve desusception in from 40–50% of cases [1,6,28,34]. With advances in valve stabilization techniques and increasing experience, the incidence of desusception has fallen to 3–12% [6,24–26,28,33]. Most of the patients in this group will require surgical revision of the valve. One-quarter of them will require a second revision [33].

Considerable effort has been devoted to development of techniques for improving valve stability. Destruction of the serosa, thinning of the
mesentery, and suture or staple fixation of the valve are currently standard modifications of Kock’s original technique [1,24,40]. Circumferential silk sutures placed from the pouch to the outflow tract have also contributed to reduction in the rate of valve slippage.

Additional work has focused on supporting the valve at the junction of the pouch and the outflow tract. The earliest efforts involved encircling the base of the valve with a strip of fascia [15] or polypropylene mesh [16, 33,41]. These techniques reduced the incidence of valve slippage but contributed to a much higher rate of fistula formation [18,33]. Substitution of other synthetic materials—including Mersilene, Teflon, and Gore-Tex—has also resulted in an unacceptably high incidence of fistula formation (Bauer et al., 1978, unpublished). Anchoring the valve to the pouch wall with staples has been suggested as a means of improving stability that is associated with a lower rate of fistula formation than that seen with synthetic materials [42].

Replacement of a prosthetic buttress with an ileal collar has gained popularity over the past 10 years [26]. Published data have shown an incidence of valve slippage of 6.3% and an overall complication rate of 12.8% occurring from 1–5 years postoperatively [43]. A novel pouch and valve design was recently described by Kaiser and colleagues [44]. The T pouch uses a valve mechanism that omits intussusception of the bowel and maintains the blood supply to the valve segment. In a small series of patients followed for 2–18 months, results were fairly good [44]. With greater experience, and longer follow-up, this technique may prove useful.

Nipple valve dysfunction by desusception is most likely to occur within the first 2 postoperative years [24,33]. The problem usually begins with dehiscence of the opposing mesenteries within the intussuscepted valve [1] (Fig. 17). The nipple desuscepts asymmetrically, causing disproportionate lengthening of the mesenteric wall of the outflow tract. The intact, antimesenteric portion of the valve is pulled toward the longer mesenteric wall, angulating the valve mechanism (Fig. 18). Asymmetrical “unrolling” of the valve initially causes difficulty with intubation. Further desusception leads to valve shortening and incontinence.

Progressive desusception with resulting angulation often leads to complete inability to intubate the pouch. Therefore intestinal obstruction is a common emergency presentation [6,24]. Initial management is directed at relieving obstructive symptoms. Pouch intubation can be accomplished by fiberoptic or rigid ileoscopy using a pediatric gastroscope or an 11-mm rigid sigmoidoscope [45,46]. A guidewire or the shaft of a long cotton-tipped swab is left in the pouch and the endoscope is removed. An ileostomy catheter is threaded over the guide and taped in place.

At the first episode of valve dysfunction, a trial of prolonged reservoir intubation is warranted. This trial often stabilizes the valve, allowing it to become fixed in the new position. The patient is instructed to leave the
catheter taped in place for 2–3 weeks. The end of the catheter is occluded
with a plastic button, which is removed to empty the pouch. At the end of
this period, intubation resumes as before. If difficulty in intubation persists,
surgical revision is indicated.

**OPERATIVE TECHNIQUE** A standard antibiotic preparation is adminis-
tered before surgery. Valve revision is usually possible through a circum-
stomal incision. The outflow tract is dissected free of the skin, subcutaneous
tissue, and fascia. Medial and lateral extensions of the peristomal incision
in the skin and fascia may be necessary for pouch mobilization. The reser-
voir is carefully removed from the abdominal wall and delivered through
the surgical wound.

**Valve Repair** The partially desuscepted valve often can be reintussus-
cepted by gentle inward pressure. If successful reduction can be achieved,
it is not necessary to open the reservoir. The intussusception is maintained
by suturing the pouch to the outflow tract as in a gastric fundoplication.
The ileostomy catheter should be inserted into the reservoir prior to place-
ment of these sutures so that the outflow tract is not narrowed. Four or five
sutures of 3-0 silk will usually suffice.

Alternatively, a bladeless linear stapler can be used to secure the valve
to the anterior pouch wall. One blade of the stapler is passed through the

*Figure 17* Nipple desusception begins at the site of the opposing mesenteries.
Figure 18  Progressive desusception of the valve causes angulation of the valve and outflow tract.
Continent Stomas

stoma and the other is passed along the side the pouch. The instrument is mated and care is exercised to see that no intervening bowel loops are within the jaws of the instrument. The stapler is fired, opened, and removed.

Once the valve has been stabilized, the outflow tract is matured in the usual fashion at the old abdominal wall site. The ileostomy catheter is fixed in place with a rubber crosspiece as already described. If there is any question about the adequacy of the valve, it should be inspected by opening the pouch along its anterior wall. If a new valve is necessary, valve reconstruction by pouch “turnaround” is performed.

Vale Reconstruction The 20-cm length of small bowel immediately proximal to the pouch is mobilized. Remnants of the outflow tract and valve are excised from the intact pouch with electrocautery (Fig. 19A). The pouch is opened from this point for another 10 cm along its antimesenteric aspect.

The new valve is created by orthograde intussusception of the proximal inflow tract. The afferent ileum is transected with electrocautery 15 cm from its junction with the reservoir (Fig. 19B). The proximal 10 cm of the inflow tract is prepared for intussusception by removing the mesenteric fat, abrading the serosal surface, and placing silk sutures as previously described. A Babcock clamp is passed into the inflow tract, grasping the ileum about 5 cm from the reservoir. The bowel is intussuscepted and fixed by sutures and staples as for the original procedure. The catheter is inserted into the pouch, and a collar of pouch is sewn to the new outflow limb with 3-0 silk sutures.

The reservoir is rotated 90 degrees on its axis, which brings the new outflow tract to an anterolateral position. The cut end of the proximal ileum is anastomosed to the pouch at a convenient location using the circular stapling instrument. The reservoir walls are reapproximated and closed with two layers of running 2-0 long-term absorbable suture (Fig. 19C). The afferent limb is occluded with a noncrushing intestinal clamp, and the ileostomy tube is inserted through the new valve. The pouch is tested for continence by insufflating air and removing the catheter.

Four 3-0 silk sutures are placed from the pouch to the parietal peritoneum near the stomal aperture prior to exteriorizing the new outflow tract. The outflow tract is then brought through the old stomal opening in the abdominal wall and the fixation sutures are tied. A closed suction drain is placed in the right gutter lateral to the pouch. The drain end is brought out at a distance from the stoma. The fascia medial and lateral to the stomal opening is reapproximated with heavy long-term absorbable suture. The outflow tract is trimmed flush with the skin, and the stoma is matured with 3-0 long-term absorbable sutures. The ileostomy catheter is left in the reservoir and connected to dependent drainage.

Fistula On average, most late fistulas will occur within 2 years from the time of the initial surgery [34]. Nearly all late fistulas are related to the
Figure 19  A. Outflow tract is removed from the abdominal wall and excised with electrocautery. B. Reservoir is opened at the site of the old valve. Proximal bowel is divided 15 cm from the reservoir, and this segment is used to create a new valve. C. New nipple valve is created from the proximal bowel in the usual fashion. Cut end of the proximal bowel is anastomosed to the pouch by using the circular stapler. Stapler is introduced through the pouch opening. When the anastomosis is complete, the defect in the pouch is closed with a double layer of running 3-0 absorbable sutures.
presence of a foreign body, either a silk suture or plastic mesh [47]. The exception to this general rule occurs in the patient with Crohn’s disease. These patients are five times more likely to develop a fistula than patients with colitis or polyposis [33].

An external fistula usually presents with evidence of cutaneous sepsis. Peristomal cellulitis or subcutaneous abscess will usually precede frank fistulization. Once the tract has been established, leakage of intestinal contents will ensue. Pouch-cutaneous fistula is an uncommon late complication, occurring in about three per cent of cases [6]. Fiberoptic ileoscopy is often helpful in establishing the diagnosis, and estimating the chance of non-operative closure [46]. If the cause of the fistula is a foreign body, the foreign body must be removed either operatively or endoscopically before the pouch will heal. If the offending agent (usually a silk suture) can be removed endoscopically, treatment by continuous pouch intubation and administration of oral antibiotics for 2–4 weeks usually will produce closure of the defect. If the foreign body can not be retrieved or the fistula does not close, operative removal by excision with primary closure of the pouch is indicated.

Late internal fistulae of the nipple valve occur more frequently and are more troublesome than external fistulas [33]. Leakage of intestinal contents through the unintubated stoma is the common presentation of this complication. The size of the fistula and its location along the length of the valve will determine the degree of incontinence. Leakage is generally greater when the fistula lies near the base of the valve. The fistula does not affect ease of reservoir intubation.

Operative revision is indicated when the amount of leakage inconveniences the patient. Dozois et al. [24] recommends complete nipple revision by pouch rotation in all cases of fistula. We have found such revision often to be unnecessary, especially when the fistula lies at the base of the valve. However, we agree that if the fistula is not readily accessible or if the repaired valve is unsuitable for any reason, then creation of a new valve using the afferent ileum is indicated.

OPERATIVE TECHNIQUE  The pouch is approached through a peristomal incision. The outflow tract is freed circumferentially. The wound is enlarged by medial and lateral incisions 2 to 3 cm long. The pouch is removed from the abdominal wall and delivered into the wound. The valve is exposed by opening the pouch along its antimesenteric wall.

The nipple fistula is identified. Any foreign body, if present, is removed. A small rim of normal ileum around the foreign body also is excised. The nipple is desuscepted to a point a few millimeters beyond the fistula. This is relatively easy if the fistula is at the base of the nipple. The edges of the fistula on both ileal walls are freshened, and closed with 3-0, long-term absorbable sutures. The intussusception is restored with care taken to avoid overlapping the suture lines. The pouch is closed with a running
3-0, long-term absorbable suture. An ileostomy catheter is placed within the pouch and valvular competence is ascertained.

The outflow tract is brought through the old stoma site. The medial and lateral incisions in the fascia are repaired with heavy, long-term absorbable sutures. The skin incisions medial and lateral to the stoma site are closed with fine nylon. The stoma is matured with 3-0, long-term absorbable sutures. The catheter is secured to the abdominal wall with a crosspiece arrangement as described earlier. Gravity drainage is instituted.

**Skin-Level Stenosis**  Stenosis of the peristomal skin occurs in 8 percent of patients [33]. Patients suffering this complication find insertion of the ileostomy catheter difficult, painful, and accompanied by modest bleeding. We have found that double Z-plasty of the peristomal skin offers the most satisfactory long-term results.

**OPERATIVE TECHNIQUE**  The scar at the mucocutaneous junction is excised circumferentially. The subcutaneous outflow limb is mobilized completely to the level of the fascia. Slightly curved, 1.5 cm tangential skin incisions are made at opposite points on the stomal circumference. The skin edges are undermined through the creation of two rotational flaps. The ileal walls opposing the skin incisions are divided longitudinally for a distance of 1.5 centimeters on each side. (Fig. 20A) The skin flaps are rotated into the groove cut on either side if the ileum. (Fig. 20B) The two Z-plasties are completed by suturing the full thickness of the ileal wall to the dermis of the flaps. The revision is completed by fixing the remainder of the ileal circumference to the skin with 3-0 absorbable sutures. (Fig. 20C)

**Prolapse**  Prolapse of the intact nipple valve is uncommon, occurring in less than 3% of cases [33]. There seems to be a greater tendency towards prolapse in patients who have undergone previous nipple revision [25]. Continence is generally maintained between episodes of prolapse.

We have found that prolapse is most often associated with an overly large fascial stomal defect. Increasing intra-abdominal pressure during exercise or late pregnancy can precipitate nipple extrusion. Reduction can usually be accomplished by gentle manual pressure. Iced witch-hazel compresses may be used to reduce stoma edema, facilitating reduction after longstanding prolapse. Once the valve has been reduced, the reservoir can usually be intubated without difficulty.

Nonoperative management of nipple valve prolapse usually involves continuous pouch intubation for 2–4 weeks. A report described “stiffening” of the outflow tract by transcutaneous electrocauterization and suture. This technique was successful in three of four cases [48].

Prolapse that occurs during pregnancy is managed best by continuous intubation after valve reduction [32]. The tube is left in place throughout labor and delivery. If cesarean section is indicated, the extracorporeal por-
Figure 10  A. Skin incisions are made on opposing sides of the stoma. Corresponding incisions are made in the ileum. Skin between a and 1 and d and 3 is mobilized to create two flaps. B. Skin flaps are rotated into the grooves cut in the ileum; b is brought to a, and 1 is brought to 2; similarly, c is brought to d. C. New mucocutaneous junction is sewn with interrupted 3-0 absorbably sutures.
tion of the catheter is draped laterally with a sterile, adhesive sheet. Midline incision is usually required. Operative delivery proceeds according to obstetrical principles, exercising care to avoid injury to the reservoir.

Recurring episodes of valve prolapse generally require revisional surgery. Relocation of the reservoir and stoma to a new site, usually the midline or the left lower quadrant, yields better results than attempts at fascial repair.

**OPERATIVE TECHNIQUE** The stoma and outflow tract are mobilized through a peristomal incision. The incision is extended medially and laterally if necessary, and the abdominal cavity is entered. The pouch is carefully mobilized from the anterior abdominal wall. If doubt exists concerning the viability of the outflow tract, creation of a new valve by pouch rotation is warranted.

The new stoma site is determined by comfortable placement of the outflow tract. When possible, transrectus placement on the opposite side is preferable. A circle of skin at the new site is excised. Dissection is continued into the abdominal cavity. The outflow tract is brought through the new stoma site, and the reservoir is fixed to the anterior abdominal wall. The fascia defect at the old stoma site is closed with heavy, long-term absorbable sutures. The wound is covered with sterile towels, and the stoma is matured with 3-0 absorbable sutures.

**Pouchitis** The syndrome of reservoir mucosal ileitis or “pouchitis” has been reported to occur in from 5–43% of patients with a reservoir ileostomy [4,24,25,33,49]. It presents most characteristically as a change in the nature and quantity of the ileostomy effluent [50]. High volume (>1000 mL/day), thin, and occasionally bloody, returns are common. Intubation may become more difficult and catheter induced bleeding may ensue. The syndrome may also include abdominal cramps or pain, arthralgia, fever, and malaise [51]. Pouchitis appears to occur almost exclusively in patients whose initial diagnosis was mucosal ulcerative colitis [24,25,33]. More than half of the patients who develop pouchitis will present with their first episode within six months of surgery [52].

The patient presenting with these symptoms for the first time warrants thorough investigation. A careful history and physical examination are performed. Assay of the ileostomy effluent for enteric pathogens and toxins, and fiberoptic ileoscopy are also indicated. Typically, ileoscopy reveals mucosal edema, friability and granularity [45]. The presence of aphthous ulcerations strongly suggests the possibility of Crohn’s disease [51]. Biopsy may suggest an alternate diagnosis, or it may show only mild, non-specific inflammation or even normal mucosa [53]. Crohn’s disease of the reservoir and infectious enteritis can mimic pouchitis. Subacute addisonian crisis and hyperthyroidism have been misdiagnosed as reservoir ileitis [25].

The cause of pouchitis is unknown. Factors implicated as contributory or causative include pouch stasis, ischemia, altered bacterial flora, bacterial metabolites, and ileal mucosal metaplasia [54]. None have been proven.
Resolution of the inflammatory process with treatment by the administration of antibiotics favors a cause related to the bacterial flora of the pouch. Pouchitis generally responds quickly to the oral administration of metronidazole [55] or ciprofloxacin. As pouchitis tends to recur in susceptible individuals [53], each subsequent episode does not require the same investigation as the first. Rather, antibiotic therapy should be started empirically based on symptoms. Some patients will fail to respond to antibiotic therapy. In this situation, steroids administered through the catheter or systemically may be of value [50,56].

Recent reports of the use of concentrated probiotics for the treatment and prevention of pouchitis in pelvic pouches have been published [56,57]. However, this treatment modality has not been evaluated in the setting of reservoir ileostomies. Uncommonly, unremitting pouchitis, recalcitrant to all modes of medical therapy, may prompt the patient to seek removal of the reservoir [35,50].

CONTINENT COLOSTOMY

Encouraged by the impressive improvement in patient comfort and life style obtained with the continent ileostomy, investigators have attempted to achieve similar results with a continent colostomy. Despite intense efforts, this quest has not been as successful.

A variety of factors has made a reliable, safe, and simple continent colostomy difficult to achieve. The typical permanent colostomy is fashioned from the end of the sigmoid or descending colon. Colostomy output is usually semisolid or solid, foul-smelling, and often accompanied by gas. The nature of colostomy stool, and the differing pattern of motor function of the colon render useless many of the continence preserving approaches used with ileostomies. Furthermore, most patients requiring permanent end colostomy suffer from invasive rectal carcinoma. This disease affects an older patient population and carries an uncertain prognosis. A continent colostomy which requires repeated surgical revision or intricate stomal maintenance may not be well accepted by these patients.

Irrigation

Colostomy continence achieved by the irrigation technique was introduced in the 1920s, mainly in response to the dearth of effective pouching systems available at the time [58]. Colostomy irrigation is essentially an enema delivered via the stoma. The irrigating fluid stimulates colonic evacuation in a predictable and reproducible fashion. In many patients, irrigation every day or every other day is all that is required to keep the stoma free of leakage between irrigations [59–61]. Between irrigations, a stomal cap or a gauze pad is all that is worn over the stoma.
Indications and Patient Selection

Only left-sided colostomies are amenable to control by this technique. Right or transverse stomas will generally have an output that is too liquid to achieve adequate results. Other relative contraindications to irrigation include parastomal herniation, stomal prolapse, and a predisposition to diarrhea related to either the underlying disease process (e.g., inflammatory bowel disease) or ongoing treatment (e.g., chemotherapy or radiotherapy) [62]. In general, children and infants are not good candidates because of increased risk of perforation, and lack of attention span.

Although the contraindications are few, irrigation is not for everybody. The patient must be generally healthy and possess the manual dexterity and motivation to learn and to apply the technique. Uninterrupted access to the bathroom for at least 1 hour on irrigation days is also required. Even under ideal circumstances, all patients will not achieve continence [59–61].

Technique

Irrigation should be performed at approximately the same time of day on alternate or third days. The patient should be comfortable with the technique, relaxed, and unhurried. Many patients will choose to irrigate seated in front of the toilet.

The water bag should be filled with no more than a quart of lukewarm tap water. Often a pint of water will yield optimum results. The bag should be suspended at shoulder level within the patient’s view. After air has been evacuated from the system, the tubing is clamped, and the cone tip is attached.

The irrigating sleeve is placed around the stoma. The long end of the sleeve is placed in the toilet. The cone is lubricated and is inserted into the stoma via the short arm of the sleeve. Gentle pressure allows the tip to occlude the stoma. The clamp is opened and the water is allowed to slowly enter the colon. The entire volume is instilled over 3–5 min. The infusion should be stopped momentarily if cramping occurs.

After infusion, the cone is removed, and the short arm of the sleeve is clipped. The long arm is left in the toilet until the initial return of water and stool has ceased. This action will usually take about 15 min. Next, the sleeve is rinsed clean but left in place. The patient can leave the bathroom or perform other tasks if desired. Stool may continue to drain for the next 30–50 min. With time the patient will recognize when the colon is empty. When there is no further drainage of stool, the sleeve is rinsed and removed. The peristomal skin is cleaned, and a “security pouch,” cap, or pad is applied.

Results

Irrigation provides colostomy continence in from 30–60% of patients [59–61]. Patients report improvement in their sense of security and self-confidence and their ability to function in work and social settings [60,63].
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The time spent on stomal management, and cost of equipment are similar to those expended by patients who use natural evacuation [60,61]. Neither age nor diagnosis prevent successful mastery of the technique [64]. Complications are distinctly uncommon [60–62].

Barrier Devices

Despite good results with colostomy irrigation, many patients find the technique cumbersome and time-consuming. Also, continence is not always perfect between irrigations. In an effort to provide stomal continence more easily, various devices have been designed for temporary stomal occlusion. These methods were intended to provide reliable continence without the need for irrigation, or at least to improve continence in the interval between irrigations.

Magnetic Cap

The first of these devices was the magnetic stomal cap [65,66]. This three part system consisted of an implantable, samarium-cobalt magnetic ring, a mushroom-shaped cap, and a three layer filter-washer used between the skin and the cap (Fig. 21). The cap contained a magnetic ring and center

Figure 21 Magnetic stoma cap.
pin. The patient centered the washer at the stoma, and occluded the colostomy by inserting the pin in the lumen. The cap was held in place by magnetic attraction. The cap was removed when the patient wished to evacuate. Irrigation was also used as an adjunct in some patients.

Despite early enthusiasm, the magnetic cap yielded disappointing results. Achievement of continence occurred in only 14–50% of patients [67–70]. Local infection, erosion of the ring through the skin, and late skin necrosis were the most common complications. The device is no longer commercially available.

**Balloon Plug**

The balloon plug, a device based on the same principle as the magnetic cap was described in 1984 [71]. This device consisted of an implantable silicone ring and an inflatable silicone balloon. The ring was sutured to the parietal peritoneum at the stomal aperture. The colon was brought through the ring and matured at skin level. The stoma was occluded by luminal insertion and inflation of the balloon. The patient deflated the balloon to evacuate the bowel.

Although continence was achieved with this device, patient acceptance was only fair. Complications such as fistula, bowel necrosis, and stomal erosion were also noted. This device is no longer available for clinical use.

**Polyurethane Plug**

Interest in the use of one- and two-piece, disposable, polyurethane colostomy plug systems resurfaced a number of years ago [72,73]. The device consists of a polyurethane foam cone which is held in a cylindrical shape by a polyvinyl alcohol film. The cylinder is inserted into the stoma and held in place by a flange (two-piece system) or an adhesive/filter base (one piece system). The moisture in the colon causes the film to desolve, allowing the polyurethane to assume its original conical shape. The cone occludes the intestinal lumen, preventing leakage of mucus and stool. Gas escapes through the filter system without noise or odor.

The most recent reports of the use of these devices showed acceptable levels of continence with most patients reporting no significant odor, noise, discharge or leakage when the plug was in place [72]. Patient acceptance of the technique was excellent [72,73]. Most patients with a colostomy in both studies were concurrently using irrigation techniques. The patients who were not using irrigation techniques were able to confine bowel movements to evening hours when the plug was not in use. Nonirrigating patients were also satisfied with the device [72].

Use of the plug appears to be best suited to those patients whose bowel action can be reliably predicted, either by irrigation or “natural” technique. Between movements, the plug serves to control odor, noise, mucus and to minimize fecal leakage. The interval between irrigations can be pro-
Continent Stomas

longed in selected patients [73]. These devices are commercially available from appliance manufacturers.

Other Techniques

Other barrier techniques have been tried with varying degrees of success. An implantable hydraulic sphincter conferred continence to a small number of patients [74]. However, infectious complications occurred in half of those cases. Kock attempted a valve similar to that used in the continent ileostomy [75]. Emptying the bowel through catheter irrigation was so time-consuming that the procedure was abandoned after use in five patients.

Achievement of continence of perineal colostomies has been demonstrated by dynamic graciloplasty [76], colonic smooth-muscle cuff wraps [77], and artificial anal sphincters [78–80]. These techniques have been used with variable results in small numbers of highly selected cases. None of these techniques has gained widespread popularity primarily because technical complexity and increased morbidity.

SUMMARY

Perfect, simple, and safe stomal continence has yet to be achieved. Ileostomy continence has come closest to this ideal through modifications of Kock’s technique of reservoir ileostomy. The price of excellent continence with this method has been a significant rate of complication and reoperation. Acceptable colostomy continence has been achieved through the use of stomal irrigation. Despite its simplicity and safety, this technique is not perfectly reliable. Although considerable progress has been made over the past 30 years, the ideal substitute for the anal sphincter remains elusive.

REFERENCES


INTRODUCTION

Permanent and temporary ostomies have been historically employed for the management of acute and chronic intestinal disorders. Over the last several decades, we have witnessed a succession in the usage of fecal diversion, with temporary stomas currently created more frequently than permanent stomas in many surgical practices. This change comes as a result of many factors, including improved blood transfusion techniques, safer anesthetic agents, enhanced antimicrobial therapy, greater understanding of oncological principles, and the development of revolutionary stapling instruments. Furthermore, loop stomas have supplanted end stomas in most instances where temporary fecal diversion is warranted. Sepsis, radiation enteritis, and inflammatory bowel disease previously mandated fecal diversion with an end stoma because of risk introduced by an acute infectious process, damaged tissue, or compromised immune function. However, most surgeons have learned that they can safely perform a primary anastomosis in many of these settings associated with a distinct risk for anastomotic leak and intra-abdominal or pelvic sepsis if the procedure is accompanied by the creation of a proximal loop stoma. Take-down of a temporary ostomy, whether it is created from small or large bowel as an end, end-loop, or loop stoma, is associated with recognized morbidity dictated by myriad factors, but the operative risk can be typically reduced to an acceptable level with appropriate preoperative assessment and suitable operative technique.

Timing of the Procedure

Take-down of a temporary stoma should be generally delayed until the patient has returned to an acceptable state of health as evidenced by healthy appetite, appropriate weight gain, relative lack of fatigue, and resumption of
preoperative activities. It is imperative that tissues have healed, infectious processes have resolved, anemia has nearly corrected, and immunosuppressive effects have been minimized.

Surgeons prefer to wait 3–6 months before takedown of an end ostomy when the distal limb is located remote from the stoma aperture and 8–12 weeks before closure of a loop stoma. Delay of the procedure is rarely associated with adverse effects [1]. Furthermore, the ease and safety of the operation generally correlate with the duration of delay [2–7]. If a patient develops a condition that requires emergent or urgent laparotomy during the interval between ostomy construction and planned closure, take-down may be considered, assuming that the surgeon can adhere to the basic tenets of anastomosis construction and that the distal bowel is devoid of lesions, strictures, and perforations. If contamination or sepsis is encountered during this urgent procedure, stoma closure is deferred until an appropriate length of additional time has elapsed following the latest procedure.

Many patients with rectal cancer will be candidates for adjuvant chemotherapy that is initiated 4–6 weeks after their initial procedure. While most persons can tolerate stoma closure between chemotherapy cycles, the oncologist may prefer that ostomy take-down be delayed until all therapy has been completed. Conversely, an occasional patient will implore his or her surgeon to reverse the stoma prior to achieving the above-mentioned milestones, and the physician will ignore convention and acquiesce to the individual’s request. This seemingly kind gesture can lead to disastrous results, because dense adhesions that mandate tedious and difficult dissection through extended incisions may yet persist at the time of early stoma take-down. Moreover, major complications can result that require reoperation and rediversion for many additional months.

PREOPERATIVE ASSESSMENT

Any patient presenting for ostomy take-down should be diligently questioned and pertinent records should be reviewed. Specifically, the patient must be quizzed regarding prior operative complications and complaints indicative of pre-existing fecal incontinence, stool urgency, chronic diarrhea, inflammatory bowel disease, or severe irritable bowel syndrome. The medical records—including operative notes, pathology reports, and discharge summaries—will usually indicate the type and configuration of the stoma as well as the presence of significant underlying diseases. Likewise, previous roentgenographic studies and endoscopy reports may provide relevant information dictating the need for further evaluation. Additional preoperative assessment of these individuals ought to be personalized but may include anorectal physiology testing, ultrasonic and radiographic imaging, as well as endoscopic scrutiny.
Anorectal Physiology Testing

During the preoperative assessment, some patients will confess that they previously experienced incontinence to flatus or stool, while others will provide a history of prior obstetrical injury, fistulotomy, or sphincterotomy that may portend continence problems following stoma closure. In these instances, as well as in the case of persons recovering from ileal pouch–or coloanal anastomosis, anal manometry might be warranted to quantify sphincter pressures. Although resting and squeeze pressure values correlate poorly with function, low measurements can assist in cautionary counseling and may provide an impetus for sphincteroplasty prior to ostomy takedown.

A competent sphincter is only one factor affecting continence. Normal anorectal sensation, adequate rectal compliance and capacity, as well as appropriate motility are also important. In a patient with a diseased rectum or anal canal, the continence mechanism can be compromised, and stoma closure will be likely associated with compromised quality of life. This poor outcome can be predicted by assessing rectal compliance, tone, and capacity in the anorectal physiology laboratory. Alternatively, if a person is able to retain a 150-mL saline enema for at least 5 min, adequate continence without urgency is typically expected [8].

Imaging

Individuals suspected of pre-existing sphincter injury may also benefit from endoanal ultrasonography to better visualize the internal and external sphincters over their entire length. Although the affected person may deny prior problems with incontinence, surgical alterations in pelvic floor musculature, rectal compliance, and anal canal sampling may complicate the pre-existing sphincter injury and result in difficulties with fecal incontinence following ostomy take-down. In these instances, repair of significant sphincter injuries must be considered prior to stoma closure.

Contrast roentgenographic studies may provide useful information in selected patients prior to stoma takedown. A small bowel series might be warranted if a patient has suffered more than one episode of partial small bowel obstruction during the period following stoma creation. In this scenario, a formal laparotomy with enterolysis may be necessary at the time of stoma closure to decrease the likelihood of subsequent obstructive episodes after reconstitution of the intestinal tract. A preoperative contrast study may assist the surgeon in identifying potential transitional points. In the instance where a loop jejunostomy has been created at the time of surgery for enterocutaneous fistula or postoperative sepsis, a preoperative contrast study of the small bowel is imperative. Water-soluble contrast is instilled through the stoma’s efferent limb and followed into the large bowel to exclude any persistent bowel leaks or areas of distal obstruction.
Before closing a stoma designed to protect an anastomosis or perforated site, some surgeons routinely obtain contrast enemas, while others question their utility. Following ileal pouch–anal anastomosis, routine contrast enemas will detect a clinically occult leak in 8% of patients [9]. Moreover, Tsao and colleagues from the Mayo Clinic found that abnormal findings in a pouchogram prior to ostomy takedown signaled those persons at higher risk for long-term pouch complications [10]. However, the same surgical group subsequently reported that patients with asymptomatic pouch sinuses can safely undergo stoma closure and experience long-term function as well as a quality of life comparable to that of the person whose restorative proctocolectomy was not complicated by a pouch sinus [11]. Therefore it would appear that contrast enemas are indicated when the clinical history and physical examination suggest a pouch complication, but their routine use following ileal pouch–anal anastomosis may not be necessary. The role of routine contrast enemas in patients with a stoma protecting colorectal or coloanal anastomoses is less clear, but similar principles can be likely applied.

Swenson and associates reported that contrast enemas in trauma patients failed to reveal unsuspected yet pertinent diagnoses, added unnecessary expenses and delays, and did not alter operative management [12]. Others have reported similar findings, and the role of the contrast enema to assess persistent rectal injury and confirm suspected fistulas remains controversial [13–15].

Endoscopy
Endoscopy can be used prior to stoma take-down to assure lumen patency, assess rectal compliance and capacity, exclude anastomotic defects, and identify inflammatory changes. Diverted anastomoses below the peritoneal reflection are commonly strictured by a web-like membrane that can easily be disrupted with an examining digit or rigid endoscope. Once the proximal stoma is closed, these strictures will usually remain dilated by the passage of stool and rarely introduce long-term difficulties. Longer strictures often herald anastomotic sepsis, radiation injury, and persistent or recurrent tumor. These narrowings rarely respond to simple measures. Instead, associated complications must be sought and treated, with stoma closure postponed until an adequate lumen persists through a healed anastomosis.

Preoperative endoscopy will often identify diversion proctocolitis, which typically accompanies fecal diversion when the large bowel mucosa is deprived of its principal nutrients, short-chain fatty acids, contained within the stool. Nearly 70% of diverted persons will develop diversion proctocolitis, the presence of which is unrelated to pre-existing conditions, stoma configuration, or duration of diversion [16,17]. This chronic inflammatory condition fortunately introduces no additional morbidity to stoma take-down and resolves soon after the fecal stream is reintroduced to the colonocytes.
PREPARATION

Because American Society of Anesthesiologists (ASA) classification, diabetes, and steroid usage are independent predictors of operative morbidity in stoma patients, comorbid conditions must be considered and treated appropriately prior to ostomy take-down [5,18–20]. Similarly, physiological deficits such as anemia, dehydration, electrolyte abnormalities and malnutrition ought to be corrected [18]. Antiplatelet medications must be withdrawn more than 10 days preoperatively, and anticoagulants should be managed as allowed by the underlying disorder.

Stress-dose steroids are indicated for anyone treated with steroids during the past 9 months, and prophylaxis against deep venous thrombosis is generally warranted [21]. Moderate-risk individuals ought to be prophylaxed against deep venous thrombosis with intermittent pneumatic compression boots or low-dose unfractionated heparin. For high-risk surgery patients, recognized guidelines recommend thrombosis prophylaxis with low-dose unfractionated heparin, low-molecular-weight heparin, or intermittent pneumatic compression. High-risk patients with a greater than usual risk of bleeding should be initially prescribed intermittent pneumatic compression boots, with heparin therapy considered during the postoperative period. In highest-risk patients with multiple risk factors, low-dose unfractionated heparin or low-molecular-weight heparin is usually combined with intermittent pneumatic compression boots.

Patients scheduled for ileostomy closure rarely require mechanical cleansing of the intestine, whereas mechanical colonic preparation is warranted for colostomy take-down. Accordingly, a clear liquid diet and polyethylene glycol (4 L) or Fleet phospho-soda (90 mL) is prescribed the day before surgery with no oral intake allowed after midnight. In persons in whom the distal bowel is to be used for an anastomosis, a saline washout of the rectum through a large rectal catheter is employed after the patient has been anesthetized. Although opinions vary on the optimal antibiotic prophylactic regimen, most pundits would agree that coverage directed against enteric pathogens ought to be provided parenterally prior to skin incision [22,23].

OPERATIVE TECHNIQUE

End Stoma

End stomas can be created from small or large bowel, and the distal limb may be located adjacent to or remote from the ostomy site. In instances where the distal limb is located near the ostomy site, the operation is conducted similarly to that described further on for take-down of a loop stoma. Otherwise, a formal laparotomy is required and the patient is positioned in
a supine manner, a modified lithotomy position being preferred if the rectum will be used for the distal limb of the anastomosis or endoscopic access to the large bowel is necessary. If the rectum has been transected below the superior rectal valve or a difficult pelvic dissection is anticipated, ureteral stents might enable the surgeon to avoid or recognize ureteral injury. Following induction of general or regional anesthesia, the abdominal cavity is entered through a midline wound and exploration is conducted following appropriate enterolysis. Generally, the stoma must be taken down prior to abdominal exploration to facilitate evaluation of the pertinent structures. An elliptical incision is made at the ostomy’s mucocutaneous junction, and the dissection then proceeds along the bowel wall with circumferential mobilization continued into the peritoneal cavity. Sharp dissection and appropriate retraction are used throughout this portion of the procedure. After delivery of the bowel into the peritoneal cavity, the open lumen is occluded with an atraumatic clamp to prevent fecal contamination of the peritoneal cavity and wound.

With an end ileostomy, the neoterminal ileum is typically joined to a segment of colon or the rectum. This ileocolostomy can be constructed in any number of configurations with sutures or staples, whereas an ileoproctostomy should generally be oriented as an end-to-end or side-to-end anastomosis. With the ileocolostomy, the mesentery of the two bowel limbs must be inspected to assure that there is no torsion, and a tongue of omentum can be mobilized to quarantine the anastomosis. The omental pedicle may help to minimize the morbidity associated with a subsequent anastomotic leak. For the ileoproctostomy, the rectal remnant must be identified and readied. Many surgeons endorse passing a circular stapling instrument transanally and performing the anastomosis with the bowel that readily accommodates the end of the stapler. However, this sometimes creates an end-to-side anastomosis characterized by a blind end of proximal rectum lying cephalad to the ileoproctostomy. This type of anastomosis is prone to stricturing, requiring hydrostatic dilatation or operative revision. Even worse, the vagina can be included in the anastomosis with disastrous results. Consequently, it is best to mobilize the upper rectum and assure that the stapling instrument incorporates the top of the rectum. Personal preference may dictate that the upper rectum ought to be amputated and a purse-string suture placed to verify that the end of the rectum is used. In mobilizing the upper rectum, the surgeon must recall that the ureters and iliac vessels can be medially drawn from their usual location. Thus, careful dissection is essential to avoid damage to these structures. In especially difficult situations, a dilator can be passed transanally or the rectum can be transilluminated with a fiberoptic endoscope to facilitate the dissection. Following completion of the anastomosis, the bowel is occluded proximal to the anastomosis and air is insufflated transanally while the ileoproctostomy is submerged in saline. As the bowel distends, air bubbles rising out of the saline
point toward an anastomotic leak, which requires suture repair prior to closure. A hand-sewn ileoproctostomy should be similarly approached and the same cautionary advice considered. The peritoneal cavity is then irrigated with warmed saline and the bowel returned in an orderly manner. The old stoma aperture is closed, assuring that the anterior sheath is included, and the fascial margins of the midline wound are approximated. The subcutaneous tissues are also irrigated and the skin edges are typically abutted with metal clips.

An end colostomy take-down usually entails either a hand-sewn or stapled end-to-end coloproctostomy. The operation is conducted similarly to the method described for ileoproctostomy. However, if the colostomy was created at the time of surgery for perforated diverticular disease, which is most common, the initial operative resection may have been limited to the perforated bowel segment. In this case it is imperative to resect the proximal bowel in an area where muscular hypertrophy is absent and to divide the distal bowel below the level where the teniae coli become confluent, demarcating the true rectum. To leave distal sigmoid colon unresected almost doubles the risk of problems with recurrent diverticulitis.

In the past decade, a laparoscopic approach to end ostomy take-down has been described by several groups [24–27]. The same surgical principles are upheld, and the operation can often be performed without conversion to laparotomy. Although the operative time is increased over that associated with laparotomy, retrospective studies suggest that the duration of ileus and length of stay are shortened without compromising safety.

**Loop Stoma**

Loop stomas are typically constructed from the terminal ileum, but more proximal small bowel or large bowel can be utilized. Three techniques can be employed for closure of a loop ileostomy; they include suture closure of the enterotomy, limited resection of the loop with end-to-end hand-sewn enteroenterostomy, and limited resection of the loop with side-to-side stapled enteroenterostomy. Regardless the technique, the patient is generally placed in a supine position with the entire abdominal wall prepared and draped in case a formal laparotomy becomes necessary, as witnessed in 1–3% of cases [28]. A general anesthetic is typically employed, but regional or local anesthesia with concomitant conscious sedation can be utilized if the clinical situation mandates [29]. An elliptical incision is made in the skin surrounding the remaining stoma ≥3 mm from the mucocutaneous junction. Clamps may be placed on the skin edge attached to the loop to facilitate retraction without traumatizing the bowel wall. The dissection is then carried adjacent to the bowel wall with circumferential mobilization of the loop continued into the peritoneal cavity. Sharp dissection and appropriate retraction are used throughout this portion of the procedure. The loop is
usually first mobilized from the lateral fascia and peritoneum because adhe-
sions to the midline wound can make the medial dissection more tedious. 
After the peritoneal cavity has been entered, a finger can gently be inserted 
alongside the loop to identify any potentially troublesome adhesions and 
facilitate mobilization of the loop ostomy. The surgeon is often tempted to 
use this guiding finger to disrupt adhesions that might be encountered. 
However, this urge must be ignored, because blunt dissection may result in 
unrecognized damage to the loop stoma or nearby segments of intestine. 
This advice is substantiated by the finding that postoperative intra-abdomi-
nal sepsis more often originates from an injured segment of adjacent bowel 
than from the closure site [30]. It is not uncommon for the most difficult 
dissection to occur at the superior and inferior aspects of the wound, where 
the rectus muscle is intimately adhered to the bowel wall. If the poor visual-
ization is compromising safe stoma mobilization, the wound can be enlarged 
by extending the skin incision or fascial aperture. Once the loop has been 
freed from its attachments and sufficient intraperitoneal fascia has been 
cleared of adhesions, dilute povidone-iodine solution is infused into the oc-
cluded bowel limbs to determine whether a significant seromuscular injury 
or enterotomy has occurred.

If the ostomy is to be closed by suturing of the enterotomy, the 
everted loop is reduced and the mucocutaneous junction excised. The edges 
of the enterotomy are transversely approximated in a one- or two-layer 
manner depending upon the surgeon’s preference. Alternatively, significant 
stricturing of the loop, associated enterotomy, or surgeon’s choice may dic-
tate that the loop be excised and continuity restored by creating an enter-
enterostomy. The bowel is sharply transected proximal and distal to the 
ostomy and the associated mesentery divided with electrocautery; suture 
control of the mesenteric vessels is occasionally needed. A hand-sewn anas-
tomosis can be created in an end-to-end configuration with the particulars 
dictated by the surgeon’s familiarity with the various techniques. Care must 
take to assure that an adequate lumen persists at the procedure’s com-
pletion. A stapled anastomosis is typically performed in a side-to side man-
ner, with particular attention directed at rotating the bowel to assure that the 
mesentery is not incorporated into the anastomosis. If this occurs, recog-
nized bleeding from the staple line must be suture-controlled. Also, ade-
quate lengths of small bowel must be delivered into the wound so that the 
distal end of the stapling instrument can be visualized and any adjacent 
bowel segments be excluded from the anastomosis.

Following closure of the loop ostomy, the intestine and wound are 
irrigated and hemostasis is assured. The bowel is returned to the peritoneal 
cavity without torsion to the mesentery, and the fascial margins are approx-
imated with absorbable suture. The wound may be primarily closed or left 
open to heal by secondary intention in 3–4 weeks.
Loop colostomies are usually closed in a manner similar to that described for loop ileostomies except that a stapled anastomosis is rarely employed because it is more difficult to mobilize sufficient large bowel to facilitate a tension-free anastomosis. The stoma aperture also tends to be larger with a loop colostomy, more commonly located in the upper abdomen, and prone to postoperative hernia [31]. Particular care must be taken to assure that both the anterior and posterior rectus sheaths are included in the fascial closure, and appropriate technique is employed to minimize the potential for future incisional hernia.

In this era of safe yet cost-effective medicine, some investigators have tried to discern the better method for loop stoma take-down. Hull and colleagues from the Cleveland Clinic randomized 61 consecutive patients to hand-sewn or stapled closure of their loop ileostomy [32]. No difference was found in return of bowel function, length of stay, postoperative morbidity, or readmission rate between the two groups. Furthermore, the added cost of the stapling instruments was more than offset by a significantly shorter operative time. Hasegawa and associates from Birmingham in the United Kingdom randomized 141 consecutive patients in a similarly designed trial [33]. While postoperative bowel obstruction occurred with significantly less frequency in the stapled group compared to the hand-sewn group (3 vs. 14%), the mean hospital stay and reoperation rate did not differ. Lastly, Moran has suggested that loop ileostomy closure can be safely performed as a same-day discharge in selected patients [34]. This approach, which apparently reduces the cost of the procedure without compromising the patient’s safety, requires further evaluation before it can be widely endorsed.

COMPLICATIONS

The complications associated with ostomy take-down include bowel obstruction, stoma site herniation, wound infection, anastomotic leak/fistula/abscess, anastomotic stricture, and intestinal hemorrhage [35,36]. Although these complications are well recognized, little prospective information is available that details the incidence of each complication for a particular type of stoma closure. This is related to the relatively infrequent nature of these complications and the fact that the risk of complications might be influenced by myriad factors, including patient age, underlying indication for diversion, type of ostomy, timing and technique of closure, and wound management.

In a review of the literature, Shellito reported that generalizations are difficult because of differences in important variables, definitions, and follow-up intervals [37]. While each of the following trends can be debated, it seems that loop ileostomy closure is safer than loop colostomy take-down,
and loop ostomy closure is less risky than end stoma take-down. Age and underlying stoma indications (i.e., cancer, diverticulitis, trauma) do not likely impact morbidity when their contribution is individually considered using multivariate analysis.

Despite the inherent limitations mentioned above, the complication rates for ileostomy closure are as follows: bowel obstruction, 1–5%; stoma site herniation, 0–0.9%; wound infection, 0.5–6%; anastomotic leak/fistula/abscess, 0–10%; anastomotic stricture, N/A; and intestinal hemorrhage, 0–0.7% [37,38]. The corresponding rate ranges for colostomy closure are as follows: bowel obstruction, 1–5%; stoma site herniation, 5–10%; wound infection, 5–15%; anastomotic leak/fistula/abscess, 2–10%; anastomotic stricture, 1–9%; and intestinal hemorrhage, N/A [37].

**SUMMARY**

Temporary ostomies can be created from small or large bowel in a variety of manners and serve a valuable role in persons undergoing surgery for acute infectious events, malignancy, or trauma. Take-down of these stomas mandates careful preoperative assessment and individualized preparation. While loop stomas can be closed with relative ease and acceptable morbidity, end ostomy take-down is more complicated, with relatively greater risk for associated complications.

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INTRODUCTION

Supravesical diversion of the urinary tract to the abdominal wall, with bowel used as a conduit, was introduced in the 1950s by Bricker [1] and Gilchrist [2] et al. The concepts described by these pioneers in urinary diversion (i.e., Bricker’s ileal conduit and Gilchrist et al.’s use of the ileocecal segment) remain the basis of most cutaneous urinary diversions used today. The recent introduction of continent urinary diversion, bladder substitution, and intermittent catheterization and the recognition of long-term complications of ileal conduits in the pediatric population have led to a decrease in the use of the standard ileal conduit.

Cutaneous urinary diversion or orthotopic neobladders are used most commonly in patients with pelvic malignancy. Bladder carcinoma is the most common lesion, but occasionally patients with urethral, prostatic, colonic, or gynecological cancer require diversion, as does the occasional patient with a pelvic sarcoma. Severe radiation damage to the pelvic viscera and recalcitrant fistulas are occasional entities necessitating diversion. The advent of intermittent catheterization, enterocystoplasty, and the artificial urinary sphincter has rendered urinary diversion a procedure of last resort in patients with neurological disorders. Certain congenital anomalies (e.g., bladder extrophy) require urinary diversion, as does the rare patient with interstitial cystitis, intractable incontinence, or severe pelvic injury.

TECHNIQUES WITH INCONTINENT STOMAS

Although various segments of bowel have been used as urinary conduits, the terminal ileum and the ileocecal segment are most commonly used. When nonrefluxing ureteroenterostomies are desired or previous radiation therapy has damaged the small bowel, colonic conduits are used.
As with any major surgical procedure, the patient’s medical and nutritional status is optimized. Important historical information—such as prior bowel surgery, gastrointestinal illnesses, and prior radiation therapy—must be carefully sought, because significant alteration of the procedure may be necessary in certain settings. A mechanical and oral antibiotic bowel preparation is performed on all patients and prophylactic systemic antimicrobial therapy is initiated before surgery, although its utility is debatable [3]. Preoperatively, antithrombotic precautions (i.e., elastic stockings and intermittent compression boots) are initiated, and the enterostomal therapist introduces the patient to collection devices, and various acceptable stoma sites are marked (Fig. 1).

ILEAL CONDUIT

A midline incision is made and exploratory laparotomy is performed. Primary procedures (i.e., cystectomy) are performed first. The ureters are isolated as they cross the iliac vessels; they are carefully mobilized and divided several centimeters above the bladder. If malignancy is present, frozen-section analysis of the proximal margins is performed. The end of the proximal ureter is secured with chromic sutures or hemoclips to allow slight ureteral dilation and prevent continuous soiling of the pelvis with urine (Fig. 2).

Figure 1  Selection of stoma site should take into consideration factors such as body habitus, scars, and planned bowel segment. Typical site for ileal conduit (a) and sigmoid conduit (b).
Attention is then directed to preparing the ileal segment. The mesentery of the terminal ileum is transilluminated and the ileocolic artery is identified. The distal end of the loop should be 10–15 cm proximal to the ileocecal junction (Fig. 3). A stay suture is placed. A segment of ileum that has at least two vascular arcades supplying it and is of sufficient length to reach the abdominal wall is identified. If a Turnbull-type stoma is to be constructed, an additional 8–10 cm of ileum should be used [4]. A second stay suture marks the proximal extent of the loop, and the mesentery is examined again to ensure adequate blood supply. The mesentery is then divided at right angles to the bowel in standard fashion. To provide greater mobility of the distal segment, the mesentery should be divided to a greater degree, with care taken not to injure a major vascular arcade.

After the ends of the proposed ileal segment are cleared of attached mesentery and fat, the bowel is divided so that a slightly shorter antimesenteric border results. The isolated loop is brought down toward the pelvis, and the proximal stay suture is removed so that the distal end of the segment is easily identifiable, allowing isoperistaltic placement of the conduit. A standard ileoileostomy is performed according to the preference of the surgeon, although the use of stapling techniques shortens operative time. The mesentery is closed with 3-0 chromic suture (Fig. 4).
Figure 3  In isolation of the ileal loop, distal end of loop should be 10 to 15 cm proximal to ileocecal junction.

The ileal segment is irrigated and, if necessary, the proximal end is closed in a watertight fashion with absorbable suture. The left ureter is delivered under the sigmoid mesentery, with care taken to avoid sharp angulation. The ureteroileal anastomosis then can be constructed, with either an end-to-side or a conjoined technique [5] (Fig. 5C). We typically place indwelling ureteral stents, although this is not a universal practice [6,7]. The proximal end of the conduit may be secured to the presacral area with absorbable suture.

Careful attention is paid to the creation of the abdominal wall stoma. The skin and the underlying subcutaneous tissue are removed circumferentially down to fascia at the previously marked stoma site (Fig. 6A). We use the end of a 20 mL syringe plunger to mark the amount of skin to be removed. A cruciate incision is made in the anterior rectus fascia and four separate 2-0 chromic sutures are placed at the four points of the incision (Fig. 6B). The fibers of the rectus muscle are separated, and the posterior sheath and the peritoneum are opened bluntly with a clamp (Fig. 6C). This opening should freely admit two fingers. The previously marked distal end of the ileal loop is delivered through the abdominal wall; it should rest without tension 3–4 cm above the skin (Fig. 7A). The conduit is secured
Methods of Urinary Diversion

After standard ileoileostomy is performed, mesentery is closed with 3-0 chromic suture.

to the anterior fascia with the previously placed chromic sutures, and a protruding, nipple-type stoma is created. To create the nipple stoma, four-quadrant 2-0 chromic sutures are placed sequentially through conduit seromuscular tissue, the full-thickness distal margin of conduit, and the subcuticular layer of skin (Fig. 7B). After all sutures have been placed, they are tied. Interrupted 3-0 chromic sutures are placed to seal bowel mucosa to skin (Fig. 7C). A finger is placed carefully in the stoma to determine that narrowing or angulation is not present at the fascial level, and a collecting device is applied. Before closing, several 3-0 chromic sutures can be placed to secure the conduit to the posterior fascia. Alternatively, particularly in obese individuals, a Turnbull-type loop stoma can be constructed (Fig. 8).

JEJUNAL CONDUIT

Jejunal conduits have a high incidence of metabolic and electrolyte abnormalities; therefore their use has been abandoned by most urologic surgeons unless no other bowel segment is available. The inefficiency of the jejunal mucosa in absorbing sodium gives rise to the classic “jejunal conduit syndrome,” consisting of hyponatremic, hypochloremic, hyperkalemic metabolic acidosis [8,9].
Figure 5  Methods of constructing ureteroenterostomies. Careful mucosa-to-mucosa apposition with fine absorbable suture is done. A, End-to-side anastomosis. B, Conjoined ureteroileal anastomosis. C, Nonrefluxing ureteroileostomies.

COMPLICATIONS AND LONG-TERM RESULTS WITH ILEAL CONDUITS

The reported rates of perioperative morbidity range from 19.7–55.9%; mortality rates from 0.7–13% [10–24].

Complications are typically divided into early and late. Nurmi [25] reported that the most common early postoperative complication was wound infection, followed by ureteroileal leakage, intestinal obstruction, intestinal fistula, and acute pyelonephritis. The most common long-term sequelae in-
included pyelonephritis, followed by parastomal hernia, severe parastomal eczema, and ureteroileal obstruction.

Superficial wound infections occur in 5–10% of cases, and fascial dehiscence has been reported in approximately 3%. Complications such as atelectasis, small bowel obstruction, and thromboembolic disease occur with a frequency similar to that associated with other major intra-abdominal procedures.

The immediate postoperative problems unique to the ileal conduit and other methods of urinary diversion are urinary extravasation and loop ne-

Figure 6 Preparation of stoma site.
crosis (see Table 1). Mild leakage of urine from the ureteroileal anastomosis occasionally occurs. It is recognized clinically by an increase in drain output with a high blood urea nitrogen (BUN) and creatinine content. This is usually a self-limited problem that resolves in 2–4 days. Rarely, however, massive leakage occurs, accompanied by anuria, large drain output, and urinoma formation. An intravenous urogram should be performed immediately to document the location of the leak, and a catheter should be left in the conduit and attached to dependent drainage. If marked drainage persists, distal ureteral necrosis or dehiscence of the proximal conduit must be considered as possibilities. Percutaneous drainage of one or both kidneys can be performed; if a stent is not already in place, placement of one in an antegrade fashion can be attempted. Most major leaks can be managed in this way in conjunction with maintenance of nutritional status, treatment of infection, and patience. Reoperation with reconstruction of the anastomosis and, occasionally, the entire conduit is sometimes necessary, but it is extremely difficult because of the severe inflammatory changes involved. The havoc wreaked by postoperative urinary extravasation underscores the importance of adhering strictly to basic surgical principles in constructing the

Figure 7  Creation of nipple-type stoma.
Figure 8  Turnbull-type loop stoma. After closure of the distal conduit, the loop of ileum is delivered (A) and opened (B). Bowel is secured to the anterior fascia, and the mucosa is approximated to the skin with absorbable suture. C, Occasionally, placement of a rod is helpful to prevent early stoma retraction, although it is usually unnecessary.

Conduit. Figure 9 summarizes an algorithm for dealing with urinary extravasation.

Loop necrosis is both disastrous and avoidable. It occurs in less than 1% of cases and has not occurred at all in several large series. An adequate blood supply and avoidance of torsion and tension on the mesentery should prevent this calamity. When loop necrosis does occur, the stoma appears dusky and the patient may become acidotic. Prompt recognition of this complication and reconstruction of the conduit are mandatory.

Late complications unique to ileal conduit and other forms of urinary diversion include deterioration in renal function, nephrolithiasis, recurrent febrile urinary tract infection, obstruction of the ureteroenteric anastomosis,
Table 1  Early Complication Rates (%) of Ureteroileal Conduit Diversion*

<table>
<thead>
<tr>
<th>Study &amp; year (N)</th>
<th>Peri-operative mortality</th>
<th>Intestinal</th>
<th></th>
<th></th>
<th></th>
<th>Ureterointestinal leakage</th>
<th>Loop necrosis</th>
<th>Acute pyelonephritis</th>
<th>Total complications</th>
<th>Renal loss</th>
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<td>2.8</td>
<td>38.1</td>
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<td>6.2</td>
<td>1.1</td>
<td></td>
<td></td>
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<td>33.7</td>
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<td>0.7</td>
<td>—</td>
<td></td>
<td></td>
<td>7.2</td>
<td>3.3</td>
<td>2.6</td>
<td>0.7</td>
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<td>21.3</td>
<td>8.1</td>
<td>—</td>
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<td>—</td>
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<td>20.2</td>
<td>3.3</td>
<td>—</td>
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<td>4.9</td>
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<td>5.6</td>
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<td>—</td>
<td>—</td>
<td></td>
<td></td>
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<td>3.0</td>
<td>5.0</td>
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<td>—</td>
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<td>—</td>
<td>10.3</td>
<td>1.0</td>
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<td></td>
<td></td>
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<td>3.2</td>
<td>10.9</td>
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<td>6.0</td>
<td>3.0</td>
<td>0.7</td>
<td>1.3</td>
<td>35.0</td>
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Methods of Urinary Diversion


loop stenosis and other stoma complications, electrolyte abnormalities, nutritional deficiencies, and, perhaps, carcinogenesis (see Table 2).

The reported incidence of renal deterioration after conduit urinary diversion has varied from 10–60%. Long-term follow-up of children with ileal conduits reveals a significant degree of deterioration of renal function seemingly directly related to time [26–32]. The longest follow-up was that reported by Pitts and Muecke [31], which revealed deterioration of renal function in 35% of patients who were followed for 16–20 years. Recurrent infection, reflux, nephrolithiasis, and anatomic obstruction all play a potential role and should be sought and treated. Because most patients with ileal conduits have asymptomatic bacteriuria, the presence of reflux is particularly bothersome. A classic study by Richie et al. [33] demonstrated an 84% incidence of pyelonephritis in refluxing units as compared to 7% in nonrefluxing ones. A more recent study [34] with a mean follow-up of 150 months demonstrated renal scarring to be twofold higher among patients with nonrefluxing anastomoses. As a result, when children or young adults require urinary diversion, a method incorporating reliable nonrefluxing ureteroenteric anastomosis is generally used. Approximately 6% of patients with ileal conduits die of renal failure [35].

Up to 10% of patients develop nephrolithiasis. Dretler [36] theorized that the mixture of urea-splitting organisms and high-conduit residual urines, with resultant acidosis, is the primary cause. We treat asymptomatic bacteriuria only when a likely urea-splitting organism is found (e.g., Pro-
<table>
<thead>
<tr>
<th>Study &amp; year (N)</th>
<th>Intestinal obstruction</th>
<th>Pyelonephritis</th>
<th>Renal deterioration Yrs %</th>
<th>Ureteroileal obstruction (mean)</th>
<th>Stomal stenosis (mean)</th>
<th>Calculi Renal (%)</th>
<th>Calculi Conduit (%)</th>
<th>Total complications (%)</th>
<th>Revision (%)</th>
<th>Years of follow-up (mean)</th>
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<td>14.9 — — — 7.5 5.1 4.0 13.4 (L) 26 (R) 28.0 — 5–21</td>
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<tr>
<td>Heath &amp; Eckstein, 1984&lt;sup&gt;20&lt;/sup&gt; (144)</td>
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<td>Stanhope et al. 1986&lt;sup&gt;23&lt;/sup&gt; (156)</td>
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teus mirabilis). Furthermore, a kidney-ureter-bladder (KUB) study should be performed on the patient every 1–2 years to identify early stone formation.

Obstruction of the ureteroileal anastomosis occurs in approximately 5% of patients and is due to either ischemia, localized fibrosis, radiation change, or recurrent tumor. This condition can occur silently, which emphasizes the need for performing serial loopograms or renal ultrasounds. When an obstructed segment is identified and the initial procedure was performed for a malignancy, its recurrence must be ruled out with cytologies and brushings of the anastomosis. Endourological management of benign strictures with balloon dilatation and cold-knife incisions is often attempted initially (Fig. 10), although open reconstruction of the anastomosis has a far higher long-term success rate [37,38].

Stomal stenosis has been reported in up to 30% of cases, but it probably has an incidence closer to 5% [39]. Use of a protruding nipple stoma and the Turnbull loop stoma in obese patients should keep the incidence low. Nevertheless it does occur and may be a source of significant morbidity. When repair is necessary, simple interposition of a segment of skin may suffice, although advancement of the conduit and reconstruction of the stoma may be required (Fig. 11). Stenosis of the conduit itself also may occur as a result of long-standing infection and fibrosis and often requires reconstruction [40].

![Image](image-url)

**Figure 10** Endourologic management of ureteroenteric structures is becoming the treatment of choice, although open repair or chronic stenting are still required for failures.
Occasionally stoma stenosis can be managed by interposition of full-thickness skin (A). Severe cases require total reconstruction (B), although simple advancement of the conduit may suffice.

Peristomal hernias, stoma prolapse, chronic intestinal fistulas, and peristomal skin complications are dealt with elsewhere in this text and are not discussed here.

When urine comes in contact with bowel mucosa, electrolyte and free-water transfer can occur, resulting in metabolic abnormalities. The ileum plays primarily an absorptive role; therefore patients with ileal conduits can develop a hypernatremic, hypokalemic, hyperchloremic metabolic acidosis [41]. This condition almost always occurs in the presence of renal insufficiency and can be treated with oral alkali. Occasionally a redundant conduit secondary to either stomal stenosis or too long an ileal loop can result in a
large amount of residual urine and hyperabsorption. These entities require surgical correction.

Resection of large amounts of ileum can result in bile salt deficiencies and steatorrhea or vitamin B₁₂ deficiency and megaloblastic anemia. These conditions do not occur after a simple ileal conduit but may develop in patients with previous small bowel resection or in whom large segments of ileum are used in the construction of urinary reservoirs [42].

Filmer and Spencer [43] reviewed carcinogenesis in bowel segments used for urinary diversion. Although adenocarcinoma occurring in an ileal conduit is rare, several cases have been reported [44,45]. More commonly described is adenocarcinoma in patients undergoing ileocystoplasty, suggesting that long contact time between urine and bowel mucosa may play a role in carcinogenesis.

SIGMOID COLON CONDUIT

Sigmoid colon conduit urinary diversion is used in those circumstances when nonrefluxing ureteroenterostomies are desirable. When total pelvic exenteration is required for locally advanced malignancies, a sigmoid colon conduit obviates the need for an enterocystostomy [46]. Mogg [47] popularized the sigmoid colon conduit in the 1960s in an attempt to avoid the complications of reflux.

Preoperative preparation is similar to that described for ileal conduits. Again, the stoma site should be selected and marked preoperatively in the left lower quadrant by the enterostomal therapist (ET), who must take body habitus and scars into account.

The descending and sigmoid segments of the colon are mobilized from the splenic flexure to the sacral promontory. A segment of sigmoid colon approximately 20 cm long is selected and marked with stay sutures (Fig. 12). The mesentery is carefully divided at right angles to the ends of the conduit, with 4-0 silk sutures used for hemostasis. The distal mesenteric division should include the superior hemorrhoidal artery to aid in mobility. After removal of the attached fat and mesenteric attachments, the colon is divided and the conduit is placed to the left. The colon is reapproximated with either a hand-sewn or a stapling technique. The conduit is irrigated to remove remaining intestinal contents, and the proximal end is closed in a watertight manner with absorbable sutures.

Construction of nonrefluxing ureterocolostomies is performed according to the method described by Leadbetter and Clarke [48]. The right ureter is delivered under the sigmoid colon beneath the parietal peritoneum. Two separate 5-cm incisions are made through the teniae, with care taken to avoid injury to the mucosa (Fig. 13A). Submucosal instillation of saline solution or saline with epinephrine (1:100,000) solution may facilitate dis-
Figure 12  Sigmoid colon conduit. A, Segment of sigmoid colon approximately 20 cm long is selected and marked with stay sutures. B, Although adequate blood supply should be ensured during creation of the sigmoid conduit, superior hemorrhoidal branch of inferior mesenteric artery may be divided to increase mobility of distal segment.

section. Traction sutures of 4-0 silk are placed to aid in retraction, and the mucosa is dissected from the muscular colon wall with fine scissors. The end of each ureter is spatulated and a mucosa-to-mucosa anastomosis constructed with 5-0 chromic sutures (Fig. 13B). Stents are used at the surgeon’s discretion. The colonic wall is reapproximated with interrupted 4-0 silk sutures, with care taken to avoid obstruction of the ureter at the proximal tunnel (Fig. 13C). And additional stabilizing 4-0 chromic suture is placed through the seromuscular layer of the ureter and the colon 2–3 cm proximal to the tunnel. The nipple stoma is created as described for ileal conduits with the exception of excising a slightly larger circle of skin and subcutaneous tissue to accommodate the colonic segment.

TRANVERSE COLON CONDUIT

The transverse colon conduit has been popularized by Schmidt [49]. It is used primarily in situations where pelvic radiation has been given or mark-
Methods of Urinary Diversion

Figure 13  Antirefluxing ureterocolostomies. A 5 cm submucosal tunnel is created for each ureter.

...foreshortened ureters are present. The procedure essentially parallels that of the sigmoid colon conduit, with the following exceptions.

The stoma can be placed in any of the four quadrants, allowing more options if significant abdominal wall abnormalities are present. A 10- to 15-cm length of transverse colon is selected, and the greater omentum is dissected from its superior surface. The blood supply is based on the middle colic artery with extensive collateral circulation, making devascularization of the segment unlikely (Fig. 14). The conduit is placed inferior to the colon, and colocolostomy is performed according to the surgeon’s preference. Colon conduits need not be placed in isoperistaltic fashion because they empty by mass contraction. The end selected as the “nonstomal” end should be closed in a watertight fashion. The ureters are delivered through the posterior peritoneum with avoidance of angulation, and nonrefluxing ureterocolostomies are constructed as described previously. Formation of the nipple stoma is the same as discussed earlier.
ILEOCECAL CONDUIT

Gilchrist et al. [2] introduced the ileocecal segment as a urinary conduit in an early attempt at continent diversion. Zinman and Libertino [50] used this ileocecal segment to construct a nonrefluxing conduit. The stoma site is again selected in the right lower quadrant. The conduit is based on the ileocolic vessels, which can be visualized with transillumination of the mesentery (Fig. 15). After the right colon has been mobilized, the ileum is divided approximately 10 cm proximal to the ileocecal valve and the colon...
Methods of Urinary Diversion

is divided just proximal to the right colic artery. Bowel continuity is re-
stored according to the surgeon’s preference, with the conduit placed to the
right of the intact colon.

The antirefluxing ureterocolostomies depend on reinforcement of the
ileocecal valve as described by Zinman and Libertino (Fig. 16A)[50]. This
reinforcement is accomplished by intussusception of the ileum into the ce-
cum and by “wrapping” the redundant cecal wall around the ileum (Fig.
16B). Conjoined ureteroleostomies are then constructed, and the standard
stoma is made.

COMPLICATIONS AND LONG-TERM RESULTS
OF COLON CONDUITS

The immediate postoperative complications do not differ significantly from
those already discussed for the ileal conduit. The presence of non-refluxing
ureteral Anastomosis has lead to stable renal function in 80–90% of patients
[48–50]. Nephrolithiasis tends to occur in those patients with failure of the
antireflux mechanism or those who develop acidosis from urine absorption.
Ureteroenteric anastomotic structure occurs with a frequency similar to that
of ileal conduits and is managed in the same fashion. The incidence of early
anastomotic obstruction may be higher because of the tunneling techniques,
leading many urologists to use stents in the early postoperative period.

Colonic mucosa is efficient at reabsorption of sodium and chloride,
although it does so less than the ileum. As with ileal conduits, the presence

Figure 16  Nonrefluxing ureteral anastomosis is dependent on reinforcement of
the ileocecal valve.
of renal insufficiency or large amounts of residual urine may lead to hyper-
chloroemic acidosis. A recent review of carcinogenesis in patients with intes-
tinal conduits documented six cases with colon conduits [51]. It is unclear
whether this carcinogenesis represents spontaneous colonic primary lesions
or lesions induced by urine-borne carcinogens.

CONTINENT RESERVOIRS WITH ABDOMINAL
WALL STOMAS

The past two decades have seen an explosion in interest in avoiding exter-
nal collecting devices. Several methods of continent urinary diversion have
been described, and modifications are reported frequently. The basic re-
quirements for a successful continent urinary diversion include (1) a large,
low-pressure reservoir, (2) absence of reflux, and (3) continence. The basic
methodologies are described below, although the reader is referred to the
References at the end of this chapter for detailed descriptions of all the
various modifications.

INDIANA POUCH

Gilchrist et al. [2] initially used the ileocecal segment in an attempt to
provide continent diversion. Their dependence on the unreinforced ileocecal
valve led to poor continence rates, and urologists did not embrace the pro-
cedure. At the University of Indiana, several modifications were introduced
in the 1980s: these developments led to what has become known as the Indi-
ana pouch [52,53]. The most important modifications include (1) plication
of the ileal segment and ileocecal valve to provide continence and (2) detu-
beralization of the bowel to avoid mass contraction and obtain greater res-
ervoir capacities.

Patient selection is important. The patient must be highly motivated
and cooperative in regard to postoperative care and lifelong intermittent
catheterization. Some surgeons believe that the need for postoperative radia-
tion therapy or chemotherapy obviates the use of continent diversion for
pelvic malignancies, although others use the procedure uniformly.

After mobilization of the terminal ileum and the ascending colon (in-
cluding the hepatic flexure), 25–30 cm of colon and 10 cm of terminal
ileum are measured and marked. The mesentery is examined to ensure ade-
quate blood supply, and the bowel is divided. An ileocolostomy is per-
formed according to the surgeon’s preference. The bowel is irrigated, and
the colon is opened along its antimesenteric border (Fig. 17A). The Indiana
group advises tapering the ileum and ileocecal valve before closure of the
Figure 17  Indiana pouch. A, Extended ileocecal segment is isolated, and colon is opened along its antimesenteric border. Nonrefluxing ureterocolostomies and tapering of ileal limb are performed before closure of colonic segment. B, Colon is closed in a Heineke-Mikulicz fashion. Flush stoma is constructed, and cecostomy tube is placed for postoperative drainage.

reservoir. (Fig. 17B). A 12F catheter is placed, and the ileum is tapered with the use of a GIA stapler. The ileocecal junction and valve are tapered with 3-0 silk Lembert sutures. The 12F catheter is removed, and easy passage of a 16F catheter is ensured. Stented ureterocolostomies are constructed as described previously. To detubularize the reservoir and avoid mass contractions, the colon is closed with two layers of 3-0 Vicryl suture in a Heineke-Mikulicz fashion. A flush stoma is created in an appropriate location, a cecostomy tube is inserted and delivered through the abdominal wall, and the ureteral stents are brought out through a separate stab incision.
Ease of catheterization is documented before closure. Drains are placed dependently.

Mucous secretion poses a problem postoperatively and requires irrigation via the cecostomy tube three or four times a day. After radiographs have confirmed the absence of extravasation and obstruction, the patient is discharged with instruction for home cecostomy tube irrigation. Intermittent catheterization is taught 2 to 3 weeks after discharge and the cecostomy tube removed.

In their most recent review [53], the Indiana group reported a 94% continence rate with 4- to 6-hr catheterizations. Approximately 50% of patients require one nocturnal catheterization to remain dry. Approximately 2% of patients required reoperation for either reflux or ureterocolonic obstruction. Since use of the stapling technique was initiated, only 1 of 35 patients required revision of the efferent limb [54]. Hyperchloremic metabolic acidosis occurs and occasionally requires oral alkali therapy.

MAINZ POUCH

Thuroff et al. [55] developed the Mainz pouch coincidentally with development of the Indiana pouch. It differs in the use of a longer segment of ileum (50 cm; Fig. 18) and a shorter segment of colon. Continence depends on the construction of a nipple valve, as described for the Kock pouch. The reservoir is constructed after detubularization of the colon and ileum along the antimesenteric border. A 10-cm segment of proximal ileum is used to construct the nipple valve. Other aspects are similar to those described previously.

MITROFANOFF PRINCIPLE

Mitrofanoff [56] first reported the use of the appendix for the construction of a continent stoma that could be catheterized. The appendix is mobilized with preservation of its mesentery, and it may be tunneled into the bladder or the cecal tinea, as in the construction of a nonrefluxing ureterocolostomy (Fig. 19). The distal end of the appendix is opened, and a flush stoma is created in a predetermined location. Most published series report continence rates usually higher than 90% using the Mitrofanoff principle [57]. Other structures used to construct a similar stoma include fallopian tubes, ureters, umbilical vein, and ileum.

TUBE-WITHIN-A-TUBE CONTINENT STOMAS

Benchekroun [58] has also described a variation on the use of the ileocecal segment to construct a continent reservoir. Of particular interest is his
Methods of Urinary Diversion

Figure 18  Mainz pouch. A shorter colonic segment and a longer ileal segment as well as reliance on a nipple valve for continence differentiate the Mainz pouch from the Indiana pouch.

method of constructing the continent stoma (Fig. 20). A separate 14-cm segment of ileum is isolated and invaginated. The anterior surfaces are secured with a continuous stitch of 3-0 Vicryl. When attached to the reservoir, the outer, mucosa-lined tube fills with urine, thereby compressing the inner, serosa-lined catheterizable tube and providing continence. Of 160 patients, 142 were continent (27 of them required reoperation to achieve continence) [59]. Koff et al. [60] used an imbricated ileal segment similar to that used in the Indiana pouch. It is augmented by a second segment of ileum approximately 10 cm long used to construct a urine-filled external compression chamber (Fig. 21). The distal end of the ileal segment is spatulated and wrapped around the imbricated ileal segment. A watertight attachment is achieved with 3-0 Vicryl sutures. The proximal end is attached to the reservoir, allowing the “cuff” to fill with urine and compress the imbricated segment, resulting in continence. Fourteen of 15 patients were continent, with 3 patients requiring reoperation for stoma problems.
Figure 19  Example of use of a catheterizable appendiceal stoma (Mitrofanoff principle) with a cecal reservoir.

KOCK POUCH

The continent ileostomy developed by Nils Kock is discussed in Chapter 10 [61]. This technique was modified for urinary diversion [62] and ushered in the era of continent urinary diversion. Skinner and associates [63] at the University of Southern California, popularized the procedure in the United States. Their methods are summarized in the following discussion.

An ileal segment approximately 80 cm long is selected. The distal margin should be approximately 20 cm proximal to the ileocecal valve. The bowel and mesentery are divided, with close attention paid to maintaining the blood supply. An ileoileostomy is performed according to the surgeon’s preference.

The ileal segment is marked into four segments of 17, 22, 22, and 17 cm. The two 22-cm segments are placed side by side and opened along their antimesenteric border (Fig. 22A), and the back walls are closed with a continuous 3-0 Vicryl suture (Fig. 22B).

Construction of the nipple valves is the crux of the procedure, because most reoperations are performed to repair them. The mesentery is separated from the bowel closest to the reservoir for approximately 8 cm and the bowel is intussuscepted. Boyd et al. currently place a 2-cm strip of Vicryl mesh through a mesenteric window 2–3 cm away from the previously made mesenteric opening. They also have begun using a GIA stapler to support the valve by placing two rows of 3.5-mm staples. The distal six staples are removed to prevent stone formation. The back wall of the valve is secured
Methods of Urinary Diversion

Figure 20  Benchekroun’s method of maintaining a continent stoma. A-B, Segment of ileum is inverted. C, Anterior walls of inverted ileum are approximated. Posterior opening is left to allow urine to enter from the reservoir, thus “squeezing” the inner chamber.

Further to the reservoir with a TA-55 stapler, and the tips of the valves are secured to the inside of the reservoir with 3-0 Vicryl suture. In a further attempt to prevent loss of intussusception, the Vicryl mesh is secured to the ileal limb and reservoir.

The pouch is closed in a watertight manner to provide a detubularized pouch. End-to-side ureteroileostomies are constructed on the afferent limb with the aid of stents. A flush stoma is constructed from the efferent limb in a convenient location previously selected by an ET. An additional 1-cm strip of Marlex mesh is used to secure further the mesenteric side of the
efferent limb to the posterior rectus fascia. A 30F catheter is left in the efferent limb to provide reservoir drainage, and a drain is placed.

As noted previously, frequent irrigation is necessary to avoid development of a mucous plug. Instruction for self-catheterization is given at approximately 3 weeks.

The most recent data from the University of Southern California state that 7% of patients have required endoscopic revision and 3.1% have required open revision of afferent valve stenosis [64]. Skinner and associates had previously reported that 11% of patients required revision of the efferent limb to maintain continence. Reflux or ureteroenteric strictures occurred only 2–3% of the time. [65] Vitamin B\textsubscript{12} levels should be closely monitored.

**SIMULTANEOUS DIVERSION OF URINARY AND FECAL STREAM**

The standard wet colostomy as described by Brunschwig and Daniel [66] has been generally abandoned because of development of severe electrolyte imbalance, pyelonephritis, and stoma complications. My colleagues and I have introduced the procedure called the “double-barreled” wet colostomy [46], which seems to have avoided the majority of these complications. Fortu-
Figure 22  Modification of Kock pouch for urinary diversion. Urerocolostomies are constructed on afferent limb, and efferent limb is used as a catheterizable stoma. Most reoperations are performed to repair the efferent limb.

nately, patients needing this procedure are rare and usually have advanced pelvic malignancies or severe radiation damage to the pelvic viscera.

If no colostomy exists, the sigmoid colon is mobilized, and an appropriate portion of the proximal sigmoid is selected as the stoma site (Fig. 23). We create the stoma first. A plug of skin and subcutaneous tissue is removed from the left middle abdomen and the rectus fascia is opened in a cruciate fashion as described previously. The muscle fibers are separated,
and a loop of sigmoid colon is delivered. The colon is secured to the ante-rior fascia to avoid retraction. The colon is opened, and the mucosa is se-cured to the skin with 3–0 Vicryl suture. The colon is divided with a GIA stapler approximately 15–20 cm distal to the stoma, thus forming a “urine limb.” The staples are removed from the urine limb, and the colon is closed in watertight fashion with 3-0 Vicryl suture. If severe ureteral dilation is not present, nonrefluxing ureterocystostomies are performed; otherwise an end-to-side technique is used.

If a loop colostomy already exists, the urine limb is constructed and ureterocolostomy is performed (see Fig. 23). If an end-sigmoid colostomy is present, it is taken down and the colon and the splenic flexure are mobilized. The procedure then proceeds as described previously.

Of the 10 patients operated on, 8 had advanced pelvic malignancies and succumbed to their disease within 2 1/2 years. The two patients with severe radiation damage to pelvic viscera are doing well after approximately 3 years. Upper tract function and/or radiographic appearance remained stable or improved in 9 of 10 patients, with the remaining patient developing malignant ureteral obstruction. There were no episodes of pyelonephritis, but metabolic acidosis occurred in two patients with renal insufficiency. Overall patient acceptance has been excellent.

**ORTHOTOPIC URINARY DIVERSION**

The first orthotopic reconstruction in a human was performed in 1913 by Lemonie [67], in which he performed a cystectomy with ureteral reimplan-
tation into the rectum. Camey and associates [68] first reported their experience with orthotopic diversion to the urethra in 1979. Prior to 1990, orthotopic reconstruction was reserved for male patients, as the female urethra was considered necessary to provide an adequate cancer margin. In 1995, however, Stein and associates [69] demonstrated the viability of the procedure in women.

The advantage to the orthotopic neobladder is that it most closely resembles the native bladder in both function and location. Moreover, it obviates the need for a cutaneous stoma and collection appliance. The orthotopic neobladder relies on the intact rhabdosphincter continence mechanism, thus eliminating the need for intermittent catheterization. The patient voids by simultaneously performing Valsalva’s maneuver and relaxing the pelvic floor musculature.

While performing the cystectomy, care is taken to preserve the continence mechanism. Tumor involvement of the distal surgical margin is excluded by frozen-section analysis. If there is no evidence of tumor, the orthotopic diversion may be performed [70].

**STUDER ILEAL BLADDER**

Described by Studer in 1989 [71], this is a popular form of orthotopic diversion (Fig. 24). Approximately 25 cm proximal to the ileocecal valve, a portion of terminal ileum 54–60 cm long is isolated. Bowel continuity is restored, and the ends of the isolated segment are closed with a running absorbable suture. The distal 40-cm portion of ileum is placed in a U shape and opened along the antimesenteric border (Fig. 24A). The ureters are then split and anastomosed in an end-to-side fashion to the proximal, nonincised, afferent tubular portion of ileum. The two medial borders of the U-shaped ileum are oversewn with a running absorbable suture (Fig. 24B). The bottom of the U is folded over between the two ends of the U (Fig. 24C). As described by Studer, after part of the upper half and the lower half of the anterior wall are closed, the surgeon’s finger is placed through the remaining reservoir opening to determine the most caudal part of the neobladder. A hole is cut out in the dependent portion of ileum, away from the suture line, allowing for urethral anastomosis (Fig. 24D). The urethroenteric anastomosis is then completed (Fig. 24E) and the remaining portion of the reservoir closed (Fig. 24F).

**COMPLICATIONS AND RESULTS**

Complications of orthotopic neobladder are summarized in Table 3. Studer reviewed his first 200 patients to undergo this procedure [72] and found that 24 had early complications, none of which were directly related to the
neobladder. One patient required conversion of the afferent tubular segment to an ileal conduit secondary to partial pouch necrosis 3 months postoperatively. Two patients required conversion following urethral tumor recurrence. In all, 194 of the patients were able to void spontaneously.

**KOCK ILEAL NEOBLADDER**

The Kock ileal neobladder evolved from the Kock continent cutaneous ileal reservoir described above, which uses intussuscepted nipple values for both the afferent and efferent limbs. In the orthotopic modification, the afferent intussuscepted limb was maintained to prevent reflux [73,74]. In total, 61 cm of terminal ileum is isolated. Two 22-cm segments are placed in a U configuration and opened next to the mesentery. The more proximal 17-cm segment of ileum is used to form the afferent intussuscepted nipple valve.
<table>
<thead>
<tr>
<th>Author</th>
<th>Form</th>
<th>No. of patients</th>
<th>Follow-up</th>
<th>Mean age</th>
<th>Mortality</th>
<th>Complications*</th>
<th>Continence</th>
<th>Antireflux mechanism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barre(^82)</td>
<td>Camey II-Ileum</td>
<td>110</td>
<td>32 mo</td>
<td>62 years</td>
<td>1%</td>
<td>Early 93%</td>
<td>Late 74%</td>
<td>IC, some form of intermittent catheterization to empty neobladder.</td>
</tr>
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<td>Elmajian(^83)</td>
<td>Kock-Ileum</td>
<td>295</td>
<td>42 mo</td>
<td>66 years</td>
<td>1%</td>
<td>Early 7%</td>
<td>Late 12%</td>
<td>IC</td>
</tr>
<tr>
<td>Steven(^84)</td>
<td>Kock-Ileum</td>
<td>166</td>
<td>32 mo</td>
<td>62 years</td>
<td>0%</td>
<td>Early 12%</td>
<td>Late 23%</td>
<td>Nipple valve</td>
</tr>
<tr>
<td>Hautmann(^85)</td>
<td>“W”-Ileum</td>
<td>363</td>
<td>57 mo</td>
<td>63 years</td>
<td>3%</td>
<td>Early 15%</td>
<td>Late 23%</td>
<td>Nipple valve</td>
</tr>
<tr>
<td>Hollowell(^86)</td>
<td>“W”-Ileum</td>
<td>50</td>
<td>20 mo</td>
<td>62 years</td>
<td>2%</td>
<td>Early 10%</td>
<td>Late 20%</td>
<td>Isoperistaltic “chimney”</td>
</tr>
<tr>
<td>Stein(^87)</td>
<td>T-Pouch-Ileum</td>
<td>40</td>
<td>10 mo</td>
<td>67 years</td>
<td>2.5%</td>
<td>Early 12%</td>
<td>Late 80%</td>
<td>Isoperistaltic limb</td>
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<tr>
<td>Studer(^88)</td>
<td>Studer-Ileum</td>
<td>200</td>
<td>30 mo</td>
<td>64 years</td>
<td>2%</td>
<td>Early —</td>
<td>Late —</td>
<td>T-limb mechanism</td>
</tr>
<tr>
<td>Cancrini(^89)</td>
<td>Studer-Ileum</td>
<td>96</td>
<td>28 mo</td>
<td>60 years</td>
<td>6%</td>
<td>Early 6%</td>
<td>Late 24%</td>
<td>Isoperistaltic limb</td>
</tr>
<tr>
<td>Thuroff(^90)</td>
<td>Mainz-Ileocecal</td>
<td>61</td>
<td>46 mo</td>
<td>—</td>
<td>—</td>
<td>Early 5%</td>
<td>Late 18%</td>
<td>Submucosal tunnel</td>
</tr>
<tr>
<td>Koletlis(^91)</td>
<td>Ileocecal (Le Bag)</td>
<td>38</td>
<td>14 mo</td>
<td>61 years</td>
<td>0%</td>
<td>Early 8%</td>
<td>Late 8%</td>
<td>Le Duc and Bricker</td>
</tr>
</tbody>
</table>

\(^*\)Complications reported related to urinary diversion.

(Fig. 25A). The posterior wall of the reservoir is then created by combining the medial portions of the U with a continuous running suture (Fig. 25B). Next a 5- to 7-cm antireflux valve is created by intussusception of the afferent limb with the use of Allis forceps clamps (Fig. 25C). The afferent limb is fixed with two rows of staples placed within the leaves of the valve (Fig. 25D), which is then fixed to the back wall from outside the reservoir (Fig. 25E). Finally, after completion of the afferent limb, the reservoir is finalized by folding the ileum into itself and closing it. The ureteroileal anastomosis is completed first, and the ureteroenteric anastomosis is performed in a tension-free mucosa-to-mucosa fashion (Fig. 25F).

**COMPLICATIONS AND RESULTS**

USC follow-up 295 male patients who underwent the Kock ileal neobladder procedure [75] revealed early and late complication rates of 7.2 and 11.6%,
respectively. The complications were primarily related to the intussuscepted antireflux afferent limb, including stone formation and afferent nipple stenosis. Late pouch related abdominal reoperation rates were 1.4%, while there were no early reoperations. Good or satisfactory daytime and nighttime continence was reported by 86 and 87% respectively, 5% perform regular intermittent catheterization, and 2.7% require an artificial urinary sphincter secondary to intolerable incontinence.

T POUCH ILEAL NEOBLADDER

More recently, the USC group has been performing the T Pouch neobladder [76] in an attempt to prevent complications from the intussuscepted afferent nipple. According to Skinner, the T pouch is created from 44 cm of distal ileum placed in an inverted V configuration; each limb of the V measures 22 cm, and a proximal 8- to 10-cm segment of ileum (afferent limb) is used to form the afferent antireflux mechanism. The ileum is then divided between the proximal afferent ileal segment and the 44-cm segment that will form the reservoir. The proximal end of the isolated afferent ileal segment is closed with a running absorbable suture. The isolated 44-cm ileal segment is laid in an inverted V configuration, with the apex of the V lying caudally and a suture marking a point between the two 22-cm adjacent segments of ileum. The opened end of the V is directed cephalad (Fig. 26A).

The antireflux mechanism is then created by anchoring the distal 3–4 cm of the afferent ileal segment into the serous-lined ileal trough formed by the base of the two adjacent 22-cm ileal segments. Mesenteric windows of Deaver are opened between the vascular arcades 3 to 4 cm proximal to the most distal portion of the isolated afferent segment (Fig. 26B).

With the sutures passed through the previously opened windows of Deaver, a series of 3-0 silk sutures are used to approximate the serosa of the two adjacent 22-cm ileal segments at the base of the V. This process is repeated through each individual window of Deaver until the distal 3–4 cm of the afferent segment is permanently fixed in the serous-lined ileal trough (Fig. 26C).

The anchored portion of the afferent ileal segment (3–4 cm distal) is then tapered on the antimesenteric border over a 30F catheter. Tapering this portion of the afferent ileal segment merely reduces the bulk of the afferent limb, facilitating later coverage of the anchored afferent limb with ileal flaps (Fig. 26D).

The remaining portion of the adjacent 22-cm ileal segments is then approximated with an absorbable suture after the distal 3–4 cm of the afferent ileal segment has been tapered. Starting at the apex of the V, the bowel is opened immediately adjacent to the serosal suture line and carried upward to the afferent limb. As this incision reaches the level of the afferent
ostium, it is extended cephalad to the base of the ileal segment and directly lateral to the antimesenteric border of the ileum. This incision provides wide flaps of ileum that will eventually be brought over the tapered afferent ileal segment to create the antireflux mechanism in a flap-valve technique (Fig. 26E).

As described by Skinner, the previously incised ileal mucosa is then oversewn with a running absorbable suture starting at the apex and running upward to the afferent limb (Fig. 26F). Once the ostium of the afferent limb is reached, an interrupted mucosa-to-mucosa anastomosis is completed between the ostium of the afferent ileal limb and the incised intestinal ileal flaps with absorbable sutures. The mucosal edges of the ileal flaps are then approximated over the tapered portion of the afferent ileal limb (3 to 4 cm) with a running suture. The suture line finalizes the posterior wall of the reservoir and produces the serous-lined ileal antireflux mechanism (Fig. 26G).

Finally, the reservoir is closed by folding the ileum in half in the opposite direction to which it was opened, similar to formation of the Kock pouch. The anterior wall is closed (Fig. 26H). This anterior suture line is stopped before the end of the right side to allow introduction of an index finger. This is the most mobile and dependent portion of the reservoir and will be anastomosed to the urethra (Fig. 26I). Once the pouch has been closed, each ureter is spatulated, and a standard bilateral end-to-side ureteroileal anastomosis is performed to the proximal afferent ileal segment (Fig. 26).

COMPLICATIONS AND RESULTS

Stein and associates [76] reviewed their results in 40 patients who underwent this procedure with mean follow-up of 10.5 months. They report one perioperative death and 5 early complications, all unrelated to urinary diversion, with no late complications. Their belief is that the intraluminal serosa-lined ileal antireflux mechanism will eliminate complications associated with the intussuscepted nipple valve technique. Fifteen of the 20 patients who were alive at 10 months follow-up had complete daytime continence, and 4 reported daytime incontinence with a minor effort only. Complete nighttime continence was reported by 13 patients.

QUALITY OF LIFE IN URINARY DIVERSION

Gburek and associates [77] compared the clinical outcomes of the Studer neobladder with those of an ileal conduit diversion and found that the perioperative and long-term morbidity to be comparable to that of an ileal conduit diversion. Similarly, Hart and associates [78] compared patients with
ileal conduit, cutaneous diversion, and urethral Kock pouch and found that the type of diversion did not affect quality of life.

LAPAROSCOPIC DIVERSION

Finally, we would be remiss without at least paying homage to the newly developing technique of laparoscopic diversion. While currently performed only by laparoscopic pioneers, both laparoscopic ileal conduits [79,80] and neobladders [81] have been described.
SUMMARY

Improvements in techniques of urinary diversion continue, to the benefit of patients requiring these procedures. The ileal conduit is losing its place as the “gold standard” in adult patients. Continent urinary diversion and ortho
topic bladder substitutions continue to grow in popularity and have become the procedures of choice in many clinical situations. Laparoscopic surgery promises to provide even newer horizons as the story of urinary diversion continues to evolve.
Figure 26  Continued
REFERENCES

I. INTRODUCTION

The creation of a stoma for diversionary purposes without a resective procedure has usually been done with a separate laparotomy incision. Since the first reports of laparoscopic cholecystectomy in 1987, there has been a tremendous amount of interest in minimally invasive approaches to surgery [1]. In the field of colon and rectal surgery, minimally invasive techniques have been used for almost every intra-abdominal procedure including the creation and reversal of stomas [2].

II. INDICATIONS AND CONTRAINDICATIONS

The indications and contraindications for a minimally invasive stoma are similar to those for open surgery. Colonic obstruction, peritonitis, and multiple adhesions are all relative contraindications to a minimally invasive approach. In addition to patient factors, the decision to create a stoma without a separate laparotomy will depend on the surgeon’s skill and familiarity with these optional approaches.

III. TREPINE STOMAS

It is worth mentioning trephine stomas at the outset. Even before the advent of laparoscopy, there was interest in the minimally invasive approach to forming stomas. Trephine (“hole”) stomas, in which the bowel is exteriorized through a small laparotomy incision, have been done almost since stomas were first reported (see Chap. 1), for many years with good success.

The technique of a trephine stoma involves making a single incision in the abdominal wall at the site of the intended stoma. Most commonly,
this will be in the left lower quadrant for a sigmoid colostomy or in the upper abdomen for a transverse colostomy. The bowel that is intended to be used for the stoma is then grasped (and perhaps minimally mobilized) and brought up through the stoma site. If technically possible, placement of a flexible sigmoidoscope can facilitate recognition, mobilization and correct orientation of the bowel. The stoma can then be matured in the desired fashion. Any type of stoma, from a loop ileostomy to an end colostomy, can be fashioned. Trephine stomas are created successfully in 80–90% of those patients in whom they are attempted [3–5]. When a laparotomy is needed, it is usually because of adhesions that prevent adequate mobilization. Like stomas formed in any fashion, there can be long-term complications, such as parastomal hernias and prolapse [3].

IV. LAPAROSCOPY-ASSISTED STOMAS

A. Operative Technique

The technique for creating a stoma with laparoscopic assistance has not been standardized, but certain general principles apply. Preoperatively, the patient should receive stoma instructions and should be marked for a stoma site to ensure optimal placement. The bowel preparation (mechanical as well as antibiotic coverage) should be done as the surgeon normally would do for a bowel resection. The patient should be placed in stirrups to allow for placement of a colonoscope at the end of the procedure should there be any question regarding the orientation of the bowel. Once adequate anesthesia and a sterile field have been established, the trochars can be placed. A port for the camera is usually placed in the periumbilical region. It is advantageous to place another port at the site of the proposed stoma. Once adequate pneumoperitoneum is established and the camera port inserted, the surgeon can determine how many additional ports are necessary (see Fig. 1). For those patients with a mobile bowel, a single port can be placed at the site of the proposed stoma and a grasper passed through it to deliver the bowel up to the abdominal wall. For many patients, an additional port or two may be necessary to allow for adequate adhesiolysis and mobilization of the bowel.

Once the trocars are placed, any adhesions that will impede the operation are lysed. If a sigmoid colostomy is to be done, the sigmoid colon and the left colon can be mobilized completely to the splenic flexure if necessary by incising the lateral peritoneal attachments (Fig. 2). The adequacy of the mobilization can be checked by grasping the proposed loop of the bowel and lifting it up toward the abdominal wall. The intestinal segment selected for stoma creation is then grasped with a “bowel type” grasper and correct orientation ensured. The distal end may be marked with cautery, a clip, or suture in order to prevent maturation of the incorrect end due to
Figure 1 Most colonic laparoscopic surgery requires three to five ports. Placeing port and location of anticipated stoma (i.e., left lower quadrant) as shown here is advantageous.

twisting when the bowel is elevated through the abdominal wall. Once there is convincing evidence of adequate mobilization, the skin is excised in a circular fashion at the stoma site, the fascia is incised and the loop of bowel is delivered upward through the abdominal wall. The colostomy can then be matured in the fashion preferred by the surgeon. The same steps and principles can be applied to formation of ileostomies as well.

V. RESULTS

The expected benefits of laparoscopic surgery include decreased pain, decreased need for narcotic analgesia, quicker return of bowel function, and decreased length of stay. There is currently little information (and no prospective randomized trials) to support these claims in the setting of placement of diversionary stomas.

When laparoscopy-aided stoma formation is attempted, the success rate is high (84–97%), with most of the conversions being necessary because of dense adhesions [6,11] (Table 1). In those studies that compared the laparoscopy group to an open control group, the operative times were longer in the laparoscopic group. In a report by Young et al. [10] operative times were 176 vs. 194 min, whereas Hollyoak et al. [11] actually found the opposite (54 vs. 72 min). Hospital stays were shorter for the laparoscopic patients in both of these studies (Table 1). In all the remaining reports on laparoscopic stomas, the length of stay tends to be rather longer.
than expected, which the authors attribute to the need for education regard-
ing stoma care and factors related to the disease state that led to the stoma [6–11].

Complication rates are low. Morbidity potentially related to the lapa-
roscopic approach include one case of a stoma outlet obstruction that
was found to be caused by a twist in the bowel as it exited the abdominal
cavity [6].

VI. COLOSTOMY CLOSURE

Although take-down of a loop ileostomy or colostomy can usually be done
through a peristomal incision, closure of a colostomy following a Hartman
procedure requires a laparotomy. Alternatively, the laparoscopic approach
may be used in this setting. Even though this procedure does not require a
bowel resection, it is often technically demanding. The conditions that led
to the Hartman procedure initially (such as diverticulitis or colonic obstruc-

Figure 2  A, Distal sigmoid colon and rectum are grasped with forceps prior to
dissection. B, Sigmoid colon is grasped with Babcock forceps and lateral peritoneal
reflection is incised.
Table 1  Series of laparoscopy-Aided Stomas

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Number of Patients</th>
<th>Percent Completion</th>
<th>Percent Complications</th>
<th>Length of Stay (days)</th>
<th>Length of Stay (days)</th>
<th>OR Time (min)</th>
<th>OR Time (min)</th>
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<td>32</td>
<td>84</td>
<td>6</td>
<td>6</td>
<td>na</td>
<td>76</td>
<td>na</td>
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<td>24</td>
<td>95</td>
<td>5</td>
<td>6</td>
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<td>60</td>
<td>na</td>
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<tr>
<td>Almqvist, 1995 [8]</td>
<td>18</td>
<td>89</td>
<td>6</td>
<td>na</td>
<td>na</td>
<td>49</td>
<td>na</td>
</tr>
<tr>
<td>Schwander, 1998 [9]</td>
<td>42</td>
<td>98</td>
<td>9.5</td>
<td>13</td>
<td>na</td>
<td>74</td>
<td>Na</td>
</tr>
<tr>
<td>Young, 1998 [10]</td>
<td>19</td>
<td>84</td>
<td>5</td>
<td>8</td>
<td>11</td>
<td>176</td>
<td>104</td>
</tr>
</tbody>
</table>
VII. TECHNIQUE

The patient is placed in the lithotomy position with the legs in Allen stirrups. A periumbilical port is placed with an open approach. An alternative is to make a peristomal incision first and begin colostomy mobilization. The anvil can be placed in the end of the newly mobilized sigmoid colon and placed back in the abdominal cavity. The stoma site can then be used to place a trocar and establish pneumoritoneum. Additional trochars are placed as needed so that an adhesiolysis can be performed. The rectal stump must be identified and freed up sufficiently from small bowel adhesions and other surrounding structures to allow for a safe anastomosis. Transanal passage of the EEA instrument (United States Surgical Corporation, Norwalk, CT) or the ILS instrument (Ethicon Endo-Surgery, Cincinnati, OH) can facilitate mobilization of the rectum. Once the rectum is sufficiently mobilized, the spike is advanced out through the rectal stump (Fig. 3). The anvil in the sigmoid colon is then mated with the transanal stapling device and an anastomosis is completed in a standard end-to-end fashion (Fig. 4). The anastomotic rings should be checked for completeness and the anastomosis air-tested under water to evaluate for leaks. If an anastomotic leak is
found, the defect must be identified and repaired. Options for repair include laparoscopic suturing, recreation of the anastomosis, proximal diversion, or proceeding with an open laparotomy. Decision making in this circumstance will be guided by the surgeon’s experience as well as the nature of the anastomotic defect.

VIII. RESULTS

Most of the studies of laparoscopy-aided colostomy take-down are quite small. Conversion rates are reported to be anywhere from as low as 0% to as high as 22%, with operating times being 130–230 min. Complication rates (0–40%) have been comparable to or better than historical results of open Hartmann’s take-down. Intraoperative complications have included stapler-related rectal perforation and incomplete anastomotic rings [15]. Hospital stays range from 4–8 days [12–15].

IX. SUMMARY

There will continue to be a role for minimally invasive approaches to colon and rectal surgery. More studies are needed to determine the optimal application of laparoscopic techniques in the formation and reversal of stomas.
REFERENCES


INTRODUCTION

While patients requiring proctocolectomy can expect to have a normal life expectancy, many may suffer from complications related to ileostomy, continent ileostomy, or ileoanal pouch dysfunction. With the loss of the colon’s absorptive surface, every patient is vulnerable to complications resulting from excessive salt and water losses. This is likely to be the most common complication associated with a conventional ileostomy, continent ileostomy, or pelvic ileoanal pouch. Diarrhea, due to either an infectious process, or a primary disease of the gut or secondary to the postoperative state, can be life-threatening for the patient who has lost the dynamic absorptive capacity of the colon. This chapter discusses some common dysfunctions of conventional ileostomy and restorative procedures, each of which centers around the potential for excessive fluid and electrolyte losses.

CONVENTIONAL ILEOSTOMY

Diarrhea

Diarrhea in a patient with a conventional ileostomy or continent stoma can be defined as a fecal volume of more than 1 L per day. The same definition can be applied to those patients with an ileoanal pouch, although such patients will often complain more of the frequent evacuations and the perineal irritation than about the dehydration associated with diarrhea. Patients who have undergone proctocolectomy are chronically dehydrated and have elevated mineralocorticoid levels. The terminal ileum responds to elevated mineralocorticoids by increasing absorption of water and sodium, with compensatory losses of potassium [1]. This is believed to account for the...
adaptive response to colectomy over the first few weeks following proctocolectomy. The gradual reduction of stomal output seen following proctocolectomy is, however; not typically seen in patients who have undergone significant ileal resection.

High stool output following proctocolectomy may be due to a multitude of causes including infectious sources, partial obstruction, recurrence of Crohn’s disease, or further resection of small bowel. Patients who have undergone proctocolectomy may develop bacterial or viral (more likely) gastroenteritis at the same frequency as the general population. However, in comparison to the general population, the consequences of gastroenteritis are more severe to the patient with an ileostomy. Without an intact colon and ileocecal valve, stoma patients are much more prone to dehydration with marked increases in effluent output and must be instructed to maintain adequate liquid intake. If they develop significant nausea and vomiting with their illness, dehydration may rapidly ensue. All stoma patients need to be aware of this phenomenon. Patients are instructed to monitor their urine output and, before severe dehydration occurs, should present to the emergency room for hydration if the urine volume decreases or becomes more concentrated.

**Partial Obstruction**

Small bowel obstruction is common following proctocolectomy. The incidence of such obstruction is highest in the first 3 years following surgery [2]. Adhesions, volvulus, and internal or parastomal hernias are the most common sources of bowel obstruction, with the majority being due to adhesion formation. Symptoms of bowel obstruction include a significant change in ostomy output (either more or less depending on degree of obstruction), abdominal cramps, bloating, and nausea and vomiting. In cases of partial small bowel obstruction, stomal output may become quite excessive, with thin, watery fluid. The mechanism by which partial obstruction leads to increased efflulent is not well understood. With complete obstruction, fluid and electrolyte absorption is impaired and the bowel proximal to the obstruction becomes secretory rather absorptive [3]. With resolution of bowel obstruction by conservative treatment, there may be a compensatory increase in ostomy output as the obstruction resolves. This is heralded by thin, watery output through which one could “read a newspaper.” Patients require commensurate intravenous fluid resuscitation. For output greater than 2 L, patients should be placed on milliliter-for-milliliter replacement with either 0.45% normal saline or lactated Ringer’s solution, depending on their electrolyte and metabolic status. The patients’ diet should not be advanced beyond clear liquids until the stoma output falls and the effluent thickens.

Partial or complete ileostomy obstruction commonly results from dietary indiscretion. An ileostomate may eat celery, raw carrots, apples, or
other fibrous food. Particularly if eaten quickly and not chewed well, this food may pass relatively undigested to the ileum just proximal to the stoma. Lodging immediately proximal to the fascia where the ileal lumen is at its narrowest point, this food bolus may cause partial or complete obstruction. In such instances, patients present with symptoms identical to those of small bowel obstruction. When questioned, they can often identify the dietary source.

In this circumstance, gentle irrigation of the stoma with water via a lubricated red rubber catheter (digital evaluation of the ileostomy is unrewarding, due to its narrow lumen) will commonly dislodge the food particle. Occasionally dramatic results ensue, as evidenced by large ileostomy output and relief of obstructive symptoms.

**Bacterial Overgrowth**

Bacterial overgrowth has been identified in patients with partial bowel obstruction and may be a cause for increased stoma output. Small bowel bacterial overgrowth is known to cause both deconjugation of bile salts and vitamin B₁₂ malabsorption [4]. Unconjugated bile salts impair sugar, water, sodium, and potassium transport in the small intestine [5]. Anaerobic bacteria are capable of binding to the vitamin B₁₂–intrinsic factor complex, making it unavailable for absorption. The combination of aerobic and anaerobic bacterial overgrowth may lead to increased fluid sequestration in the obstructed bowel by the above mechanisms.

**Recurrent Regional Enteritis**

Recurrence rates after colectomy for Crohn’s disease vary. Recurrence following proctocolectomy and ileostomy is less common than segmental colonic or small bowel resection with anastomosis and ranges from 10–20% [6–7]. High-volume output in these patients may be caused by either mucosal disease—with resultant malabsorption of fluid, electrolytes, and nutrients—or partial intestinal obstruction, with its attendant pathophysiology.

Even a pathologically confirmed diagnosis of ulcerative colitis does not preclude the possibility of regional enteritis (Crohn’s disease) as a cause of ileostomy diarrhea. In a small percentage (<5%) of patients thought to have ulcerative colitis, an ultimate diagnosis of Crohn’s disease will be identified postoperatively when regional enteritis develops in the small intestine. This is especially true following ileal pouch surgery. In a study from the Lahey Clinic, 3% of patients with a pathological diagnosis of ulcerative colitis were eventually found to have Crohn’s disease in the residual small intestine [8]. In more than half of these patients, high stool frequency related to the Crohn’s disease was identified, thus highlighting the need to consider recurrent regional enteritis in all patients with an ileostomy regardless of the original colonic pathology.
Ileal Resection

Resection of even small lengths of terminal ileum can have significant long-term effects on the volume of effluent from a conventional stoma. In addition to a chronically elevated effluent volume, patients have higher-than-normal output of sodium and potassium. They may also have higher-than-normal fecal concentrations of nitrogen and fat [9]. This phenomenon may be a result of more rapid transit of intestinal contents, loss of the portion of small bowel that is most responsive to mineralocorticoids, or steatorrhea. Steatorrhea after resection is probably secondary to impairment of bile salt absorption from loss of the terminal ileum, with secondary depletion of the bile salt pool. Whatever the precise mechanism, patients who require ileal resection will have persistently high effluent volumes.

Gastric Hypersecretion

Gastric hypersecretion is rarely seen after proctocolectomy alone. It occurs more commonly when proctocolectomy is combined with excessive small bowel resection. The period of hypersecretion may last up to several months. H₂ blockers or proton pump inhibitors may curtail some of the effects. If untreated, acid hypersecretion results in low jejunal pH, impaired micellar solubilization of fat, steatorrhea, and diarrhea [10].

CONTINENT ILEOSTOMY OR ILEOANAL POUCH

Pouchitis

Patients with a continent ileostomy or ileoanal pouch are prone to develop a type of ileostomy dysfunction that is not seen in patients with conventional ileostomies. This syndrome, termed pouchitis, may occur in up to 50% of patients following either of these procedures. Patients will complain of increased stool frequency, abdominal or pelvic cramps, and tenesmus (if they have a pelvic pouch). They may sometimes complain of fever, arthralgias, anorexia, or weight loss. Arthralgias are often seen in patients who had arthralgias associated with their inflammatory bowel disease. Patients with a continent ileostomy may have difficulty intubating their pouch. More than any single symptom, a patient with an ileoanal reservoir who develops pouchitis will complain that his or her “colitis” has returned. The precise mechanism of pouchitis remains unknown, but most theories center around bacterial overgrowth of the ileal reservoir. This alone, however, is insufficient. Patients with continent ileostomies and ileoanal reservoirs who develop pouchitis almost universally have inflammatory bowel disease; pouchitis rarely occurs in patients with familial adenomatous polyposis who undergo similar procedures [11]. This suggests that pouchitis is multifactorial, involving genetic, immune, and microbial mediators. Ileal reservoirs are colonized with high concentrations of bacteria, which—combined with incom-
Ileostomy and Pouch Dysfunction

Complete evacuation and stasis—may be a major factor in the pathogenesis of pouchitis. The role of bacterial overgrowth is further supported by the use of antibiotics and probiotics in the treatment of pouchitis. Metronidazole and ciprofloxacin are the most commonly prescribed antibiotics in the treatment of pouchitis. A recent randomized control trial compared these two antibiotics; both were found to be highly effective, and they significantly lowered pouchitis activity indices [12]. Further studies have demonstrated the efficacy of probiotics for the treatment and remission of pouchitis. Probiotics, by restoring the microbial imbalance in the pouch, are a new alternative for the treatment of chronic pouch inflammation. In a placebo-controlled trial by Gionchetti and colleagues, a highly concentrated mixture of probiotic bacteria was highly effective as a maintenance treatment for pouchitis [13]. Future studies will evaluate the role of probiotics in the prevention of pouchitis. Until then, oral antibiotics will likely remain the mainstays of therapy.

Patients with an ileoanal pouch may also be at risk for long-term metabolic consequences, which are most prominent in patients with chronic pouchitis. In a recent evaluation of 104 patients with an ileoanal J pouch for more than 5 years, the incidence of pouchitis was 42% and was strongly associated with villous atrophy [14]. In patients with severe villous atrophy, serum levels of albumin, calcium, cholesterol, triglycerides, and vitamin E were significantly reduced. Rates of vitamin B_{12} absorption were lowest in patients whose inflammation extended into the afferent limb. Vitamin D deficiency was seen in 10%, and deficiencies of vitamins A and B_{12} were noted in 5%. In patients with chronic pouch inflammation, therefore, an assessment of these metabolic disturbances should be considered.

Outlet Obstruction

Patients with an ileoanal reservoir may develop frequent stools and incontinence secondary to poor emptying of the pelvic pouch as a result of mechanical outlet obstruction. For patients with a J-type pouch, this likely relates to stricture at the pouch’s anal anastomosis. This typically responds to in-office or operative dilatation. For patients with an S-shaped pouch, outlet obstruction occurs secondary to elongation of the efferent limb, which results in a kink at the junction of the efferent limb and pouch. This typically requires abdominal revision of the pouch by shortening the efferent limb and reseating the pouch. An alternative is a transanal approach that divides the obstructing septum between the pouch and the efferent limb. This approach has been highly effective in a small series of patients [15].

Afferent Limb Obstruction

Afferent limb obstruction should be suspected in patients with recurrent obstruction following the construction of an ileoanal reservoir [16]. Patients often present with chronic symptoms of intermittent obstruction. The bowel
proximal to the ileoanal pouch becomes adherent to the ileoanal pouch; thus, when the pouch distends, external compression worsens the obstruction. Symptoms are relieved when the patient evacuates the ileal reservoir. The diagnosis is difficult to establish, although radiographic demonstration of dilated bowel to the level of the pouch is suggestive. Because the obstruction is distal in the small bowel and often not complete, antegrade contrast studies may not be definitive. Retrograde contrast enema using fluoroscopy is probably the most effective study to demonstrate the site of obstruction. The obstruction is treated by resection or preferably by bypassing the obstructed afferent limb. Resection of the afferent limb may result in inadvertent injury to the pouch or its blood supply. Afferent limb obstruction should be considered in a pouch patient who has chronic intermittent obstruction without evidence of proximal adhesive obstruction.

MANAGEMENT OF ILEOSTOMY DIARRHEA

Since many patients with a well-functioning ileostomy are prone to mild dehydration, it is no surprise that severe dehydration can develop quite rapidly when diarrhea occurs. With a reduction in both total body water and exchangeable sodium, serum sodium levels may be normal. A secondary potassium deficiency can develop, as the kidney will excrete potassium in an attempt to conserve sodium. Occasionally magnesium and calcium depletion may be identified in patients with long-standing high ileostomy output. Vitamin B₁₂ deficiency is a well-known sequela of ileal resection, and patients with chronic ileostomy diarrhea are prone to develop uric acid or calcium oxalate kidney stones and cholelithiasis.

CLINICAL EVALUATION

History

Knowledge of the details of the original diagnosis, the type of procedure performed, and the postoperative complications helps in narrowing the differential diagnosis. Symptoms beginning early after surgery suggest ileal resection, chronic obstruction, or a preexisting condition (such as lactose intolerance) as a cause of high stomal outputs. The volume of stool effluent can be estimated by the frequency of ostomy device emptying. The character of the stool and the presence of blood can also provide clues. The patient’s volume status can be estimated by the frequency and volume of urination and recent weight loss. Associated intestinal symptoms such as cramping, bloating, and difficult evacuation or intubation should be ascertained, as should extraintestinal symptoms of stomatitis, arthritis, or uveitis. Such symptoms are suggestive of partial intestinal obstruction, bacterial overgrowth, pouchitis, or recurrent Crohn’s disease. Current medications or recent changes
Ileostomy and Pouch Dysfunction

of medication should be reviewed, as should similar diarrheal symptoms in other family members and any preceding travel history that might suggest an infectious source.

**Physical Examination**

Physical examination should focus on hydration status, abdominal evaluation, stomal appearance, and the perineum. In patients with an ileoanal reservoir, the perianal skin should be examined for manifestations of Crohn’s disease and digital examination should be performed to exclude anastomotic stricture. Flexible or rigid endoscopy through the stoma or anus will allow assessment of the small bowel mucosa.

**Laboratory Studies**

The history and physical examination will dictate which studies should be obtained. Blood chemistries—including complete blood count, serum electrolytes, creatinine, and blood urea nitrogen—are appropriate in most patients. Quantification of gastric acid secretion and serum gastrin levels may be indicated. Fecal studies for *Campylobacter, Yersinia, Shigella, Salmonella, Clostridium difficile* toxin, other pathogens, and ova and parasites may be required. Quantification of 24-hr fecal volumes, electrolytes, and fat is appropriate in most chronic cases. Contrast examinations of the small intestine and endoscopy are useful to exclude obstruction or recurrent Crohn’s disease.

**MEDICAL MANAGEMENT**

For patients in whom a surgically correctable source of the diarrhea has been identified, resection is appropriate. In patients with recurrent Crohn’s disease, appropriate medical therapy may avoid the need for surgery.

For patients with a continent ileostomy or ileoanal pouch with symptoms consistent with pouchitis, antibiotic therapy should be instituted. A 2-week course of metronidazole or ciprofloxacin should be tried and then the antibiotics discontinued. Other broad-spectrum antibiotics may also be used. If symptoms recur, patients may be retreated. There is increasing evidence that probiotics may be used as a primary or supplemental treatment for recurrent pouchitis. For patients with persistent symptoms, endoscopic examination of the pouch is useful in documenting the degree and location of the inflammation and is best done when patients are symptomatic. In some cases inflammation may occur in the distal pouch or retained rectal mucosa if a stapled anastomosis was performed. These patients will respond well to steroid suppositories or steroid foam injections. For patients with chronic recurrent pouchitis, resumption of 5-aminosalicylic acid (5-ASA) class medications, 6-mercaptopurine, or systemic steroids may be required. Also in this group, repeated endoscopic examination of the after-
ent limb proximal to the pouch along with a small bowel series should be performed to exclude Crohn’s disease.

In patients who have high ileostomy output after ileal resection in whom other treatable conditions have been excluded, it is important to quantitate the amount of steatorrhea on a diet with a known amount (70–100 g) of daily fat intake. Patients with a stomal output of greater than 15 g of fat a day generally have fat malabsorption should be treated with a 50 to 70-g fat diet. In more severe cases, further reduction to a 40-g fat diet may be tried with medium-chain triglyceride supplementation. Patients should also be on maintenance antidiarrheal agents, such as loperamide or codeine. Supplemental fiber may be used to thicken the effluent. If response is minimal, opium may be added. For patients with steatorrhea, there has been some success from treatment with an H2 blocker.

A host of other therapies have been utilized to maintain fluid and electrolyte balance, with varying results. Active absorption of an orally administered glucose polymer solution (Polycose; Ross Laboratories, Columbus, OH) in the proximal jejunum is believed to result in passive absorption of salt and water [17]. There are also scattered case reports of good response to long-acting somatostatin analogues. Somatostatin leads to decrease water secretion and prolonged small bowel transit time. Gastric emptying and glucose and nitrogen excretion were not altered in the patients studied, although fat excretion was increased [18].

In patients with truly uncorrectable ileostomy diarrhea and problems maintaining fluid and electrolyte balance, fluid therapy through a permanent indwelling intravenous catheter may be necessary. If a patient with long-term high ileostomy output develops urolithiasis, alkalinization of the urine should be considered. For patients who develop symptomatic cholelithiasis, cholecystectomy is required. Elective cholecystectomy should be considered in a patient with an ileostomy who requires further small bowel resection resulting in the development of short bowel syndrome.

SUMMARY

Most patients with ileostomy and or pouch dysfunction have an underlying cause that is relatively easy to diagnose and treat. In most instances the cause relates to the underlying disease or the type of surgical procedure performed. Successful management, often without surgery, is possible in the majority of cases.

REFERENCES


INTRODUCTION

Parastomal hernia, an incisional hernia at the site of an intestinal stoma, has been a recognized complication of stoma surgery for a long time. According to Goligher [1], “Some degree of herniation around a colostomy is so common that this complication may be regarded as inevitable.” Although hernias associated with ileostomy and urostomy are less frequent, they are still common. The potential complications of parastomal hernia can be mild and easily managed or serious and potentially life-threatening. The patient may present with a cosmetic problem, with difficulty managing the stoma, or with any of the usual complications of a hernia. Repair is complex, although infrequently necessary. The poor results with standard local repair have caused surgeons to favor relocation of the stoma or techniques using prosthetic material. Even with these methods, results are often less than ideal. As is often the case, the best solution to the problem is prevention. Good preoperative planning and careful attention to technical detail can minimize parastomal herniation.

INCIDENCE AND PREDISPOSING FACTORS

Identifying the incidence of parastomal hernia is difficult. Various authors have reported frequencies ranging from 0–100%. Table 1 lists the incidence in the published series to date. Clearly the rate varies with the type and age of the stoma and with the technique and circumstances of the operation. Patient characteristics and postoperative events also affect the likelihood of hernia development.

Table 2 lists identified or suggested predisposing factors for parastomal hernia formation. Despite the long list of factors that might predispose an individual with an ostomy to hernia development, only a handful of
Table 1  Published Series of Incidence of Parastomal Hernia

<table>
<thead>
<tr>
<th>Authors</th>
<th>Year</th>
<th>Stoma type</th>
<th>Number</th>
<th>Years of follow-up*</th>
<th>Incidence in &gt;30-day survivors</th>
<th>Required operation</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birnbaum and Ferrier [2]</td>
<td>1952</td>
<td>End colostomy</td>
<td>569</td>
<td>1–34</td>
<td>27/569 (5%)</td>
<td>—</td>
<td>b,d</td>
</tr>
<tr>
<td>Grier et al. [3]</td>
<td>1964</td>
<td>End colostomy</td>
<td>50</td>
<td>5.2</td>
<td>29/50 (58%)</td>
<td>—</td>
<td>c,e,f</td>
</tr>
<tr>
<td>Green [4]</td>
<td>1966</td>
<td>Loop colostomy</td>
<td>160</td>
<td>2–7</td>
<td>8/318 (3%)</td>
<td>—</td>
<td>b,d,g</td>
</tr>
<tr>
<td></td>
<td></td>
<td>End colostomy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Watts et al. [5]</td>
<td>1966</td>
<td>End ileostomy</td>
<td>151</td>
<td>3.4</td>
<td>3/119 (3%)</td>
<td>0/3</td>
<td>b</td>
</tr>
<tr>
<td>Roy et al. [6]</td>
<td>1970</td>
<td>End ileostomy</td>
<td>497</td>
<td>7.4</td>
<td>3/469 (1%)</td>
<td>—</td>
<td>b,h</td>
</tr>
<tr>
<td>Burns [7]</td>
<td>1970</td>
<td>Loop colostomy</td>
<td>99</td>
<td>0–21</td>
<td>1/99 (1%)</td>
<td>6/16</td>
<td>b</td>
</tr>
<tr>
<td></td>
<td></td>
<td>End colostomy</td>
<td>219</td>
<td></td>
<td>15/219 (7%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harbach et al. [8]</td>
<td>1971</td>
<td>Urostomy</td>
<td>244</td>
<td>3–15</td>
<td>12/214 (6%)</td>
<td>—</td>
<td>b</td>
</tr>
<tr>
<td>Schmidt et al. [9]</td>
<td>1973</td>
<td>Urostomy</td>
<td>178</td>
<td>3–11</td>
<td>8/172 (5%)</td>
<td>6/8</td>
<td>b,i</td>
</tr>
<tr>
<td>Saha et al. [10]</td>
<td>1973</td>
<td>Loop colostomy</td>
<td>190</td>
<td>1–7</td>
<td>2/200 (1%)</td>
<td>—</td>
<td>b,d</td>
</tr>
<tr>
<td></td>
<td></td>
<td>End colostomy</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kronborg et al. [12]</td>
<td>1974</td>
<td>End colostomy</td>
<td>362</td>
<td>1–10</td>
<td>42/362 (12%)</td>
<td>4/42</td>
<td>b,d</td>
</tr>
<tr>
<td>Harshaw et al. [13]</td>
<td>1974</td>
<td>End colostomy</td>
<td>99</td>
<td>1–8</td>
<td>9/99 (9%)</td>
<td>—</td>
<td>b,d</td>
</tr>
<tr>
<td>Marshall et al. [14]</td>
<td>1975</td>
<td>Urostomy</td>
<td>400</td>
<td>2–10</td>
<td>18/400 (5%)</td>
<td>—</td>
<td>b,d,h</td>
</tr>
<tr>
<td>Prian et al. [15]</td>
<td>1975</td>
<td>Colostomy</td>
<td>262</td>
<td>0–20</td>
<td>8/262 (3%)</td>
<td>—</td>
<td>b,d,h</td>
</tr>
<tr>
<td>Marks and Ritchie [16]</td>
<td>1975</td>
<td>End colostomy</td>
<td>227</td>
<td>0–6</td>
<td>23/224 (10%)</td>
<td>—</td>
<td>b,j</td>
</tr>
<tr>
<td>Whittaker and Goligher</td>
<td>1975</td>
<td>End colostomy</td>
<td>251</td>
<td>7–20</td>
<td>36/251 (14%)</td>
<td>—</td>
<td>b,e</td>
</tr>
<tr>
<td>Year</td>
<td>Study</td>
<td>Procedure</td>
<td>N</td>
<td>Range</td>
<td>Hernias</td>
<td>Hernia Rate</td>
<td>Notes</td>
</tr>
<tr>
<td>------</td>
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</tr>
<tr>
<td>1977</td>
<td>Raza et al. [18]</td>
<td>End umbilical colostomy</td>
<td>101</td>
<td>2.5</td>
<td>0/101 (0%)</td>
<td>—</td>
<td>b</td>
</tr>
<tr>
<td>1979</td>
<td>Abrams et al. [19]</td>
<td>Loop transverse colostomy</td>
<td>202</td>
<td>9-18</td>
<td>4/189</td>
<td>—</td>
<td>b</td>
</tr>
<tr>
<td>1981</td>
<td>Wara et al. [20]</td>
<td>Loop transverse colostomy</td>
<td>257</td>
<td>0-10</td>
<td>10/212 (5%)</td>
<td>—</td>
<td>bk</td>
</tr>
<tr>
<td>1982</td>
<td>Stothert et al. [21]</td>
<td>Ileostomy</td>
<td>10</td>
<td>0-5</td>
<td>2/42 (5%)</td>
<td>—</td>
<td>bj</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Transverse colostomy</td>
<td>23</td>
<td></td>
<td></td>
<td>—</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sigmoid colostomy</td>
<td>18</td>
<td></td>
<td></td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>1981</td>
<td>Eldrup et al. [22]</td>
<td>Transrectus colostomy</td>
<td>77</td>
<td>2.8</td>
<td>1/77 (1%)</td>
<td>—</td>
<td>b,e</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lateral colostomy</td>
<td>63</td>
<td></td>
<td>12/63 (19%)</td>
<td>—</td>
<td>b</td>
</tr>
<tr>
<td>1984</td>
<td>Burgess et al. [23]</td>
<td>End colostomy</td>
<td>124</td>
<td>0-10</td>
<td>6/121 (5%)</td>
<td>1/6</td>
<td>b,e,m,n</td>
</tr>
<tr>
<td>1985</td>
<td>Phillips et al. [24]</td>
<td>Ileostomy</td>
<td>232</td>
<td>1-4</td>
<td>11/243 (5%)</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8/175 (4%)</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>1985</td>
<td>Pearl et al. [25]</td>
<td>All stomas</td>
<td>610</td>
<td></td>
<td>5/610 (1%)</td>
<td>—</td>
<td>b,o</td>
</tr>
<tr>
<td>1986</td>
<td>von Smitten et al. [26]</td>
<td>End colostomy</td>
<td>54</td>
<td>1-8</td>
<td>26/54 (48%)</td>
<td>2/26 (8%)</td>
<td>ce</td>
</tr>
<tr>
<td>1986</td>
<td>Winkler [27]</td>
<td>All stomas</td>
<td>164</td>
<td></td>
<td>42/164 (30%)</td>
<td>—</td>
<td>cgpa</td>
</tr>
<tr>
<td>1987</td>
<td>Carlstedt et al. [28]</td>
<td>End ileostomy</td>
<td>203</td>
<td>8</td>
<td>3/203 (1%)</td>
<td>3/3 (100%)</td>
<td>e</td>
</tr>
<tr>
<td>1988</td>
<td>Sjodhal et al. [29]</td>
<td>End colostomy</td>
<td>79</td>
<td>7</td>
<td>7/79 (9%)</td>
<td>4/9</td>
<td>h,e</td>
</tr>
<tr>
<td></td>
<td></td>
<td>End ileostomy</td>
<td>45</td>
<td></td>
<td>1/45 (2%)</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>1989</td>
<td>Porter et al. [31]</td>
<td>End colostomy</td>
<td>130</td>
<td>2.9</td>
<td>14/130 (11%)</td>
<td>5/14 (36%)</td>
<td>b</td>
</tr>
<tr>
<td>1989</td>
<td>Leenan and Kuypers [32]</td>
<td>Colostomy</td>
<td>184</td>
<td></td>
<td>20/184 (11%)</td>
<td>—</td>
<td>bs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ileostomy</td>
<td>153</td>
<td></td>
<td>3/153 (2%)</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>1989</td>
<td>Phillips et al. [33]</td>
<td>End ileostomy</td>
<td>70</td>
<td>6</td>
<td>3/70 (4%)</td>
<td>—</td>
<td>bg</td>
</tr>
<tr>
<td>1990</td>
<td>Williams et al. [34]</td>
<td>End ileostomy</td>
<td>60</td>
<td>6.5</td>
<td>13/46 (28%)</td>
<td>9/13</td>
<td>ce</td>
</tr>
<tr>
<td>Authors</td>
<td>Year</td>
<td>Stoma type</td>
<td>Number</td>
<td>Years of follow-up*</td>
<td>Incidence in &gt;30-day survivors</td>
<td>Required operation</td>
<td>Comment</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>-------</td>
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<td>---------</td>
</tr>
<tr>
<td>Fleshman and Lewis [35]</td>
<td>1991</td>
<td>Ileostomy</td>
<td>6024</td>
<td>—</td>
<td>4%</td>
<td>50%</td>
<td>a</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Colostomy</td>
<td>7083</td>
<td>—</td>
<td>11%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Urostomy</td>
<td>2613</td>
<td>—</td>
<td>8%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ortiz et al. [36]</td>
<td>1994</td>
<td>End sigmoid colostomy</td>
<td>54</td>
<td>5</td>
<td>26/54 (48%)</td>
<td></td>
<td>c,e</td>
</tr>
<tr>
<td>Londono-Schimmer et al. [37]</td>
<td>1994</td>
<td>End colostomy</td>
<td>203</td>
<td>5.5</td>
<td>43/203 (21.2%)</td>
<td>10/43 (23%)</td>
<td>e,v</td>
</tr>
<tr>
<td>Carlsen and Bergan [38]</td>
<td>1995</td>
<td>End ileostomy</td>
<td>358</td>
<td>2.7</td>
<td>8/358 (2%)</td>
<td>8/8 (100%)</td>
<td>t</td>
</tr>
<tr>
<td>Cheung [39]</td>
<td>1995</td>
<td>Colostomy</td>
<td>189</td>
<td>3.2</td>
<td>66/189 (35%)</td>
<td></td>
<td>b,e,v,w</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Urostomy</td>
<td>123</td>
<td></td>
<td>34/123 (28%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ileostomy</td>
<td>10</td>
<td></td>
<td>0/10 (0%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cheung et al. [40]</td>
<td>2001</td>
<td>Sigmoid colostomy</td>
<td>322</td>
<td>—</td>
<td>127/322 (39%)</td>
<td>41/127 (32%)</td>
<td>b,e,w,y</td>
</tr>
</tbody>
</table>

*Single numbers indicate mean follow-up; hyphenated numbers indicate range.

- a, questionnaire; b, chart review; c, all patients examined; d, fails to exclude early deaths; e, survivors only; f, nonrandom groups of patients selected by fact that they did not irrigate colostomy; g, 86 patients had stoma closure during study period; h, only considers hernias that required repair; i, five hernias occurred within 1 week of operation; j, 32% of patients followed >5 years had hernias; k, 105 were closed during study period; l, both hernias in proximal colon group; m, 141 colostomies were closed during study period; n, in group of 100 patients referred for stoma problems, 11 had hernias; o, study of early postoperative complications occurring during the admission at which stoma was created; p, rate in outpatient group was 45%; q, nonrandom group of patients presenting for stoma problem; r, does not identify which hernia required repair; s, results for end, loop; double barreled stomas not distinguished; t, methods of study unknown; u, hernias present in 36.7% of patients followed for 10 years; v, series includes 26 loop colostomies and 2 loop ileostomies; w, nonrandom group of patients attending a stoma clinic; x, may include patients also reported in Cheung’s 1995 series; y, includes 20 loop colostomies.
Table 2  Factors Predisposing to Parastomal Hernia

<table>
<thead>
<tr>
<th>Factors</th>
<th>Supporting studies</th>
<th>Refuting studies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Patient characteristics</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Obesity</td>
<td>14</td>
<td>26,32</td>
</tr>
<tr>
<td>Advanced age</td>
<td>37</td>
<td>1,27,29</td>
</tr>
<tr>
<td>Debility/malnutrition</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Malignancy</td>
<td>—</td>
<td>29,32</td>
</tr>
<tr>
<td>Obstructive pulmonary disease</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Urinary outflow disease</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Steroid use</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td><strong>Factors at operation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colonic stoma</td>
<td>21,29,35,39</td>
<td>24</td>
</tr>
<tr>
<td>Large trephine size</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Stoma placed in laparotomy incision</td>
<td>1.4</td>
<td>31</td>
</tr>
<tr>
<td>Stoma placed lateral to rectus muscle</td>
<td>2,3,22,29</td>
<td>16,26,34,36,37</td>
</tr>
<tr>
<td>Transperitoneal technique</td>
<td>13,16,17,37</td>
<td>26,31</td>
</tr>
<tr>
<td>Prior denervation/devascularization of site</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Laparotomy or other incision nearby</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Urgent/emergent operation</td>
<td>20,21</td>
<td>31,32</td>
</tr>
<tr>
<td>Intestinal distention/edema</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>No intraabdominal fixation of bowel</td>
<td>—</td>
<td>26,38</td>
</tr>
<tr>
<td><strong>Postoperative factors</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parastomal infection</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Other abdominal complications</td>
<td>14,16</td>
<td>26</td>
</tr>
<tr>
<td>Postoperative distention/ascites</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Radiation therapy</td>
<td>14</td>
<td>—</td>
</tr>
<tr>
<td>Weight gain</td>
<td>—</td>
<td>34,37</td>
</tr>
<tr>
<td>Development of prolapse</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Early or excessive exertion</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Long-term survival</td>
<td>12,16,29,34,37</td>
<td>—</td>
</tr>
</tbody>
</table>

*Numbers shown for studies refer to references listed at end of chapter.

Factors have been studied and found truly instrumental in increasing the risk. Although many factors—such as obesity, steroid use, advanced age, and obstructive pulmonary disease—are likely to play a part in hernia formation, the evidence is largely anecdotal. One frequent observation is that a permanent colostomy develops a hernia (0–58%) more commonly than a permanent ileostomy or urostomy (0–28%). Goligher et al. [41] have proposed that this may be related to the relatively advanced age and associated muscle weakness in the colostomate, whereas Winkler [27] has noted the tendency of solid stool to enlarge the orifice over time. DeRuiter and Bijnen [42] have offered a compelling explanation of the forces contributing to parastomal hernia formation. According to the Law of Laplace, there is a
radial force on the abdominal wall that is related to the pressure in the abdominal cavity and that cavity’s diameter. Any opening constructed in the abdominal wall is subject to a tangential force (which would tend to enlarge it) that is proportional to this radial force and to the radius of the opening itself. This law of physics elegantly explains an increased hernia rate with colostomy formation (larger trephine size), emergency operation (increased abdominal pressure and larger trephine size), and obesity (greater abdominal diameter).

Improperly located stomas also have a higher incidence of hernia. Goligher [1] and Green [4] discuss at length the many early and late complications associated with bringing a stoma through the laparotomy incision. Goligher notes that “the grosser forms [of paracolostomy hernia] are found in cases where the colon has been brought out in the line of the main incision.” Several authors have noted that stomas placed through the rectus muscle have significantly lower incidence of parastomal hernia than those placed lateral to the rectus muscle. Birnbaum and Ferrier [2], in one of the largest series in the literature, noted that the incidence was four times greater in lateral colostomies. Grier et al. [3] examined 50 patients with a mean time of 5.4 years after colostomy and found hernias associated with only 1 of 10 (10%) transrectus stomas but with 28 of 40 (70%) of those placed lateral to the rectus muscle. Eldrup et al. [21] found hernias in 1 and 19% of transrectus and lateral colostomies, respectively, and Sjodahl et al. [29] noted rates of 3 and 26%. Five other series in which the subject was investigated, however, failed to show a significant difference [16,26,34,36,37].

In 1958, Goligher [43] described a technique to create extraperitoneal stomas. Devlin [30], and Todd [44] do not believe that this practice lessens the incidence of parastomal hernia. The literature contradicts this impression. In a series by Harshaw et al. [13], none of 17 extraperitoneal colostomies developed hernias, whereas 9 of 28 (31%) transperitoneal ones did. In a series of colostomies by Marks et al. [16], the figures were 1 of 37 (3%) and 22 of 190 (12%), respectively. Whittaker et al. [17] found hernias associated with 8 of 89 (9%) extraperitoneal colostomies and 28 of 162 (17%) transperitoneal colostomies. Finally, Londono-Schimmer et al. [37] found a tenfold increase in paracolostomy hernias when a transperitoneal technique was used (3.5 vs. 35%).

Urgent or emergency surgery has been implicated as a risk factor for hernia. This hypothesis is very difficult to study, because mortality is high in this group and survivors often have their stoma closed or revised. Wara et al. [20] nonetheless found, in children, a statistically significant increase in herniation and prolapse with urgently created stomas. Stothert et al. [21] also noted a higher rate of hernia in stomas created at emergency surgery. As already discussed, this may be related to larger stoma apertures required to accommodate an obstructed colon or to the increased pressures associated with intra-abdominal catastrophes.
Although many technical factors that predispose to parastomal herniation have been documented, patient characteristics and postoperative factors have been less well studied. Many experts cite obesity, advanced age, debility, malignant disease, pulmonary disease, and steroid use as certain culprits; however, good studies of these factors are lacking. Since these comorbidities also are associated with a decrease in life expectancy, their influence on incidence of the hernia may be diminished statistically, since nonsurvivors are included in most calculations. Similarly, in many series evaluating the incidence of parastomal hernia, the only factors shown to be important are the occurrence of a postoperative abdominal complication (especially wound infection and urinary retention) and the use of postoperative radiation therapy [14,16]. A number of authors have cited anecdotal experience that parastomal infection and abdominal distention or ascites are commonly followed by hernia formation.

One finding that has been widely noted is that the likelihood of parastomal hernia development increases over time. Some 23–48% of hernias appear within 1 year and 36%–100% within 2 years [12,15,16,39,45]. It has also been reported that loop stomas may have a lower rate of hernia formation. However, many loop stomas are temporary and are closed in less than 1 year (before a hernia can develop). Therefore their true incidence of herniation may be higher.

The many reported series of parastomal hernias suffer largely from being retrospective chart-review or questionnaire-type evaluations. Duration and degree of follow-up are variable, different stoma types are grouped together, and often only large, symptomatic, or operated hernias are noted. Only Grier et al. [3], Balslev [11], von Smitten et al. [26] and Ortiz et al. [36] performed physical examination in end colostomy patients with mean follow-up exceeding 5 years. They found parastomal hernias in 58, 56, 48, and 48% of their patients, respectively. Williams et al. [34] did the same for end ileostomy patients. A total of 28% were found to have hernias. These series most accurately assess the magnitude of the problem.

**TYPES OF HERNIA**

Four distinct types of hernia or pseudohermia can develop near a stoma. The most common is the “true parastomal” hernia (Fig. 1), which has a peritoneal sac emanating from an enlarged fascial opening. The sac may be found in a subcutaneous or interstitial position. A second type of hernia, designated “intrastomal” (Fig. 2), occurs when an intraperitoneal structure protrudes into the space between the serosal surface of a spout ileostomy or the extension of the peritoneal cavity created whenever stoma prolapse occurs. The fascial defect is enlarged, if only slightly, and the sac may be composed only of the visceral peritoneum of the prestomal bowel. Both variants have been described, but they are rare [30,46]. The third and fourth
hernia types are actually pseudohernias, but their symptoms and treatment may be similar to those of true hernias. Figure 3 depicts “subcutaneous prolapse.” As with frank prolapse, redundancy and other factors may lead to advancement of the prestomal intestine from the peritoneal cavity proper. This results in a subcutaneous redundant loop that creates a bulge when distended. Identification of this variant is important, because there may be little or no fascial defect and local revision may suffice (if symptoms warrant repair). The final type (Fig. 4) is the classic “pseudohernia.” Seen less and less frequently because it is peculiar to laterally placed stomas, the pseu-

Figure 1  True parastomal hernia.

Figure 2  Intrastomal hernia (may be associated with prolapse).
do hernia is a diffuse bulge without enlarged fascial defect or herniated structure in the subcutaneous space that develops over time because of relatively weak or denervated muscles lateral to the rectus muscle.

More than 90% of the parastomal hernias seen today are of the true parastomal variety. The fascial defect is often relatively small although it can be large, especially when the stoma trephine is close to the fascial closure of another incision. Small bowel and omentum commonly occupy the hernial sac, but virtually any intraperitoneal organ may enter it. Parastomal hernias seem to occur most commonly at either the mesenteric aspect or lateral to the stoma. Knowing the difference between prolapse and herniation is important. Prolapse results largely from intestinal redundancy and lack of fixation, whereas hernia implies excessive size of the fascial ring.

---

**Figure 3** Subcutaneous prolapse (pseudohernia) with intact fascial ring.

**Figure 4** Pseudohernia due to weakness of abdominal wall without fascial defect.
Prolonged or repeated prolapse may lead to widening of the trephine and development of a hernia, and patients with a hernia may coincidentally develop prolapse.

EVALUATION AND MANAGEMENT OPTIONS

The evaluation of the patient with an ostomy who may have a hernia begins with a directed history, eliciting the abdominal or stoma-related complaint, its duration, and its relationship to body positioning and physical activities. Local pain is common. A bulge may occur with straining, standing, or after a large meal. Intermittent difficulty with the appliance may also indicate occult hernia. It is important to inquire about signs and symptoms of intestinal obstruction (which may be very mild) and difficulty with irrigation of the stoma. Stool size and consistency and presence of prolapse should also be elicited.

Parastomal hernia may be relatively obvious or extremely difficult to diagnose. Examination requires that the patient be unclothed with the ostomy management system removed. The region of the stoma is examined. Palpation is done with the patient first recumbent and then standing. The patient is asked to relax and then to perform a Valsalva maneuver repeatedly. Perhaps the most valuable and often omitted technique in the evaluation of patients with stoma problems is digital examination of the stoma during these maneuvers. Such examination allows palpation of the fascial aperture and the most direct evaluation of the subcutaneous parastomal region. The site of the stoma, presence of scars, degree of obesity, evidence of abdominal muscle denervation, quality of the skin locally, and potential alternative stoma sites should be noted during the examination.

In the patient whose symptoms suggest parastomal hernia but where no hernia can be detected, computed tomography (CT) scanning may be of value. In a population of patients with ileostomy, Williams et al. [34] found that 20% of parastomal hernias were detectable only by CT. Such detection allowed two symptomatic patients to undergo repair.

Not all hernias require repair. Central to the decision between operative and nonoperative treatment is the surgeon’s accurate assessment of the nature of the hernia, its current or potential seriousness, and how adversely it affects the patient. The indications and contraindications for repair of parastomal hernia are listed in Table 3. Most contraindications are relative, because life-threatening complications require repair in all but the terminal patient.

Virtually all authors agree that for the ostomy patient with an asymptomatic or mildly symptomatic hernia, nonoperative management should be attempted. Most hernias are well tolerated. Serious complications are uncommon, and operative repair may be difficult, produce morbidity, and
Table 3  Indications and Contraindications to Parastomal Hernia Repair

<table>
<thead>
<tr>
<th>Indications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absolute</td>
</tr>
<tr>
<td>Incarceration</td>
</tr>
<tr>
<td>Strangulation</td>
</tr>
<tr>
<td>Obstruction</td>
</tr>
<tr>
<td>Fistulization</td>
</tr>
<tr>
<td>Perforation (related to incarceration or irrigation)</td>
</tr>
<tr>
<td>Stoma ischemia</td>
</tr>
<tr>
<td>Relative</td>
</tr>
<tr>
<td>History of incarceration</td>
</tr>
<tr>
<td>Symptoms suggestive of obstruction</td>
</tr>
<tr>
<td>Difficulty maintaining appliance fit</td>
</tr>
<tr>
<td>Patient unable to see or manage stoma</td>
</tr>
<tr>
<td>Irrigation difficulty</td>
</tr>
<tr>
<td>Pain related to hernia</td>
</tr>
<tr>
<td>Ulceration of overlying skin</td>
</tr>
<tr>
<td>Cosmetic unacceptability</td>
</tr>
<tr>
<td>Tight neck of hernia that is difficult to reduce</td>
</tr>
<tr>
<td>Concomitant prolapse, stricture, or other indication for revision</td>
</tr>
</tbody>
</table>

Contraindications:

<table>
<thead>
<tr>
<th>Absolute</th>
</tr>
</thead>
<tbody>
<tr>
<td>End-stage malignancy</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Relative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recurrent, metastatic, or inoperable malignancy</td>
</tr>
<tr>
<td>Severe comorbid disease</td>
</tr>
<tr>
<td>Temporary stoma</td>
</tr>
</tbody>
</table>

have a significant rate of recurrence. Three authors who investigated the rate at which parastomal hernia is complicated by incarceration, obstruction, or strangulation found that such emergencies developed in only 13–16% of cases [30,39,47]. Nonoperative management centers around the use of a binder or a belt that incorporates a plastic disk atop the flange of the ostomy device to maintain the hernia in a reduced state. Such an approach may allow the symptomatic poor-risk patient to live comfortably with a hernia.

It has been suggested that only 10–20% of parastomal hernias will ever require repair [48]. However, this figure may be low. In Balslev’s study [11], which included meticulous long-term follow-up, 9 of 62 (15%) patients with hernias required repair. Londono-Schimmer et al. [37], who followed consecutive patients who had an end colostomy created over a 10-year period, noted that 10 of 43 (23%) who developed a hernia underwent
repair. Cheung et al. [40] reported on a large group with sigmoid colostomies who presented to a stoma clinic. Of these, 127 had a paracolostomy hernia and 41 (32%) required repair. There is some evidence that the necessity for repair is greater when the hernia is associated with an ileostomy. Williams et al. [34] found that 9 of 13 (69%) paraileostomy hernias had needed repair when he examined a group of long-term survivors. On Fleshman and Lewis’s questionnaire evaluation [35], 50% of patients with a paraileostomy hernia reported that they required repair, although some may have had other reasons for revision besides hernia. The liquid, somewhat caustic effluent may make a paraileostomy hernia more difficult to manage nonoperatively. For similar reasons, paraurostomy hernias also seem to require repair frequently. Schmidt et al. [9] reported that 6 of 8 of their series underwent repair, as did all 18 in a series by Marshall et al. [14]. Unfortunately, both of these chart review studies and the paracolostomy hernia series reported by Cheung et al. suffer from identifying only patients who returned for examination because of particularly symptomatic hernias. By underestimating the total number of hernias, such studies may exaggerate the frequency with which repair is required. Nonetheless, it is probable that paraileostomy and paraurostomy hernias are more likely to require repair than paracolostomy hernias.

OPERATIVE REPAIR

The patient who fails nonoperative management or has an absolute indication for repair has several options. They include simple local repair, relocation of the stoma, and local repair with prosthetic material. This last class of repairs may be accomplished by either an open or a laparoscopic approach. Preparation for surgery requires thoughtful evaluation of the need for repair and identification of comorbid disease, such as recurrent malignancy or inflammatory bowel disease. Potential risk factors for recurrence, such as obesity and pulmonary or urinary dysfunction, should be treated preoperatively whenever possible. The surgeon must consider factors such as hernia size, stoma location, and sites of associated scars that might influence repair type. In the perioperative period, a standard mechanical and antibiotic bowel preparation is used for paracolostomy repair. Ileostomy patients are restricted to clear liquids. If prosthetic mesh will be used, both systemic and intraluminal antibiotics should be given. Otherwise, management is similar to that for any clean-contaminated operation.

Techniques of Repair

Local repair, as described by Thorlakson [49], is the oldest and, until recently, had been the most widely practiced form of repair. Thorlakson’s
technique involved making a semicircular or L-shaped skin incision just outside the ostomy management system zone, exposing and reducing the sac, and clearing the anterior fascia for several centimeters around the stoma and the fascial defect. Interrupted nonabsorbable sutures were used to “snug” the fascia and close the defect around the stoma. Other authors describe similar repairs using the original laparotomy incision and developing an extraperitoneal flap to expose the parastomal fascia or incising at the mucoscutaneous junction, performing the repair, and rematuring the stoma. Local repair may also be effected by formal laparotomy, with mass closure of the defect from within. A novel local approach reported by Bewes [50] utilizes a musculofascial rotation flap to accomplish repair.

Most authors consider relocation of the stoma to be superior to local repair. Relocation usually requires laparotomy, lysis of adhesions, and fashioning a new stoma. Consequently morbidity is higher. The enterostomal therapist plays an important role in preoperative planning and the choice of alternative stoma sites. The patient is fitted with a sham ostomy management system at several potential sites and is observed in supine, sitting, standing, and various activity-related positions. The best and second-best alternative sites are determined and marked. There are six generally acceptable stoma sites [51] (Fig. 5). In any given patient, the number of sites available may be significantly fewer. Body habitus may be a restricting factor (obese patients may have difficulty seeing a stoma located at any of the three lower sites), as may surgical scars and regions of denervation (proximity to them is believed to predispose to recurrence) [52].

Figure 5  Acceptable abdominal stoma sites.
There are two techniques of stoma relocation. The classic resiting operation is nicely described by Devlin [30]. A circumstomal incision is made and the stoma is mobilized and closed. If the hernia is very large, the incision can be extended and used for laparotomy, but most often the previous laparotomy incision is reopened. Reduction of the hernia and completion of the takedown of the stoma are accomplished through simultaneous intraperitoneal and extraperitoneal dissections. The new stoma site is created and the stomal intestine is delivered. The laparotomy incision is closed and the old hernia is repaired with or without prosthetic material. After these incisions have been closed and draped outside the field, the new stoma is matured. If prosthetic material is used or if there is a large subcutaneous space, closed drainage is used. In 1967, Turnbull and Weakley [53] described a technique of relocating ileostomies without laparotomy. Subsequently, Taylor et al. [54], Kaufman [55], and Botet et al. [56] used this approach successfully to relocate a total of 35 stomas. This approach avoids the morbidity of formal laparotomy, which has been reported to be substantial [47]. Although several surgeons have performed the operation safely, experience with this technique is limited and there are concerns about potential difficulties arising from the blind nature of the procedure. The inability to lyse adhesions safely, to ensure that no twisting has occurred, and to mobilize and assess the prestomal bowel make this operation potentially risky.

The third general type of repair is local repair with prosthetic material. The development of well-tolerated synthetic mesh and its successful use in inguinal, ventral, and incisional hernia repair have fostered an increasing interest in this form of herniorraphy. Most such repairs avoid laparotomy and the need to fashion a new stoma. The recurrence rate is lower because repair with mesh circumvents reliance on the weakened musculofascial tissue in the region of the stoma. Many authors have described their favored technique of prosthetic local repair [30,42,45,46,57–65], utilizing a variety of approaches. Circumstomal, parastomal, and standard laparotomy incisions have been used. Mesh has been placed in the extraparietal, retromuscular, properitoneal, or intraperitoneal plane, and bowel has been brought out through the center of the mesh or beside it. Most recently, laparoscopic variants of this repair type have been described [66–69].

In 1977, Rosin et al. [45] first described prosthetic local repair. Their method uses a large elliptical incision to dissect out the prestomal intestine, the hernial sac, and a rim of good fascia around the hernia. The sac is opened, its contents are reduced, and the peritoneum and fascia are closed in layers around the exiting bowel. A piece of polypropylene mesh with a central orifice sized to fit snugly around the prestomal intestine is passed over the stoma and sutured to the fascia with interrupted nonabsorbable sutures. The subcutaneous tissues are irrigated and drained with closed suction. The skin defect is closed linearly, the former stoma is excised, and a
new stoma is primarily matured in the center of the incision. Although their results were excellent, the technique has some theoretical drawbacks. Having the mesh in the same field with the stoma and leaving the matured stoma in the incision may increase the chances of infectious complications. The proximity of the incision to the stoma also may interfere with the fit of the ostomy management system.

Four years later, Leslie [59] described a method that addresses such concerns (Figs. 6 and 7). An L-shaped incision is made outside the zone of the ostomy device. Whenever feasible, the previous incision is used as one limb of the L. The subcutaneous tissue is raised from the anterior rectus sheath as a flap until strong fascia is reached at the edges of the hernial defect. The stoma is not disturbed. The hernia is reduced and, if possible, the fascia is repaired around the stoma with nonabsorbable sutures. A square sheet of prosthetic mesh is then partially cut as a keyhole, passed around the bowel, and sutured atop the anterior sheath with nonabsorbable material. The split portion is overlapped, producing the correct degree of snugness, Leslie allows the redundant mesh to fold up along the bowel to reinforce the repair and prevent future prolapse and retraction. The flap is closed over a drain, and the ostomy management system is replaced.

Although this is essentially the repair I have used most commonly, I have found several minor modifications be helpful. I drape the stoma from the surgical field to minimize the chance of contaminating the prosthetic material and intubate the stoma with a large Foley catheter to assist in the often complex task of delineating the prestomal bowel from any herniated

Figure 6  L-shaped incision outside ostomy management system zone for extrafascial mesh repair.
loops. Usually polypropylene mesh is used, but the softer, more flexible polytetrafluoroethylene (PTFE) mesh may also be employed successfully. The mesh is affixed to the fascia with two concentric rows of interrupted nonabsorbable sutures, one near the outer edge of the mesh and one close to the reapproximated trephine to prevent lifting and subprosthetic insinuation of a hernia. Sutures are placed at 2-cm intervals, starting opposite the split side of the mesh and working toward the split around both sides of the stoma. In this way the snugness of the repair can be adjusted gradually by increasing or decreasing the degree of overlap at the split in the mesh. A finger adjacent to the stoma may help in evaluating the size of the opening. Finally, interrupted 3–0 silk seromuscular sutures (carefully avoiding the mucosa) are used to attach the mesh to the prestomal bowel. This attachment may prevent insinuation of a small hernial sac inside the mesh repair as well as motion of the mesh against the bowel, which might lead to perforation. Adverse consequences due to the proximity of the mesh to the bowel have been rare. Recently, Moisidis et al. [65] have suggested that the rate of recurrent herniation following repair with prosthetic mesh cut to encircle a stoma might be reduced by reinforcing the cut circular margin.

Figure 7  Extrafascial mesh repair showing mesh sutured in place around stoma. Note collar sutured to stoma and concentric placement of anchoring sutures (inset). (Modified from Ref. 59.)
Their tests applied forces simulating those acting on the parastomal abdominal wall to polypropylene mesh with a circular opening cut in it. Significant enlargement of the orifice resulted. Reinforcement with a polypropylene suture placed as a purse string about the cut circular margin markedly reduced this dilation. Although there is no published clinical experience with this technique, it is simple, readily available, and unlikely to be associated with complications in excess of those associated with the use of unreinforced mesh.

Another useful prosthetic repair, described by Sugarbaker [60], is of particular value in patients with large hernias and those whose anterior fascia is too attenuated for use even in a mesh repair (Figs. 8 and 9). In this method the old laparotomy incision is reopened after intubating and draping the stoma. The hernia is reduced from within the peritoneal cavity and a sheet of prosthetic material is sutured in place to close the defect from the peritoneal side. All sutures are placed with deep bites through the mesh, peritoneum, and posterior fascial sheath, at close intervals. The mesh is fixed circumferentially, overlapping the fascial ring except laterally, where the intestine is made to exit the peritoneal cavity, curving medially atop the mesh to become the stoma. Sugarbaker believes that his excellent long-term results have derived in part from the oblique egress of the prestomal bowel (essentially creating an extraperitoneal stoma). Increased intra-abdominal pressure is exerted on the mesh rather than on the fascial opening. An alternative form of this intraperitoneal technique uses split mesh fixed circumferentially around the bowel. Intraperitoneal mesh is particu-

![Figure 8](image_url)
Figure 9  A. Intraperitoneal mesh repair with detail of bowel entering tunnel above mesh. B. Cross-sectional view corresponding to a-b in A.

larly useful in a recurrent hernia in which there is a marked fascial defect or in which extraperitoneal mesh has been used previously. Devlin [30] has described a variant in which the mesh is placed in the properitoneal plane, theoretically avoiding a difficult intraperitoneal dissection.

Laparoscopic parastomal hernia repair was first reported by Porcheron et al. [66] in 1998. Three subsequent reports have also been published. The goal of the approach is to provide the benefits of minimally invasive surgery (less pain, shorter hospital stay), to achieve repair results that are at least equivalent to open repair and to avoid the wound problems (infection, incisional hernia, recurrence) that can complicate these operations. The technique involves placement of a 10–12-mm Hasson trocar under direct vision in the quadrant farthest from the stoma. Two or three additional trocars are inserted to either side of the first, forming a triangle or semicircle whose apex, the Hasson trocar, is furthest from the stoma. One trocar should be large enough to accept a clip-application device. Adhesions are lysed and the hernia contents reduced. The sac need not be excised. A large sheet of mesh is then inserted and placed, covering the peritoneal surface of the hernial defect with several centimeters of overlap. Mesh may be applied uncut (as described by Sugarbaker) or cut to encircle the stoma. A tacking instrument may be used to fix the mesh in place or percutaneous tacking sutures may be placed through cutaneous counterincisions. Syn-
chronous abdominal wall hernias may be repaired simultaneously by using a larger section of mesh or adding additional mesh.

Certain principles are applicable to all types of mesh repair. Perioperative antibiotics should be used. All incisions should be made outside the zone of the ostomy management system. Whenever possible, the stoma should be draped outside the operative field. The fascial defect beneath the mesh may be sutured, but this step is not essential. The mesh must be attached securely to strong fascia at least 3 cm from the hernia defect. Finally, when mesh is placed subcutaneously, the space should be drained by closed suction. While local complications specifically related to the use of prosthetic material have been surprisingly uncommon, the use of intraperitoneal mesh is known to incite adhesion formation. Most authors have favored polypropylene mesh to repair parastomal hernias. This material has excellent incorporation characteristics but a high rate of adhesion to bowel. Greenwalt et al. [70] have recently reported their experience with a composite mesh (polypropylene coated on one side with chemically modified sodium hyaluronate and carboxymethylcellulose), which reduced such adhesions when it was used to repair simulated hernias in animals. Such a composite, once studied clinically, may prove to be ideal when an intraperitoneal mesh repair is selected.

Results

The technique of local repair has been described largely for historical interest because most results with this method have been very poor. Table 4 lists articles reporting follow-up of parastomal hernia repairs. Local repair has resulted in recurrence in 64% of cases [14,15,38,40,47,68,73–75,77]. This technique has had a poor record despite the fact that it was used, in most series, only on small hernias.

Many experienced authors believe relocation of the stoma to be the best method of repair for parastomal hernia [1,30,71]. Some consider reposing to be the only choice for large or recurrent hernias. The combined results of the 16 series in which this technique was used reflect a success rate of 70% [14,15,26,34,38,40,47,54−56,64,73,75–78]. Several of these authors have noted that they reserved this technique for the most difficult hernias. When relocation is performed, recurrence has been lower with repositioning to the contralateral side of the abdomen or the umbilicus rather than medial to or above the original stoma site [75]. The reported results of prosthetic local repair are probably better than those with stoma relocation. A tally of the published outcomes with this technique indicates a success rate of approximately 88% [34,40,42,45,47,57,58,62,63,71,72,74–77,79–84]. Infections and other complications have been uncommon. Of 133 mesh repairs in 22 published series, just 11 infectious complications have been reported. In only one case did the mesh erode into the bowel, and only 4
Table 4  Published Results of Parastomal Hernia Repair

<table>
<thead>
<tr>
<th>Authors</th>
<th>Year</th>
<th>Years of follow-up</th>
<th>Local repair: success/total</th>
<th>Relocation of stoma: success/total</th>
<th>Prosthetic repair: success/total</th>
<th>Laparoscopic repair: success/total</th>
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<td>Range</td>
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<td>114/162</td>
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*aSingle numbers indicate mean follow-up; hyphenated numbers indicate range.*
patients have required removal of their mesh. Other reported complications directly attributable to the mesh include intestinal obstruction in 3 patients and mesh migration in two.

Both stoma relocation and prosthetic repair may be associated with significant morbidity and complications. In one published series, stoma relocation was associated with a 44% recurrence rate, and an additional 24% of these patients developed an incisional hernia. When a prosthetic repair was used, the recurrence rate was 43%, and 29% of patients required treatment for a postoperative parastomal infection [47].

Laparoscopic repair of parastomal hernias represents a new approach that may address the problems of incision and wound-related complications. It has a very limited track record, but early results are promising. One area of concern is the apparent difficulty of performing the procedure. Operative times have ranged from 47 min to 5½ hr. Excellent results with similar techniques in the management of difficult incisional hernias suggest that this method has the potential to become the repair of choice [85,86].

**Selection of Repair Type**

Once the indication for operative repair has been established, the surgeon must decide which type of hernia repair is most appropriate. This decision must be individualized. As a rule, simple local repair should be avoided. The choice between local prosthetic repair, stoma relocation, and laparoscopic repair depends on the condition of the stoma and abdomen locally, the general condition of the patient, and, ultimately, the surgeon’s preference. Both Goligher [1] and Corman [46] consider resiting preferable, although Goligher’s data antedate much of the recent literature on mesh repairs. Table 3 suggests that the efficacy of prosthetic repair is probably superior. My approach is to use whichever type of repair seems most suitable for the particular patient. If a stoma is poorly situated, it should be resited if possible. For example, a hernia at a stoma that is not transrectus or is out of view in an obese patient should be resited. On the other hand, a mesh repair may be chosen for a patient who likes the current site and has had no management difficulties. In a patient with severe comorbid disease, performing an extraperitoneal mesh repair or a translocation without laparotomy may avoid the complications associated with a major abdominal operation. In younger patients, local prosthetic repair should be considered first, saving relocation to alternate stoma sites for further recurrences. A patient with multiple scars at the other potential stoma sites may also be best treated with a local mesh repair. Stomas may be placed in previous incision sites, but this is likely to increase recurrence rate and difficulty with the fit of the ostomy management system. As experience with laparoscopic repair techniques increases, such procedures may be undertaken with greater confidence.
Postoperative Management and Complications

Except the fact that these patients must avoid heavy lifting and vigorous activity for at least 2 months, their postoperative management is the same as that of any patient with a new stoma. Winkler [27] believes that use of a corset or binder is essential in the short- and long-term management of these patients, but there is little evidence at this time to justify this recommendation.

Serious complications other than recurrence are uncommon with parastomal hernia repair. Seroma occurs to some degree in almost all patients. Most seromas should be treated expectantly, although aspiration may be indicated for those who are significantly symptomatic. To prevent contamination, aspiration should be avoided, if possible, when prosthetic material has been used. Infectious wound complications are unusual; when present, they are usually minor. Few such complications are noted in the literature. Even when mesh is used, local infection occurs in fewer than 10% of patients and is serious in fewer than 5%. Other mesh-related complications such as erosion, migration, and intestinal obstruction are very uncommon. Recurrence is a significant problem, however, occurring after over 70% of local repairs, almost 30% of relocation repairs, and approximately 10% of prosthetic repairs. Incisional hernia is also not unusual after parastomal hernia repair. When relocation is performed, concern for infection often precludes using mesh to repair the previous (enlarged) stoma site. The incisional hernia rate following these operations may exceed 50% [47]. Finally, there is always the risk that manipulating, moving, or dissecting near the stoma will cause a complication, such as an injury to the bowel or its blood supply, that will have adverse consequences in the early or late postoperative period.

PREVENTION

It is undeniable that parastomal hernia is a common problem in individuals with an ostomy and that it may cause serious complications or management problems. Repair, when required, may be difficult, and the condition is prone to recurrence. As with many other surgical complications, prevention is the most efficacious way to deal with the problem. Goligher [1] says that he knows of no certain preventive of this complication, but that by adhering to a few principles, the risk of herniation can be minimized.

Preoperatively all possible efforts should be made to improve the risk factors for hernia. Preoperative planning and marking of the stoma site are essential and have been covered in detail in Chapter 3 on preoperative considerations. Meticulous attention must be paid to the construction of the initial stoma, as described in the chapters on the end sigmoid colostomy.
(Chapter 6) and the end ileostomy (Chapter 9). The choice of incision is important. While there is no published work suggesting that proximity of the laparotomy incision to the trephine increases the risk of hernia, confluence of a parastomal hernia with a midline incisional hernia is not an unusual occurrence. It may be reasonable to choose a contralateral paramedian incision to diminish hernia risk. Many colorectal surgeons prefer a midline approach, as a paramedian scar may preclude using that side of the abdomen for future stomas. A right-sided paramedian incision should certainly be avoided in a patient with inflammatory bowel disease. In locating the stoma, a transrectus construction is superior to a lateral one. An umbilical stoma will also have a lower rate of hernia formation [18]. When possible, the creation of an extraperitoneal stoma probably also reduces the risk of herniation. The size of the trephine should only be large enough to admit the bowel itself. Resnick [87] has devised a device that controls the size of the fascial aperture. He believes that it reduces the risk of hernia development. An interesting report by Bayer et al. [74] investigated the benefit and risks of placing a ring of polypropylene mesh around all colostomies to prevent hernia (Fig. 10). A total of 43 patients were followed for up to 4 years. None developed a hernia and only 7 had complications attributable to the mesh. Light [88] has championed a similar technique. These results are intriguing, but a randomized prospective study of this method against

Figure 10  Paracolostomy mesh reinforcement showing collar mesh (inset) around stoma and anchored to anterior fascia. (Modified from Ref. 74.)
conventional technique should be completed before considering its adoption for routine use. Inserting prophylactic mesh in high-risk patients, however, may be an appropriate measure.

The surgeon must remember that, for the long-term survivor, the single most important part of the operation is the creation of the stoma. Even minor malfunction of the stoma may seriously hamper the patient’s daily activities and quality of life. The construction of the stoma should be meticulous, and it should be performed by an experienced attending surgeon or done under the guidance of such an individual.

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INTRODUCTION

Many issues confront patients with a newly formed stoma. These issues include the need to meet the physical and psychological challenges unique to their new body architecture. Any complications in stoma management can hinder patient acceptance. The ideal stoma combines optimal functional and cosmetic results in the eyes of both the patient and surgeon. Stoma prolapse, a condition in which the full thickness of the intestine protrudes through the stoma, is one of the most common complications (Fig. 1). Prolapse occurs in both end and loop stomas, ileostomies and colostomies, as well as urostomies and continent ileostomies. This chapter reviews the current literature on stomal prolapse, specifically addressing etiology, risk factors, and technical considerations in preventing and treating prolapse.

INCIDENCE

The incidence of stomal prolapse is variable, depending on the type of stoma and its location, age of patient, primary diagnosis, and length of follow-up. Fleshman and Lewis [1] reported the incidence of stoma-related complications based on a review of 16,740 entries in the United Ostomy Association Registry. The incidence of prolapse for ileostomy, colostomy, and urostomy was 3, 2, and <1%, respectively. Other published data have often revealed far less optimistic numbers (Table 1).

In a comprehensive analysis of 1616 enteric stomas created at Cook County Hospital over a 20-year period, Park and colleagues [9] found an overall 2% incidence of prolapse. A multivariate analysis revealed that only advanced age and lack of preoperative marking by an enterostomal therapist were significant risk factors for the development of long-term complications, including prolapse.
Figure 1  Stoma prolapse.

Table 1  Incidence of Stomal Prolapse

<table>
<thead>
<tr>
<th>Author</th>
<th>Date</th>
<th>No. of patients</th>
<th>Follow-up (months)</th>
<th>End ileostomy</th>
<th>Loop ileostomy</th>
<th>End colostomy</th>
<th>Loop colostomy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chandler [2]</td>
<td>1978</td>
<td>491</td>
<td>2.4%</td>
<td></td>
<td>26%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Londono-Schimmer [4]</td>
<td>1994</td>
<td>203</td>
<td>156</td>
<td>11.8%</td>
<td>4.3%</td>
<td>38.5%</td>
<td>3.7%</td>
</tr>
<tr>
<td>Cheung [5]</td>
<td>1995</td>
<td>316</td>
<td>38</td>
<td>4.3%</td>
<td>12.5%</td>
<td>3.7%</td>
<td>42.1%</td>
</tr>
<tr>
<td>Makela [6]</td>
<td>1997</td>
<td>156</td>
<td>104</td>
<td>12.5%</td>
<td>3.7%</td>
<td>42.1%</td>
<td>5.6%</td>
</tr>
<tr>
<td>Gooszen [7]</td>
<td>1998</td>
<td>76</td>
<td>3.1%</td>
<td>42.1%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edwards [8]</td>
<td>2001</td>
<td>70</td>
<td>0%</td>
<td>5.6%</td>
<td>38.5%</td>
<td>42.1%</td>
<td></td>
</tr>
</tbody>
</table>
According to most authors, prolapse tends to present within the first year of stoma creation [2,10]. This may reflect the temporary nature of stomas in some patients or the short life expectancy of other patients upon whom they were performed (i.e., palliation for metastatic cancer). Nonetheless, patients with ostomies are continually susceptible to new prolapse.

In general, loop colostomies tend to prolapse more often than do end colostomies [2,5], and the distal limb is more often involved than the proximal limb. It is postulated that this results from an appropriately sized fascial defect at the time of operation becoming disproportionately enlarged as the distal limb atrophies. Incidence reported in the literature ranges from 5–47% [2,5,7,8].

A commonly associated finding with colostomy prolapse is parastomal hernia. In a series by Allen-Mersh, 50% of the patients with colostomy prolapse had concomitant parastomal hernia [10]. This may occur because the fascial and skin apertures for colostomies are larger than for ileostomies. This is especially true for end colostomies because they are often created at the time of obstruction, mandating overly large fascial and skin openings at the time of surgery. Although parastomal hernias can occur with end or loop ileostomies or loop colostomies, they are most often associated with end colostomies.

**SYMPTOMS**

Prolapse can cause unsightly bulging of the stoma, which can adversely affect the ostomy patient’s acceptance of the stoma. The presence of this bulge, especially if associated with a parastomal hernia, commonly results in difficulties with proper fitting of the ostomy management system. The mere bulk of the prolapsed colon may result in dislodgement of the pouch from the parastomal skin. As a result of an improperly fitted appliance, leakage and parastomal skin irritation can ensue (Fig. 2). Thus pain or bleeding from skin excoriation and a poorly fitting ostomy management system may be a symptom of prolapse. The prolapsed colon itself is susceptible to trauma, including mucosal ulceration and bleeding. Although it is usually easily reduced, maintenance of reduction is often difficult or impossible [11]. Ultimately obstruction from incarceration or even strangulation, leading to possible peritonitis, can occur. Although these complications are unusual, they do require immediate recognition and treatment [2]. The management of incarceration is addressed further on in this chapter.

It is important to recognize that the ostomy patient’s overall quality of life can be severely hampered by a poorly functioning stoma. In a prospective, randomized study of 76 patients, Gooszen and colleagues [12] followed patients after either loop ileostomy or loop colostomy, evaluating quality of life with questionnaires at scheduled visits. Patients were catego-
Figure 2  Peristomal skin irritation.
rized into various groups, ranging from “socially interactive” to “socially isolated.” Prolapse was rarely seen in patients seeking “social isolation less than once per week” (2 of 33; 6%), but was quite common in patients seeking “complete isolation” (3 of 8; 38%). The authors concluded that prolapse was a contributing factor to social isolation and decreased quality of life for these patients.

**RISK FACTORS**

The development of stomal prolapse is usually insidious rather than acute. Certain circumstances are thought to predispose to the development of prolapse, but the level of evidence in the literature is often inadequate. There are both patient- and surgery-related factors (Table 2).

Conditions that increase intra-abdominal pressure likely predispose to stomal prolapse. Chronic coughing (i.e., patients who smoke) and straining (i.e., frequent constipation) are believed to be associated with stoma prolapse. Neonates and infants are felt to have higher rates of prolapse (13–30%) not only because stomas are usually placed during obstruction (i.e., Hirschsprung’s disease, imperforate anus) but also secondary to frequent crying and screaming episodes, which cause increased intra-abdominal pressure [13,14]. Although never demonstrated in a prospective trial, many surgeons believe obese patients are at a higher risk for developing a variety of stomal complications, including prolapse, parastomal hernia, and retraction. Efforts by the patient to lose excess weight, quit tobacco habits, and improve bowel regimen may be rewarded with lower incidences of prolapse.

**Table 2** Factors Contributing to Stomal Prolapse

<table>
<thead>
<tr>
<th>Patient-Related Factors</th>
<th>Surgery-Related Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Higher Level of Evidence</strong></td>
<td></td>
</tr>
<tr>
<td>Age—i.e., pediatric and elderly</td>
<td>Loop &gt; end stomas</td>
</tr>
<tr>
<td>Bowel obstruction</td>
<td>Oversized aperture—i.e., trephine technique</td>
</tr>
<tr>
<td>Increased intra-abdominal pressure</td>
<td>Proximal &gt; distal colon</td>
</tr>
<tr>
<td>Pregnancy</td>
<td>Improper site—i.e., lateral to rectus muscle</td>
</tr>
<tr>
<td>Spinal cord injury</td>
<td>No preoperative marking by stoma nurse</td>
</tr>
<tr>
<td>Obesity</td>
<td>Failure of mesenteric fixation</td>
</tr>
<tr>
<td>Bowel redundancy</td>
<td></td>
</tr>
<tr>
<td>Weak fascia</td>
<td></td>
</tr>
</tbody>
</table>

**Lower Level of Evidence**

- Obesity
- Bowel redundancy
- Weak fascia

Sources: Refs. 2, 13–16.
Creation of an abdominal wall aperture that is too large is likely to lead to prolapse and herniation. Following the “two finger” rule can obviate this technical error. If the aperture accepts two fingers placed through the internal opening, so that both interphalangeal joints are at the level of the skin defect, an adequate opening has been achieved. An abdominal wall opening that is too large, especially in the presence of other predisposing factors, will lead to the development of prolapse. Extra care must be taken in forming an end-sigmoid colostomy for an obstructing distal lesion because the colon proximal to the obstruction will be very dilated. Patients who undergo surgery while obstructed have a significantly higher risk of prolapse (38 vs. 7%) [2]. Although dilation and bowel wall edema resolve rapidly after diversion, the aperture remains as large as was necessary to permit exteriorization of the divided colon. Golladay described using a purse-string technique in pediatric patients to avoid this problem [17]. Two purse strings of absorbable suture are used to fasten the seromuscular layer of the bowel to both layers of fascia in a running fashion and then “cinched” to reduce the diameter of the greatly dilated bowel to a more normal size (Fig. 3). With resolution of edema, the stoma remains widely patent but does not prolapse. The authors used this technique in 85 patients and reported no episodes of prolapse.

It is not uncommon for pregnant women to notice increased protrusion of their stomas during the last trimester of pregnancy. Gopal reviewed 67 ostomates during 82 pregnancies in order to determine the risk of gestation and labor to stomal prolapse; 4 prolapses occurred (4.8%) [16]. Pregnancy may increase risk of prolapse via an enlarging uterus, hyperemesis [18], or changes in the abdominal wall. Often, surgical correction is unnecessary, as the condition resolves after delivery with the return to normal intra-abdominal pressure. When surgery is required, it should be deferred until after delivery.

Patients with spinal cord injuries may require the creation of a colostomy. Arun et al. reviewed ostomy prolapse in paraplegic patients in an acute spinal cord injury unit. They concluded that prolapse is more likely to occur in paraplegic patients with an injury at or above the T-10 level [19]. The exact reason for this association is unknown.

PREVENTION

The single most important factor in the prevention of stomal prolapse is adherence to sound surgical technique. Technical aspects have a direct effect on the ultimate outcome of the stoma, its function, and its propensity for complications. Factors that directly affect the predilection for prolapse include selection of the stomal site, creation of the abdominal wall aperture, and the technique of fixation.
During construction of the stoma, strict attention to technical detail is imperative. A common factor in the development of prolapse is improper location of the stoma site. The ideal location for a stoma is away from bony prominences, skin creases, old scars, the umbilicus, the belt line, and future incision sites. The stoma should be brought out through the rectus abdominis muscle. If the stoma is located outside the rectus abdominis, it is more prone to prolapse and herniation. In the series by Weaver et al., parastomal hernia and prolapse were associated with an improperly sited stoma in 10 of 17 patients [20]. Fleshman and Lewis reported malpositioning of the
stoma in 12% of patients with stomal prolapse [1]. Preoperative marking of
the stoma site by an enterostomal therapist allows for proper site selection.

Many authors hold that failure to fix the bowel mesentery at the level
of the internal opening can contribute to prolapse. This remains a debatable
point and is not universally accepted [21,22]. There is good evidence sug-
gestting that fixation of the mesentery to the abdominal wall will prevent
prolapse. Makela et al. evaluated patients with stomas for “late complica-
tions” in order to elucidate potential contributing factors. Of the 13 pro-
lapsed stomas in 156 patients, 10 were nonfixed and 3 were fixed [6]. Fur-
ther evidence is provided by Ng et al., who performed a prospective,
randomized controlled trial of 55 pediatric patients to evaluate the efficacy
of distal colon tethering in preventing prolapse of a loop colostomy. Using
specific criteria for successful tethering (length of mesentery tethered to
abdominal wall being greater than three times the width of the fascial aper-
ture), it was demonstrated that no patient with successful tethering suffered
a prolapse, while patients without tethering experienced higher rates of pro-
lapse (26 and 7%, respectively) [23].

Although the stoma can be secured to the posterior rectus sheath and
peritoneum or to the anterior rectus sheath, neither of these adjunctive ma-
neuvers obviates stomal prolapse. Moreover, the use of seromuscular su-
tures for fascial fixation may encourage subsequent fistula formation. More
important than the number of levels through which sutures are placed is the
size and location of the aperture in the abdominal wall.

Whittaker and Goligher favored the use of the extraperitoneal approach
for the construction of the stoma [24]. In their experience, this technique was
associated with a decreased incidence of complications, including prolapse,
when compared to a standard intraperitoneal colostomy. However, despite
the authors’ enthusiasm, these differences were not statistically significant.
Ein reported his experience with the creation of a divided-loop colostomy
in 13 infants by using a modification of the extraperitoneal approach. Dur-
ning the 3-year study period, no prolapse was observed [25].

Patients who undergo stoma construction via a trephine approach may
have an increased incidence of prolapse [15]. This is thought to be second-
ary to enlarging the fascial defect during the procedure while attempts are
made to improve visualization, usually while mobilizing mesenteric attach-
ments. The tendency to create an oversized stoma must be avoided because
it is both unnecessary and inadvisable.

Laparoscopy-assisted stoma formation may help overcome the ten-
dency to stretch the fascial defect. Kini followed patients for up to 18
months after laparoscopy-assisted trephine stoma formation, with no evi-
dence of prolapse or hernia [26]. Fuhrman reviewed 17 rectal cancer pa-
tients who underwent laparoscopic intestinal stomas. Only one patient de-
veloped prolapse and subsequently died from complications of metastatic
disease within weeks of developing prolapse. Fuhrman stated, “the laparos-
Stomal Prolapse

Copic method does not compromise the surgeon’s ability to choose a location for the stoma, nor does it impair the ability to mobilize and prepare the intestine for exteriorization” [27]. Ludwig published the Cleveland Clinic experience with 24 laparoscopic procedures, with no reoperations for stoma-related complications [28]. Although no large study has been published to analyze long-term complication rates of laparoscopic stomas, there is no current evidence that stomas created using laparoscopic techniques are more prone to complications or specifically to prolapse.

The design of a rodless end-loop stoma is felt to protect against prolapse of the distal limb, since only a small portion of the stapled antimesenteric border is brought out and matured through the abdominal wall opening (Fig. 4). Over a 7-year period, 229 patients had end-loop stomas created at the University of Illinois, lasting for 3 months to 7 years; only 1 prolapse (0.4%) occurred [29].

When the bowel is exteriorized though the stoma site, attention should be directed toward creating a well-vascularized stoma. Redundant bowel proximal to the stoma should be resected to lessen stomal prolapse. The spout should be of proper length after eversion and maturation: 2 cm for an ileostomy and <2 cm for a colostomy.

Clearly a variety of techniques are available for the creation of a stoma. Adherence to sound surgical judgment, proper selection of the site, and careful creation of the aperture are most important in preventing stomal prolapse. Furthermore, adjunctive techniques such as fixation of the mesentery or exteriorization of the segment and alternative stomas such as the rodless end-loop stoma may have a role in the prevention of stomal prolapse.

MANAGEMENT

The physician caring for the patient with stomal prolapse must decide which course of therapy to pursue. Indications for surgery are based on degree of inconvenience experienced by the patient balanced against fitness to undergo surgery and probability of achieving a successful outcome [10]. If the prolapse is minimal and asymptomatic, an expectant course is indicated. If the patient has significant comorbid diseases, the risks of surgery may outweigh the potential risks associated with ostomy prolapse. If the patient is a reasonable surgical candidate and nonoperative means fail, surgical options should be considered. There are two surgical approaches to the management of stomal prolapse: local parastomal procedures and intrabdominal procedures. The choice of surgical procedure should be tailored to the individual patient and to the type of stoma. It is recognized that those patients who undergo surgical repair for prolapse have a higher rate of recurrent surgery than patients with other ostomy complications, such as hernia and stenosis [10].
Figure 4  Rodless end-loop stoma. (Adapted from Ref. 29.)
**Ileostomy**

A variety of local techniques are available for the management of a prolapsed ileostomy. Local repair of the prolapse can be performed by dividing the mucocutaneous junction. Some advocate leaving a rim of mucosa on the skin of the mucocutaneous junction, thereby eliminating the need for further skin excision and further widening of the skin aperture. Others advocate excising only a small amount of parastomal skin with the mucocutaneous junction. Once mucocutaneous division is accomplished, the bowel is dissected and delivered through the skin aperture, thus eliminating any excess proximal redundancy. The redundant bowel is resected, and a new primarily everted stoma is created. Nonabsorbable mesh can be secured around the stoma at the level of the posterior rectus sheath. This option is reserved for patients with concomitant parastomal hernias. Another surgical approach to the prolapsed ileostomy is laparotomy with relocation of the ileostomy. This is usually reserved for patients with associated large parastomal hernias or for those in whom a local approach has already failed.

**End Colostomy**

Several options are available in the management of the prolapsed permanent end colostomy, including local revision and laparotomy with relocation. If the stoma is temporary, re-establishment of intestinal continuity may be preferable to surgical repair of the prolapse. Those who undergo early closure secondary to prolapse symptoms or sequelae do not suffer increased rates of operative complications [2]. If the stoma is permanent, local measures should be attempted whenever possible. Gauderer and Izant described a technique of postreduction intraluminal bowel fixation. After reduction of the prolapsed segment, the reduced bowel is attached to the parietal peritoneum with the use of large U sutures several centimeters away from the stoma. The sutures are bolstered to the skin with latex tubing. The authors used this technique on four children with prolapsed colostomies [30]. Button colopexy has also been described by Berzin and Canil (Fig. 5) [31,32]. This involves fastening a button in the stoma (below fascia level) to another button adjacent to the stoma (on the skin), thus fixing the reduced stoma. After 1 month, during which adhesions have presumably formed, the buttons may be removed. This technique has been described in 12 patients with no complications reported.

Abulafi described a modification of the Delorme procedure for prolapsed colostomy [33]. A mucosal dissection is performed with a redundant seromuscular layer left behind. Several pleating sutures are placed in the muscular coat, precluding the need for resection. Good results were reported in two patients. This option might be appropriate in elderly patients or those considered unfit for major surgery.
However, the standard approach for paracolostomy hernia repair is similar to that for paraileostomy hernia. Via a parastomal approach, after complete bowel preparation, the mucocutaneous junction is dissected circumferentially. Redundant colon is mobilized and excised, and a new colocutaneous anastomosis is fashioned with or without slight eversion.

If there is a large parastomal hernia associated with the prolapse, local hernia repair should be performed at the time of prolapse repair. The fascial defect is identified and a primary suture repair is performed. If the defect is too large for primary repair or if a previous local repair has failed, relocation of the stoma may offer a superior alternative to mesh fixation or repeat primary fascial suture closure. For complete details on parastomal hernia repair, see Chapter 15.

**Loop Colostomy**

As already mentioned, loop colostomies have a higher predilection for prolapse than do end colostomies. The prolapse usually occurs in the defunctionalized distal limb. If there is a symptomatic prolapse of a temporary colos-
Stomal Prolapse

If stoma reversal is not appropriate or possible, correction of the prolapse should be considered. One option in the management of a prolapsed loop colostomy is to convert the loop to an end colostomy. A parastomal incision is made and the stoma is mobilized from the mucocutaneous junction. After the loop colostomy has been divided, the redundant colon is resected and an end colostomy is created. Several options are available for the management of the distal limb. A mucous fistula can be created either at the stoma site or at a separate site. Alternatively, the distal limb can be left as a long Hartmann’s pouch either in the abdomen or in the subcutaneous parastomal space.

When a large parastomal hernia is associated with the prolapse, the same options apply as with the end colostomy. The surgeon must choose between a local direct fascial repair and stoma relocation.

Accumulated data in the literature, however, reveal treatment of colostomy prolapse is not very satisfactory. As shown by Allen-Mersh and colleagues [10], local resection and fixation was successful in only 35% of cases and resiting the stoma with further resection did not greatly improve chances of achieving a good outcome (33%). Colectomy with ileostomy provided better results (67%) in recurrent prolapse.

Incarceration

A more difficult situation arises when the patient has an incarcerated prolapsed stoma. Only 10% of patients with stomal prolapse will present with an obstructed or incarcerated stoma [2]. However, attempts at reduction in these patients are often unsuccessful because of edema and patient discomfort from extra foliating techniques utilized for bovine prolapse. Myers and Rothenberger have described a nonoperative approach for the management of this condition [34]. Sprinkling ordinary table sugar on the incarcerated segment causes dramatic desiccation of the tissues within minutes. The amount of edema is thus decreased, allowing spontaneous or easy manual reduction. The technique is particularly attractive as it is inexpensive and easy to perform as well as, reportedly, highly successful. It should be used for stomas that are prolapsed and incarcerated, but viable and may avert the need for urgent surgery.

Irreducible prolapsed stomas or prolapsed stomas with vascular compromise require urgent surgical repair. In these circumstances a parastomal approach is preferred, as it avoids intraperitoneal contamination. Rarely, it may be necessary to perform a concomitant laparotomy to mobilize viable intestine to recreate a well-vascularized stoma without tension. This, however, is an unusual occurrence.
SUMMARY

Ostomy prolapse is a common complication after colostomy or ileostomy construction. Presentation may range from asymptomatic protrusion to incarceration with vascular compromise. A variety of surgical options are available for the management of this condition. The physician caring for the ostomy patient with prolapse must be aware of all options.

The surgeon who creates stomas must adhere to the basic surgical principles of stoma construction. Prolapse is one of the stoma-associated complications that is directly related to the surgical technique. Prevention, therefore, is preferable to treatment of this often avoidable complication. It is our recommendation that creation of intestinal stomas be performed or directly supervised by the senior member of the operating team, as this is often the part of the operation that will remain with the patient for months to years and will have a major impact on his or her quality of life.

REFERENCES


INTRODUCTION

Few complications of gastrointestinal surgery are as disturbing to both surgeon and patient as a postoperative external intestinal fistula. For the surgeon, it implies a possible failure in judgment or an aberration in surgical technique. It presents an immediate and often formidable challenge to (1) stabilize the patient by correcting the effects of sepsis, fluid and electrolyte or acid-base imbalance, and any nutritional problems; (2) gain control of the fistula; and (3) achieve eventual closure and integrity of the gastrointestinal tract. For the patient, there is the grim prospect of a protracted, highly morbid illness with a long, costly hospitalization. The potential for mortality is compounded by the psychological trauma and abhorrence of stool draining from the abdomen.

Such patients are best managed by a multidisciplinary team approach that includes the surgeon, the internist and/or gastroenterologist, the enterostomal therapy (ET) nurse, and a dedicated general nursing staff. This team must be cognizant of the metabolic, septic, nutritional, and wound care consequences of such a fistula. The team members must direct care aggressively in order to prevent mortality, which, in general, has declined in recent years to less than 20% because of improved multidisciplinary care [1].

The focus of this chapter is the management of enterocutaneous fistulas, including those originating from the duodenum, jejunum, ileum, and colon. Emphasis is given to those fistulas originating from the small intestine. A four-phase management plan is outlined to address both nonoperative and surgical management, including the rationale, indications, timing, and decision making for definitive surgery. The ultimate goal of therapy is to restore the continuity of the gastrointestinal tract.
CLASSIFICATION

External fistulas can be classified by several different methods. In addition to forming a rational basis for discussion, classification systems are useful in predicting the morbidity and mortality associated with a specific fistula and the probability of spontaneous closure. For purposes of this discussion, fistulas are classified on an anatomic basis as simple or complex (see Table 1). Simple fistulas have a short tract that is in direct communication with the skin and has no septic focus and no other organ involvement (Fig. 1). Complex fistulas can be divided into two types. Complex type 1 fistulas are those that are associated with an abscess or have multiorgan involvement (Fig. 2). Complex type 2 fistulas are those that open into the base of a disrupted wound (exposed fistula) (Fig. 3). By their nature, complex fistulas are associated with higher rates of morbidity and mortality as well as a lower rate of spontaneous closure [1–4].

All fistulas, whether simple or complex, may be divided into two groups based on their site of intestinal origin. Fistulas that arise in the upper small bowel are generally associated with a higher morbidity and mortality and a lower rate of spontaneous closure than those originating from the large intestines [3].

Fistula output relates directly to the site of origin. Fistulas of the large bowel almost always have low output, whereas those of the small bowel can have either low or high output [5]. Most authors use 200 mL/24 hr as the distinction between high- and low-output fistulas [1]. However, not all authors agree with this distinction, and some use 500 mL/24 hr to define high- vs. low-output fistulas [5]. The fistula output is a significant factor in fistula closure, with the odds of spontaneous closure three times greater for low-output fistulas than for high-output fistulas [6].

ETIOLOGY

Acquired enterocutaneous fistulas may occur either postoperatively or spontaneously (see Table 2). Postoperative fistulas are much more common, comprising well over 90% in some series [7]. They are primarily caused by.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Anatomic Classification of Fistulas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple</td>
<td>Complex</td>
</tr>
<tr>
<td>Short, direct tract</td>
<td>Type 1</td>
</tr>
<tr>
<td>No associated abscess</td>
<td>Associated with abscess</td>
</tr>
<tr>
<td>No other organ involvement</td>
<td>Multiple organ involvement</td>
</tr>
<tr>
<td>Type 2</td>
<td>Opens into base of disrupted wound</td>
</tr>
</tbody>
</table>
anastomotic breakdown [8]. These fistulas are largely preventable if basic surgical principles of anastomotic construction are observed, including adequate blood supply, lack of tension, and good suture technique. Intrinsic intestinal disease and characteristics of the individual patient also contribute to the occurrence of postoperative fistula. Incidental intestinal injury during lysis of adhesions figures prominently in several series [1,7,9–11].

Less common are the spontaneous causes, which accounts for 15–25% of enterocutaneous fistulas secondary to either intrinsic intestinal disease or external trauma. Inflammatory bowel disease is presently the most common cause of spontaneous enterocutaneous fistulas. These fistulas are difficult to treat and usually very resistant to spontaneous closure [8,9].

**MORBIDITY AND MORTALITY**

The morbidity and mortality associated with intestinal fistulas depend on the type of fistula, its etiology, and individual patient characteristics. These
factors explain in part the differences in morbidity and mortality rates between selected series, which to a large degree reflect the caseloads and referral patterns of individual institutions [12].

Morbidity from intestinal fistulas is difficult to quantitate. It arises primarily from fluid and electrolyte imbalance, sepsis, malnutrition, and the local effects of corrosive small bowel fluid on skin [12]. These physiological derangements, which are all interrelated, are central to an understanding of the pathophysiology of fistulas. Large-volume losses of electrolyte- and protein-rich secretions combined with third-space losses secondary to surgical trauma and infection cause rapid fluid shifts, upsetting general homeostasis. Sepsis, which is commonly associated with enterocutaneous fistulas, may arise from either a localized abscess or continuous gastrointestinal contamination. Sepsis has far-reaching effects on all organ systems and contributes to poor wound healing, poor nutritional status, and multiple system organ failure. Malnutrition, in turn, contributes to fistula formation and poor wound healing and increases the patient’s susceptibility to infection.

Figure 2  Complex type 1 fistula with associated abscess.
Management of Intestinal Fistulas

Figure 3  Complex type 2 fistula with multiple fistulous openings associated with a large abdominal wall defect.

In addition, the physical and emotional effects of a serious complication requiring prolonged hospitalization and often additional surgical procedures cannot be overlooked. Iatrogenic morbidity occurs primarily from central venous catheters used for nutrition and includes complications of insertion, septicemia, phlebitis/thrombosis, and hyperglycemia from hypertonic glucose solutions [7].

Mortality rates from intestinal fistulas have declined in recent years, but they remain relatively high, ranging from 6% [5,9] to 23% in some series [1,4,8]. Even in some recent studies, the mortality for enterocutaneous fistulas is significantly high, ranging from 16% [13] to as high as 60% [2,14]. As already mentioned, this disparity is caused largely by differences in patient populations. In a series reported by Schein and Decker
Table 2  Etiology of Acquired Enterocutaneous Fistulas

<table>
<thead>
<tr>
<th>I. Postoperative occurrence</th>
<th>II. Spontaneous occurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Anastomotic problems</td>
<td>A. Intrinsic disease</td>
</tr>
<tr>
<td>1. Technical factors</td>
<td>1. Inflammation</td>
</tr>
<tr>
<td>a. Tension</td>
<td>(inflammatory bowel</td>
</tr>
<tr>
<td>b. Blood supply</td>
<td>disease, diverticulosis</td>
</tr>
<tr>
<td>c. Technique</td>
<td>2. Malignancy</td>
</tr>
<tr>
<td>2. Intestinal factors</td>
<td>3. Infection (tuberculosis,</td>
</tr>
<tr>
<td>a. Inflammation</td>
<td>actinomycosis, amoebiasis</td>
</tr>
<tr>
<td>b. Ischemia</td>
<td>4. Ischemia (embolus,</td>
</tr>
<tr>
<td>c. Malignancy</td>
<td>thrombosis, low flow)</td>
</tr>
<tr>
<td>d. Infection</td>
<td>5. Foreign body</td>
</tr>
<tr>
<td>a. Malnutrition</td>
<td>7. Radiation</td>
</tr>
<tr>
<td>b. Steroids</td>
<td>B. Extrinsic disease</td>
</tr>
<tr>
<td>c. Malignancy (including</td>
<td>1. Trauma</td>
</tr>
<tr>
<td>chemotherapy and x-ray</td>
<td>2. Other organ</td>
</tr>
<tr>
<td>therapy</td>
<td></td>
</tr>
<tr>
<td>d. Systemic disease</td>
<td></td>
</tr>
<tr>
<td>(diabetes, renal failure)</td>
<td></td>
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<tr>
<td>B. Incidental injury</td>
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<td>1. Lysis of adhesions</td>
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[15], a 37% mortality rate in high-output postoperative small bowel fistulas was seen despite modern supportive therapy.

In a classic paper, Edmunds et al. [16] noted that mortality was related to three factors: fluid and electrolyte imbalance, malnutrition, and sepsis. Fluid and electrolyte imbalance is primarily related to fistula output. Initially 35–40% of patients with fistulas have severe fluid and electrolyte disturbance and acid-base imbalance [12]. The effluent from high-output fistulas originating close to the ligament of Treitz is made up largely of pancreatic and biliary secretions, which contain high concentrations of sodium and bicarbonate. As a consequence, fistulas arising in the upper small bowel are associated with a higher morbidity and mortality and a lower rate of spontaneous closure than those originating from the large intestine [3]. In a series reported by Fazio et al. [4], the mortality rate for high-output fistulas was 31%, as opposed to 5% in low-output fistulas.

The importance of malnutrition was demonstrated in 1964 by Chapman et al. [17], who found that patients who received <3000 cal/day had a 55% mortality rate, whereas those who received >3000 cal/day had a mortality rate of only 12%. The absence of food intake for several days (especially during the postoperative period), the hypercatabolism of sepsis with the breakdown of lean body mass, and the loss of hypertonic protein-rich secretions from the fistula all contribute to malnutrition. Under normal cir-
cumstances, the intestinal secretions are digested and the amino acids are resorbed and resynthesized into protein. When a fistula is present, most of these secretions are lost.

Uncontrolled sepsis remains the most common cause of death in patients with enterocutaneous fistulas and contributes to a high rate of associated complications. In most series it accounts for approximately 70% of all deaths [3,15,18,19]. Altomare et al. [18] found that 54% of septic patients died, in contrast to 14% of nonseptic patients. Similarly Reber et al. [7] described mortality rates of 85% in patients in whom sepsis was uncontrolled vs. 8% in patients with controlled sepsis. Such patients are often postoperative and in a state of immunosuppression from surgery. If there has been an anastomotic disruption, devitalized tissue is present, forming a nidus for abscess formation with continued contamination from the gastrointestinal tract.

Fistula etiology is also predictive of mortality. Fistulas associated with malignancy and radiation have a high mortality rate [19,20]. Patients with fistulas arising from inflammatory bowel disease have a lower mortality rate [21], yet this rate is higher than that for simple postoperative anastomotic fistulas (simple type 1), which have the lowest associated mortality [3,4].

Many other factors contribute to the high mortality rate associated with fistulas. Advancing age has often been related to a higher mortality rate; however, this connection has not been consistently demonstrated [18]. Many significant risk factors are associated with increasing age, and the presence or absence of these risk factors may be more important than chronologic age in determining outcome. Patients with malignancy who develop an unrelated fistula have an increased mortality rate [18,19]. Anemia and hypoalbuminemia also have been implicated, with associated mortality rates of 31 and 42%, respectively [18,20]. Perhaps the greatest risk factor for increased mortality is the presence of an open fistula (complex type 2), which drains into the base of an incision. Mortality rates in this situation range from 50–60% and have not improved significantly, even with advances in supportive care [3,15,20].

In 1989, Levy et al. [2] developed a risk score that correlated eight so-called severity factors: multiple fistulas, intra-abdominal abscess, septicemia, ileus, adult respiratory distress syndrome, upper gastrointestinal hemorrhage, renal or hepatic failure, and thromboembolic complications. They found that any patient with three or more of these factors has a mortality risk of 50%.

**REASONS FOR NONCLOSURE**

Many factors contribute to the persistence of an intestinal fistula. The most important of these are (1) undrained sepsis (Fig. 4), (2) distal obstruction
(Fig. 5), and (3) underlying disease (e.g., Crohn’s disease, radiation-induced bowel injury, or malignancy) (Fig. 6). Other potential factors are separation of the bowel ends (Fig. 7), a short (<2-cm) fistula tract (Fig. 8), a foreign body, a bowel wall defect >1 cm in diameter, and epithelialization of the tract (Fig. 9) [22–25]. Reber et al. [7] have reported that in the absence of mitigating factors, the spontaneous closure rate is 32%. They also stated
that once sepsis has been controlled, 90% of fistulas that close spontaneously do so within 1 month. Persistent sepsis, however, affected closure rate significantly. In those patients whose sepsis was controlled within 1 month, 48% of fistulas closed spontaneously with an 8% mortality, compared to a 6% closure rate and 85% mortality when sepsis was not controlled.

Hugh et al. [26] have stressed that distal obstruction with adhesions or abscess is a critical factor in fistula persistence. The fistula acts as a vent, and because the obstruction is usually partial, the diagnosis is often difficult to confirm. Of 93 patients with colovesical fistula reported on by Fazio et al., [27] 38 (41%) had persistent distal obstruction as a contributing factor.

**Figure 6** Underlying bowel disease, which may be a reason for nonclosure.

**Figure 7** A disrupted anastomosis as a reason for nonclosure.
Persistence of underlying disease is responsible for nonclosure of many fistulas. In a study of enterocutaneous fistulas in patients who underwent surgery for Crohn’s disease, 6 of 7 patients with no active disease had closure with conservative management, whereas only 1 of 20 patients with documented active disease had spontaneous closure [21]. In the series by Reber et al. [7], when an enteric fistula was associated with Crohn’s disease, only 8% of fistulas closed spontaneously. When abdominal irradiation was a factor, only 14% of fistulas healed with conservative treatment.

McIntyre et al. [5] have presented data suggesting that (1) a postoperative fistula is more likely to close than a spontaneously occurring one (26 vs. 17%), (2) a simple fistula is more likely to close than a complex one (37 vs. 15%), and (3) surprisingly, a high-volume fistula is just as likely to
close as a low-volume fistula (25 vs. 28%). Poor nutritional status and a transferrin level <200 mg/dL are some of the other factors predicting that the fistula will be unlikely to close spontaneously [28,29].

**MANAGEMENT**

The management of patients with intestinal fistulas can be very challenging and requires a team approach. Treatment can be divided into four phases: stabilization, investigation, conservative treatment, and decision/definitive surgery.

**Phase 1: Stabilization**

At the time of fistula presentation, patients are often in the postoperative period and have been without adequate nutrition for several days. Prior to the discharge of intestinal contents from either a drain site or a surgical wound, clinical progress usually has been poor. The combination of third-space losses from inflammation and fistula discharge rapidly depletes the patient’s intravascular volume. The first priority in this situation is the immediate restoration of intravascular volume with crystalloid, colloid, and blood (when appropriate) to establish tissue perfusion and adequate urine output. The goal of stabilization of gastrointestinal fistulas is to control the major complications of fistulas, such as fluid and electrolyte imbalances, malnutrition, and sepsis, including abscess formation and wound infection.

The patient must be evaluated to determine whether immediate surgery is necessary. Emergency surgery carries a high mortality (55%) [2] and should be performed for only three reasons: a septic focus requiring surgical drainage, uncontrolled hemorrhage, or evisceration. If an abscess has been identified and is approachable through the abdominal wall, percutaneous drainage should be considered (Fig. 10). After localization with the help of computed tomography (CT) scanning or ultrasound, a needle is introduced into the cavity, the contents are aspirated, and a sample is sent for aerobic and anaerobic culture. Water-soluble contrast can be injected at this time to delineate the site of origin before draining the abscess [30]. The latter is accomplished with either a catheter introduced by the Seldinger technique or through a local procedure. In the septic patient, every effort should be made to identify and drain all abscesses. Dependent placement of large-bore catheters is preferred. Uncontrolled sepsis in a patient in whom an abscess is suspected but cannot be identified may require a formal laparotomy if the patient’s condition continues to deteriorate. Uncontrollable sepsis is associated with death in up to 85% of patients, many of whom have underlying malignancy (50%) or prior radiation therapy (25%) [31]. The importance of surgical intervention to control sepsis has been empha-
A abscess associated with an enterocutaneous fistula (complex type 1) should be drained percutaneously whenever possible.

sized by Reber et al. [7], who found that, in patients who required surgery to control sepsis, 90% eventually achieved spontaneous closure. When laparotomy is necessary for control of sepsis, no attempt should be made to definitively repair the fistula; instead, proximal diversion along with drainage of the abscess should be performed and definitive repair reserved for a later time, when the patient has been restored to health (Fig. 11).

Antibiotics should be reserved for patients who are septic. The patient who is not septic and who has a simple fistula tract (without associated abscess) does not require antimicrobial therapy. The administration of antibiotics in no way obviates the need for adequate surgical drainage. Initial use should be empirical, covering intestinal organisms such as coliforms, Bacteroides, and enterococci. Prior to initiation of treatment, fistula drainage should be Gram stained and cultured to determine bacterial flora and sensitivities. The average number of antibiotics used in a series by Soeters

**Figure 10** An abscess associated with an enterocutaneous fistula (complex type 1) should be drained percutaneously whenever possible.
et al. [1] over the course of fistula therapy was six to eight. Thus, indiscriminate use of antibiotics will select out organisms with high levels of antibiotic resistance.

Early in this initial management phase, attempts should be made to diminish intestinal output. This approach not only decreases the fluid and electrolyte losses experienced by the patient but makes wound and skin care easier. All patients should have NPO designation, not only to decrease luminal contents but also to decrease gastrointestinal stimulation and pancreaticobiliary secretion. Giving the patient nothing by mouth and placing a nasogastric tube may remove 4000–7000 mL of secretions from the saliva,
esophagus, stomach, duodenum, pancreas, and biliary tree. In addition, all patients should be given H₂ antagonists to prevent stress erosions and decrease gastric secretions. In 1978, Reber et al. [7] demonstrated a 60% decrease in fistula output with the addition of intravenous cimetidine. This method can be extremely helpful in decreasing drainage from high-output fistulas from the upper gastrointestinal tract.

Several studies have shown that nasogastric tubes do not increase the closure rate of fistulas [1,9]. The use of such tubes should be restricted to patients with partial small bowel obstruction. Their long-term use can be detrimental, causing erosions, bleeding, and late strictures [10]. If a patient is expected to have prolonged postoperative ileus, consideration should be given to placing a gastric tube.

Wound and Skin Care

During the stabilization phase of fistula management, early attention must be directed at wound and skin care. Many of the complications of enteric contents eroding the abdominal wall can be minimized by early intervention. A skilled and knowledgeable ET nurse working with a dedicated general nursing team is invaluable. Efforts should be directed toward the management of abdominal wall fistulas, containment of the effluent, and maintenance of skin integrity and patient support.

Phase 2: Investigation

Once the patient has been resuscitated and stabilized and the sepsis has been controlled, the fistula must be investigated to determine (1) the course and origin of the fistula tract, (2) the presence of a persistent abscess, (3) the condition of the adjacent bowel, and (4) the presence of distal obstruction or discontinuity. The best means of evaluating a fistula is a fistulogram, which is obtained with the use of a soft-tipped catheter (e.g., Foley) or pediatric feeding tube (if the skin opening is small). Inflating the Foley balloon prevents leakage of contrast material onto the skin. The fistulogram may provide information such as (1) the cause of the fistula, (2) the length of the fistula’s tract, (3) whether the bowel is completely disrupted or the fistula is a lateral one with the bowel in continuity, (4) whether there is an abscess cavity, (5) the size of the bowel wall defect, and (6) whether there is a distal obstruction. A water-soluble contrast material is used, and it should be injected gently to prevent rupture. Once the origin of the fistula has been determined, either an upper gastrointestinal and small bowel follow through or a barium enema should be performed to visualize the adjacent bowel and rule out distal obstruction. The choice of study depends on the fistula’s level of origin [32].

The role of CT scanning in the initial evaluation of the fistula’s tract, once the patient is stable, is limited to the identification of an associated abscess and, occasionally, to delineate three-dimensional anatomy. CT scan-
ning may also help to define the extent, nature, and location of underlying disease [33]. CT is most useful for re-evaluating patients who are not responding to conservative treatment when an inflammatory process is suspected [32]. Other examinations, such as cystoscopy and intravenous pyelography, are used as necessary if other organ systems are involved.

**Phase 3: Conservative Treatment**

**Total Parenteral Nutrition**

The development of total parenteral nutrition (TPN) has revolutionized the treatment of enterocutaneous fistulas [34]. In 1972, Wolfe et al. [35] demonstrated that TPN decreased the output of experimental enterocutaneous fistulas by 93%. Subsequent clinical studies have confirmed this figure [9]. However, the effect of TPN on the rate of spontaneous closure is less clear. Most authors claim slightly improved rates of spontaneous closure with TPN [1,7,9]. This association has led some authors to believe that spontaneous closure is primarily a function of fistula etiology, anatomy, and associated sepsis [4]. Disagreement also exists about the effect of TPN on mortality. Uncontrolled sepsis is still the most common cause of mortality, and TPN does not alleviate this problem [1]. The improvement in mortality rates over the past 20 years may also be attributed to the general improvement in other forms of supportive care. Undoubtedly, the greatest contribution TPN has made, as stated by Reber et al. [7], is the simplification of nutritional management for patients with enterocutaneous fistulas. TPN has allowed better timing for operative intervention when required, improved the nutritional status of patients undergoing reoperation, and increased the rate of postoperative recovery.

TPN should be started early, after volume, electrolyte, and clotting deficits have been corrected and sepsis is under control. It is administered through a central venous catheter, most commonly placed in the subclavian vein. Alternatively a percutaneous, intravenous central catheter (PICC) via the antecubital fossa may be used. The nutritional goal is 30 to 40 kcal/kg/day with a calorie-nitrogen ratio of 150:1. Approximately 0.25–0.35 g of nitrogen per kilogram of body weight per day is necessary to maintain a positive nitrogen balance. It may be given daily with a concomitant reduction in glucose solution to patients with diabetes, congestive heart failure, or chronic obstructive pulmonary disease to decrease the glucose load, the volume of administration, and carbon dioxide production. In addition, trace elements, multivitamins, and vitamin K must be given weekly.

Initially, patients must be watched closely for fluid and electrolyte balance by monitoring daily weights, hydration status, and serum electrolyte levels. All electrolytes can be replaced through TPN except for large amounts of calcium and phosphate, which may be limited by solubility. The potassium level may fluctuate markedly, and since replacement solu-
tions are limited to 80 mEq/L, use of a supplemental line or oral administration may be required. Magnesium, an important electrolyte for energy-requiring processes, is often overlooked [30]. Low levels of magnesium are associated with large losses of gastrointestinal fluid and may make hypocalcemia resistant to treatment.

**Enteral Nutrition**

TPN has become the mainstay of nutritional therapy for patients with enterocutaneous fistulas; however, enteral nutrition may also play a role. There has recently been a renewed interest in enteral feeding for selected patients with enterocutaneous fistula. Potential advantages of enteral nutrition include improvements in hepatic protein synthesis, gut mucosal integrity, and immunological competence. Complete nutritional support with enteral feeding is possible in selected patients. In most cases TPN is necessary initially to stabilize the patient and establish positive nitrogen balance. In selected cases TPN must be continued to maintain an anabolic state because only a portion of the necessary calories can be given enterally.

Enteral nutrition in the form of low-residue diets has been shown experimentally [35] and clinically [36] to significantly decrease fistula output, although to a lesser extent than TPN. Low-residue diets are relatively low in cost, simple to administer, and require very little special equipment or preparation. In addition, they help to preserve gut integrity [37]. Unfortunately, low-residue diets have limited application in gastroduodenal and upper small bowel fistulas unless the diet can be delivered to a point distal to the fistula. With distal small bowel or colonic fistulas, low-residue diets may be tolerated quite well, because an adequate length of small bowel will affect complete absorption. At least 4 ft of functioning bowel must exist between the ligament of Treitz and the fistula or between the fistula and the ileocecal valve to allow adequate absorption.

Low-residue diets should not be used in patients with sepsis or peritonitis. Adynamic ileus, intra-abdominal abscess, and distal obstruction must also be ruled out prior to the initiation of enteral feeding. The diet can be administered through a nasogastric tube, a nasoduodenal tube, a feeding jejunostomy, or a needle-catheter jejunostomy (elemental diets only). Tube placement should always be checked either visually (at surgery) or radiographically before feeding is started.

Elemental or low-residue diets are hyperosmolar and should be administered by continuous infusion to minimize cramping and dumping. Initially the diet should be diluted to half strength and administered at a rate of 50 mL/hr because the upper small bowel cannot tolerate hyperosmolar infusion. When the small bowel is being used, the rate should be increased before osmolarity. In some patients the small bowel may not tolerate more than half-strength enteral feed and supplemental TPN will be required [37].

Very few series have involved the use of enteral nutrition exclusively. Bury et al. [36] reported a 54% spontaneous closure rate and a 14–80%
decrease in fistula output. Voitk et al. [38] reported a 75% rate of spontaneous closure and a fistula-related mortality rate of 16%. Recent studies evaluating “immune-enhanced” enteral formulas suggest a decrease in infectious complications and may be indicated in a group of high-risk, complex patients [31].

**Somatostatin**

Several studies have described the use of somatostatin to decrease fistula output in patients with enterocutaneous fistulas [39–41]. The proposed mechanism of action is a reduction in gastrointestinal secretions, primarily through the inhibition of gastrin, gastric acid, biliary flow, pancreatic output, and intestinal secretions. Somatostatin also is believed to inhibit gastrointestinal motility, thus increasing intestinal transit time [40]. The definitive role of somatostatin in the treatment of patients with fistulas is unclear at this time as no prospective studies have demonstrated an increased rate of fistula closure with its use.

In a review of 175 patients treated with native somatostatin and TPN, the overall spontaneous closure rate was 78%, with a mean closure time of 7 days [40]. However, side effects with native somatostatin are numerous; they include hyperglycemia and rebound phenomena upon discontinuation of the drug. Somatostatin analogue has demonstrated neither of these side effects. Nubiola et al. [40] treated 27 patients with enterocutaneous fistulas by using long-half-life somatostatin 201-995 analog. Within 24 hr of administration, fistula output was dramatically reduced (mean reduction of 55%). Of 27 patients, 21 experienced spontaneous closure at a mean of 6 days (3–10 days). All six failures involved high-output fistulas; one patient died of continued sepsis, and the remaining five had an anatomical reason for nonclosure demonstrated at surgery (three complete anastomotic disruptions and two distal obstructions). Mean spontaneous closure in a previous group of patients treated with TPN alone was 3–5 weeks. The most encouraging results occurred with high-output small bowel fistulas in which the addition of long-acting somatostatin analog increased the spontaneous closure rate from 50–90%.

Somatostatin analogue seems to be most effective in postoperative, high-output fistulas. Its primary effect seems to be shortening of the time to closure. It has no effect on fistulas that are anatomically incapable of closure and does not appear to be effective in the treatment of fistulas related to intrinsic intestinal disease such as Crohn’s disease and ulcerative colitis [42]. In fact, some authors do not recommend somatostatin and octreotide in the treatment of intestinal fistulas outside of clinical trials [43].

**Fibrin Glue**

Many different substances have been injected into fistula tracts to obliterate them. Cyanoacrylate glue, prolamine, and, most recently, fibrin glue all have been used [44–46]. The most successful agent to date appears to be fibrin glue. It is applied endoscopically if the internal origin can be visualized.
The tract is irrigated clear and the patient is given pre- and postoperative antibiotics. Aprotinin, a fibrinolysis inhibitor, is added to the solution to reduce enzymatic breakdown. In 1990, Eleftheriadis et al. [46] reported on seven patients with high-volume postoperative enterocutaneous fistulas who were treated through endoscopic application of fibrin glue in the second postoperative week. There were no complications, and an average of 2.4 sessions were required to close the fistulas. The mechanism of action appears to center around the ability of fibrin to induce a cellular response to injury and to assist in neovascularization and fibroblast proliferation.

When the intestinal opening cannot be identified, the tract can be visualized percutaneously by using a flexible endoscope, as described by Lange et al. [45] in 1990. Eighty-three patients were prepared with systemic antibiotics, and the fistula tracts were irrigated with streptokinase and streptodornase. The endoscope or fistuloscope was advanced along the fistula tract, and fibrin glue was injected to obliterate it. Of 48 patients who underwent a gastroscopic or colonoscopic approach, 36 had successful occlusion of their fistulas. An additional 16 of 35 patients had successful closure after fistuloscopy and percutaneous obliteration. One patient died of air embolism and another had pneumoperitoneum secondary to air insufflation. Air insufflation is not currently performed because the tracts are usually mature enough to remain open for visualization. Patients with an opening >2 cm in diameter or extensive necrotic masses were excluded from treatment. Treatment failure occurred in fistulas <1 cm long, fistulas arising in irradiated tissue, fistulas associated with active Crohn’s disease, and fistulas that could not be completely obliterated with sealant.

Fistula obliteration with fibrin glue is a promising new option for the nonoperative treatment of fistulas. Whether it should be used in conjunction with other conservative therapy or reserved for high-risk patients who have failed conservative therapy remains to be determined. The use of minimally invasive techniques using occlusive agents to attempt fistula closure has shown promising results. In a recent study, closure of abdominal-cutaneous fistula tracts by occlusion with a modified VasoSeal collagen plug shows promise in the management of low-volume fistulas refractory to catheter drainage and other conservative approaches [47].

**Outcome of Conservative Therapy**

Overall, spontaneous closure can be anticipated in 60–70% of fistulas [3, 7,8,19], depending on anatomy, etiology, and concurrent sepsis. Simple type 1 fistulas have the highest success rate, with reported closure rates approximating 90% [3]. In contrast, complex type 2 fistulas have the lowest rate of spontaneous closure, at less than 10% [2,3]. Fistulas arising secondary to intrinsic disease processes also have very low rates of spontaneous closure when compared to postoperative fistulas. Reber et al. [7] reported spontaneous closure rates of only 8, 26, and 14% in patients with Crohn’s
disease, cancer, and radiation, respectively. Similar results were reported by Rose et al. [19].

Fistulas occurring in patients with Crohn’s disease can be subdivided into two types according to etiology [21]. Those fistulas secondary to spontaneous extension of active disease have a very low rate of spontaneous closure (10%), whereas those occurring secondary to leakage of an anastomosis usually close with conservative management (86%).

In a multivariate analysis to determine prognostic factors in gastrointestinal fistulas, Campos et al. [6] concluded that the likelihood of spontaneous fistula closure is higher for fistulas with surgical causes, low output, and no complications. Mortality is higher in patients with complications and with high-output fistulas.

Phase 4: Decision/Definitive Surgery

The decision to proceed with definitive surgical reconstruction should be carried out only after the patient is stable, nutritionally replete, and free of infection and an appropriate plan has been developed.

**Indications and Timing of Definitive Surgery**

Simple and Complex Type I Fistulas  It cannot be overemphasized that control of sepsis must be the number one priority in the management of an enterocutaneous fistula. Control of sepsis must be undertaken as soon as it is recognized during the course of management and must be sought and treated in phase 1 and/or phase 2 of management. Definitive surgery for the fistula should not be attempted at this time. Once sepsis has been controlled, a persistently draining fistula in a sepsis-free environment for 6–8 weeks constitutes an indication for definitive surgical repair of simple and/or complex type I fistulas as long as the patient is both metabolically and nutritionally stable. Reber et al. [7] documented that 90% of fistulas that close spontaneously will do so within 1 month of control of sepsis, but less than 10% will do so in the second and third months after sepsis control. Hence the investigators concluded that there is no reason to delay definitive surgery beyond 3 months after control of sepsis. One possible exception is the low-volume distal fistula with progressively diminishing output in a patient who shows continuing clinical improvement. Therefore good clinical judgment is important, and definitive surgical therapy must be individualized for the patient’s circumstances. On the other hand, early surgical intervention may be indicated in certain situations that make the fistula unlikely to close. The two most commonly cited reasons are discontinuity of the bowel ends and distal obstruction [5,7]. Active Crohn’s disease, abdominal irradiation, malignancy, and a short tract (<2 cm) also constitute reasons for earlier surgery [7,22].

Even when earlier surgical treatment is indicated, it is best to delay surgery for a minimum of 6 weeks, because it has been well documented
that obliterative peritonitis follows many major procedures, particularly those associated with fistulization. This process is most likely to occur from 10–21 days after surgery and persists for 6–8 weeks [25]. The dense, woody adhesions make dissection extremely hazardous and multiple enterotomies frequently occur, which may compound the patient’s problem. Fazio et al. [4] have reported that although the fistula cure rate did not change whether the surgery was done after less than 10 days, 10–42 days, or more than 6 weeks, the mortality was significantly higher in the middle period (21%). This rate was compared to a 13% mortality when surgery was done before 10 days and an 11% mortality when 6 weeks were allowed to pass. Therefore definitive surgery should be delayed for at least 6 weeks. However, there are instances in which very early surgical intervention (less than 10 days) is indicated, when the abdomen can be re-entered before sepsis becomes established and before the obliterative adhesive process develops [4].

The timing of surgical intervention may also be influenced by the status of the abdominal wall. It is preferable to delay elective surgery until the abdominal wall is soft, supple, and not inflamed. This situation generally can be appreciated by palpation and inspection.

The site may have some bearing on spontaneous closure and the indication and timing of the definitive surgery. MacFadyen et al. [9] reported spontaneous closure in 100% of duodenal fistulas, 88% of jejunal fistulas, 79% of colonic fistulas, but only 40% of fistulas arising from the ileum.

Complex Type 2 Fistulas  Guidelines to the indications for and the timing of surgical treatment for simple or complex type 1 enterocutaneous fistulas, as outlined earlier, should not be applied to the more complex fistulas, in association with which mortality rates of 25–50% are commonly reported [4,48]. Complex type 2 fistulas (those associated with large abdominal wall defects) constitute a major challenge to the surgeon and the management team. The indications for and the timing of definitive surgical intervention differ from those associated with simple enterocutaneous fistula because of the complexity in this seriously ill group. Whereas 30–80% of simple and complex type 1 fistulas can be expected to heal spontaneously within 6 weeks, a complex type 2 fistula almost invariably requires definitive surgery at some juncture.

Conter et al. [49] reported on a series of 51 patients with complex enterocutaneous fistulas managed by delayed reconstructive surgery; they noted a mortality of 4% and overall restoration of gastrointestinal continuity in 94%. Conter et al. stressed that in their opinion “the single most important factor is delaying of definitive surgery for an extended period of time.” In this report, the mean time from fistula recognition to definitive operation was 4.2 months (range of 10 weeks–13 months).

Guidelines for the timing of surgery for complex fistulas are not well defined because few published reports address this important question. Nu-
tional and metabolic status should be normalized and immunocompetence restored, and adequate time should be allowed for the obliterative peritonitis to resolve. Since the majority of patients with complex fistulas have had considerable peritoneal contamination and inflammation, a longer time is generally required for this reaction to resolve. The abdominal wall should be soft and pliable to palpation, in contrast to the woody induration suggestive of an ongoing inflammatory process. Conter et al. [49] suggested digitalizing any existing stoma, if available, in order to further clarify abdominal status. By judicious individualized timing of appropriate surgery, successful reconstruction with acceptable morbidity and mortality in these complex fistulas can be achieved.

**Definitive Surgery**  This discussion deals with definitive surgery and treatment in patients who have persistent fistulas despite adequate conservative measures. The optimum timing of such surgery has already been addressed.

**Simple Fistulas**

**SMALL BOWEL (JEJUNUM AND ILEUM)** Small bowel resection of the fistula segment with primary anastomosis is the treatment of choice [7,25] (Fig. 12). Success rates of 90% can be achieved [7]. Any temptation to try direct suture repair should be avoided, because Reber et al. [7] have reported that this method failed in 41% of 32 patients in whom it was tried. In some instances, dissection of the entire length of the small bowel and resection of the diseased segment is not safe, and a bypass or exclusion procedure should be considered (see “Special Considerations,” below).

After induction of anesthesia, a Foley catheter is inserted and the abdomen is prepared. Every attempt should be made to exclude the draining fistula site from the main operative wound. This exclusion can be accomplished by suture closure of the skin or by an exclusion barrier (e.g., Opsite or Vidrape) or another similar method. The abdomen should be opened through the old scar, but first it should be entered through an uninvolved area in longitudinal continuity with the original scar. This area often is located in the upper midline. Such entry minimizes the chances of small bowel injury to the potentially densely adherent loops that are expected to be present under the old scar. Once entry has been accomplished, Metzenbaum scissors are used to dissect the small bowel from under the old incision, which is extended as the bowel is cleared. The intent should be to divide all the adhesions and to free the small bowel in its entirety. This process may be tedious and time-consuming, and extreme care should be taken to avoid further injury to the small bowel.

Once the fistula site has been encountered, it is cut across at the level of the abdominal wall. Spillage from the opening in the small bowel should be controlled by temporary direct suture. A loop of small bowel is sought for beginning the dissection to separate the loops and free the small bowel...
The operation of choice for a simple fistula is resection and primary end-to-end anastomosis. Resection of the segment of small bowel is then performed back to soft, pliable intestine on either side of the fistula. At this point distal obstruction should be ruled out. In many cases such obstruction can be reasonably determined through inspection and palpation of the small bowel. However, in those instances where doubt may exist, a Baker tube can be used to aid in identifying an occult obstruction. Once the tube has been passed distally, the balloon is inflated and the tube gradually withdrawn, with any sites of narrowing noted. If such sites are found, the obstruction should be relieved by either strictureplasty or resection. In some instances enteroscopy with a colonoscope passed transanally, cannulation of the ileocecal valve, and examination of the small bowel directly may be of value. This procedure necessitates that the patient be placed in the modified lithotomy position with the legs in the Allen stirrups at the outset. Once distal obstruction has been ruled out, primary anastomosis of the small
bowel can be accomplished. We prefer a one-layer 4–0 silk hand-sewn anastomosis. Alternatively, a functional end-to-end stapled anastomosis can be used.

In most cases an extensive dissection has been necessary and prolonged postoperative ileus occurs. Consideration should be given to performing a Stamm gastrostomy to avoid prolonged nasogastric intubation and patient discomfort. The abdominal cavity is irrigated with saline and hemostasis is checked and secured. The abdominal wall fistula tract is debrided and usually left open. Alternatively, the internal aspect at the peritoneal level can be sutured closed with 2–0 polyglycolic acid suture. The abdominal wall is then closed in the usual manner.

TPN is continued during the postoperative period. Suction is maintained on the gastrostomy until flatus or stool is passed. At this point the gastrostomy tube can be clamped and intermittently irrigated for patency. Oral fluids can be started, and the patient’s diet can be advanced as tolerated. When sufficient oral nutrition can be maintained, TPN is discontinued. It is best to retain the gastrostomy tube for at least 2 weeks after discharge or until the patient is thriving without complication.

**DUODENAL FISTULAS** Duodenal fistulas present a different management problem. Anatomical considerations make simple resection and anastomosis infeasible in most cases. Spontaneous closure rates vary from 37–100% [7,9,50]. Overall mortality is 18–35% [7,50]. Two types of fistulas occur: (1) end duodenal fistulas, which are almost invariably a complication of duodenal stump leakage after a Billroth II anastomosis, or (2) lateral duodenal fistulas of the second, third, or fourth part of the duodenum. End duodenal fistulas usually have low output; with adequate drainage, they should heal spontaneously [22]. Rarely, such fistulas may require a serosal patch or Roux-en-Y duodenal jejunostomy. Lateral duodenal fistulas of the second portion usually have high output and rarely close spontaneously. They are associated with increased mortality and most require operative management [22]. The operative treatment of choice is the application of a serosal patch [25]. If one-half to two-thirds of the duodenal circumference is intact, a Roux-en-Y jejunal patch is preferred by Malangoni et al. [51] and Wolffman et al. [52]. If, however, less than one-half of the circumference is present, a Roux-en-Y jejunal end-to-end or end-to-side anastomosis is performed to avoid stenosis [52]. When a fistula arises from the third or fourth portion of the duodenum, the segment can usually be mobilized and resected and an end-to-end anastomosis in front of the superior mesenteric artery achieved [25]. Very rarely, a Whipple pancreaticoduodenectomy is needed for a complicated duodenal fistula [50].

Complex Type I Fistulas The general approach to definitive surgery for a complex type 1 fistula (initially associated with intra-abdominal abscess) is identical in most respects to that of a simple fistula. In fact, many
complex type 1 fistulas have been converted to simple fistulas by earlier control of sepsis, either by percutaneous drainage or by laparotomy drainage of the abscess and proximal diversion. The goal of surgical treatment should be to resect the small bowel segment with primary reanastomosis and closure of the proximal stoma when present. The same technique and principles as previously outlined are followed. Dense adhesions of small bowel loops are likely to be present at the site of the previously drained abscess. If the timing of the surgery has been appropriate, these adhesions can usually be separated with preservation of small bowel. Occasionally small bowel is so adherent and indurated that an additional adjacent segment may require resection. Once distal obstruction has been ruled out, the anastomosis can be performed. If all aspects of the procedure have been uneventful, the proximal stoma, if present, can be safely closed at this time. If, however, the circumstances of the primary anastomosis have been less than ideal, the stoma can be left standing and can be closed at a later date once healing has been ensured.

Complex Type 2 Fistulas Complex fistulas, particularly those associated with a large abdominal wall defect, rarely close spontaneously (7–10%) [3,49]. They carry a mortality of 50–60% [3,15]. In a series by Schein and Decker [15], the mortality was almost threefold that of the other forms of fistulas. Sitges-Serra et al. [3] defined these more serious fistulas as being associated with an abdominal wall defect >20 cm². These complex fistulas occur as a result of (1) major wound dehiscence secondary to underlying intra-abdominal wall sepsis and intestinal leakage or (2) a laparotomy as a planned procedure in order to control massive intraperitoneal sepsis. Of 45 fistulas associated with a major abdominal wall defect, Schein and Decker [15] reported that 25 were caused by spontaneous dehiscence, whereas 20 were the result of an open wound management policy.

A common pathophysiological mechanism is illustrated by the following example. A patient sustains an anastomotic leak with massive peritoneal contamination and then undergoes repeated laparotomies in an attempt to control sepsis. The obliterative peritonitis is compounded by the repeat laparotomies, and further small bowel injury often ensues. The abdominal wall becomes edematous and often infected, and attempts at closure under tension result in wall necrosis. Increased intra-abdominal pressure secondary to ileus and fluid accumulation further compounds the process. Draining intestinal juices digest the anterior bowel wall. Eventually dehiscence occurs, leaving the fistula and multiple loops of small bowel exposed. This situation is the mark of a true surgical disaster. It is often the result of injudicious management of intra-abdominal infection at the initial insult.

Those patients who have undergone a planned laparostomy usually benefit from adequate control of sepsis, but the open method contributes to the development of a type 2 fistula. Nevertheless, such patients may well have been salvaged by this treatment method.
Patients with complex type 2 fistulas present a demanding therapeutic challenge to the surgeon and management team. Surgical management is described here through a two-phase plan—initial control and late reconstruction.

INITIAL CONTROL  Proximal gastrointestinal diversion in an area remote from the abdominal wall defect is the ideal initial surgical therapy, but such diversion may be very difficult to achieve. Some authors have advocated exteriorization of the ends of the fistulized bowel or exclusion bypass. Although these approaches may be ideal if they can be achieved, they are often not possible because the bowel is edematous and distended and the mesentery is commonly foreshortened. Schein and Decker [15] have emphasized that multiple fistulas at the base of the defect may be better left undisturbed rather than risking resection of an undefined mass. They have stated that a proximal jejunostomy, even if done at a point just distal to the ligament of Treitz, is tolerated reasonably well, and that the surgeon should not rule out high proximal jejunal diversion for fear of unknown consequences. If a fistula associated with a large abdominal wall defect is close to the surface and properly walled off from the remainder of the peritoneal cavity and sepsis is under control, such situations may not need proximal diversion; a creative draining collection system may suffice to control output until definitive restorative surgery can safely be performed.

When a large open wound defect is present, some authors advocate initially covering the defect with mesh and later with a split-thickness skin graft for definitive coverage [15]; others have advocated the use of pedicle flaps [53]. In our experience, neither coverage method is routinely necessary; most such wounds can be allowed to granulate and contract.

LATE RECONSTRUCTION Once initial control of a fistula in association with a dehisced or open wound has been achieved, definitive reconstructive surgery should be delayed for several months and sometimes for as long as 1 year. This delay allows for adequate resolution of the extensive inflammatory process and improves the likelihood of successful reconstruction. The 6-week guideline for simple or even complex type I fistulas is not appropriate for the more difficult problems posed by complex type 2 fistulas.

Conter et al. [49] reported on a series of 51 patients with complex fistulas (15 patients, or 29%, had large abdominal wall defects; 36 patients, or 71%, had either multiple or recurrent fistulas) managed by a policy of delayed reconstructive surgery. The mean time to definitive surgery was 4.2 months. Spontaneous closure occurred in 5 of the 51 patients (10%); 46 patients, therefore, underwent reconstructive surgery, 38 by resection and anastomosis (3 recurrences, 2 of which closed spontaneously), 5 by simple diversion, and 3 by fistula takedown and repair (two of which recurred). Morbidity was 57%, fistula-related mortality was 4%, and gastrointestinal continuity was restored in 94%.

The authors attribute their excellent results to this delayed approach. Fazio et al. [4] reported on four patients with multiple fistulas and severe
sepsis who were treated by urgent surgery and proximal diversion with wide open drainage and delayed reconstructive surgery. All four patients were successfully managed and eventually had gastrointestinal continuity restored.

Complex type 2 fistulas, while presenting a formidable challenge, can be managed successfully by initial aggressive therapy, including adequate control of intra-abdominal sepsis and control of fistula output in conjunction with nutritional and adjunctive metabolic support, followed by judiciously timed, delayed reconstructive surgery.

Special Considerations

CROHN’S DISEASE AND EXTERNAL FISTULAS One of the features of Crohn’s disease is the propensity to fistulization. Spontaneous closure with active Crohn’s disease is unlikely. Driscoll and Rosenberg [54] noted that 10 of 11 patients with active Crohn’s disease who had enterocutaneous fistulas required surgical treatment. In an initial report by the Birmingham group [21], who reported on 39 Crohn’s external fistulas, 9 postoperative fistulas involving no active disease closed spontaneously with medical treatment. In contrast, all 30 patients with active Crohn’s disease required surgical resection. In a subsequent report, this group found that only 7 of 24 postoperative fistulas closed spontaneously; they concluded that surgical resection and anastomosis is the best option when surgery is required [24]. Attempts at simple closure of the fistula in 4 patients resulted in abscesses in 3. Of 3 patients treated with strictureplasty, 2 developed leaks. Of 20 patients with Crohn’s disease and spontaneously occurring fistulas, spontaneous closure occurred in only 1. Therefore surgical resection is almost always advised for fistulas associated with active Crohn’s disease. In most situations, anastomosis can be done primarily, although in some patients with extensive concomitant intra-abdominal sepsis, the creation of a proximal stoma may be prudent. Results of strictureplasty in active Crohn’s disease with enterocutaneous fistulas were poor (only one of three was successful).

RADIATION-INJURED BOWEL When an enterocutaneous fistula arises from irradiated bowel, the ordinary guidelines for definitive surgery do not apply. The irradiated bowel is usually encased in dense adhesions, with a frozen pelvis. In such instances resection with primary anastomosis is either not feasible or not safe. Therefore the most distal portion of nonirradiated small bowel should be divided, leaving the distal end closed and the proximal end anastomosed to the transverse colon as a bypass procedure (Fig. 13). Lui et al. [55] have reported on the successful use of vascularized muscle flaps from a distant nonirradiated field to achieve safe repair of bowel defects in three refractory enterocutaneous fistulas associated with radiation injury. The role of this adjunctive procedure has not yet been established. Bypass for most enterocutaneous fistulas arising from irradiated small bowel is the treatment of choice [25].
MALIGNANCY When an underlying malignancy exists with an entero-cutaneous fistula, there is no hope of spontaneous closure and operative therapy is required. If possible, a standard cancer operation should be performed, with wide en bloc excision of the fistula tract and any adjacent organ structures in continuity with it. It is not possible to tell whether such adherence is secondary to neoplastic invasion or solely inflammatory. If widespread metastatic disease is evident, palliative resection or bypass may be all that is possible. Soeters et al. [1], in a review of 100 enterocutaneous fistulas at the Massachusetts General Hospital between 1960 to 1970, found that 26 fistulas (26%) were associated with cancer, 12 occurring spontaneously and 14 postoperatively.

COLOCUTANEOUS FISTULAS In general, colocutaneous fistulas are low-output fistulas associated with fewer nutritional and metabolic consequences to the patient than other types; therefore they are usually are tolerated reasonably well. There is some discrepancy in the literature about the rates of spontaneous closure and hence the timing of surgical intervention. Sitges-Serra et al. [3] reported spontaneous closure in 11 of 12 colocuta-
neous fistulas with 0% mortality. They noted, however, that 20–25% required some form of surgical intervention to achieve adequate drainage of the abscess or fistula site. In contrast, Schein and Decker [15] reported on 15 patients with colocutaneous fistulas in whom surgical intervention (usually in the form of dismantling of the disrupted anastomosis) was necessary in 60%. Mortality in this series was 20%. However, it may not be valid to compare these two series because it is likely that they involve two different presentations of colocutaneous fistulas. Sitges-Sera et al. [3] stated that colocutaneous fistulas generally occur late, suggesting that in their series most fistulas were likely leaks, initially confined, that found their way to the wound after being initially walled off. In a series by Schein and Decker [15], the patients had diffuse fecal peritonitis; hence the differing results both in mortality and spontaneous closure rates.

For established colocutaneous fistulas, some authors have reported high spontaneous closure rates, ranging from 75–79% [9,16]. In contrast, however, Zera et al. [56] reported only a 20% spontaneous closure rate and therefore advised early surgery. Doglietto et al. [57] also reported that in their experience only 25% of colocutaneous fistulas closed spontaneously, in contrast to a 73% closure rate for upper gastrointestinal and small bowel fistulas. They also favored an early surgical approach for large bowel fistulas. Fazio et al. [27] reported on 93 colocutaneous fistulas associated with diverticular disease; 88 fistulas developed postoperatively, whereas 5 were spontaneous. Of the total, 92 patients were treated surgically, 80% by one- or two-stage resection and anastomosis. Morbidity was 48%, with one mortality. Surgery was successful in achieving closure in 77% of patients. Crohn’s disease was diagnosed in 10 of the patients with complicated and persistent fistulas.

Although there is no unanimity in the literature about the likelihood of spontaneous closure, it is generally agreed that a contained colocutaneous fistula is well tolerated by the patient and a reasonable period of time should be given to allow closure. If closure has not occurred by 6 weeks after control of sepsis and fistula has been achieved, surgical intervention should be considered. The goal of surgery is one-stage resection and primary anastomosis after complete mechanical and antibiotic bowel preparation.

RECENT ADVANCES
Role of Minimally Invasive Surgery

Recent advances in instrumentation and accumulated experience have made minimally invasive surgery an alternative approach in handling complex surgical problems even in the setting of enterocutaneous fistulas. Although conversion rates may be higher, various reports are showing that minimally invasive surgery is feasible, with acceptable morbidity, especially in the
management of lower gastrointestinal fistulas [58,59]. Vacuum-assisted closure is being used increasingly as an adjunct for the medical management of complex cutaneous gastrointestinal fistulas when the fistula is draining into an open healing wound. This is a subatmospheric pressure technique that has been demonstrated both clinically and in the laboratory to enhance wound healing [60,61].

Recent studies with the monoclonal antibody infliximab have shown promising results in the treatment of enterocutaneous fistulas, especially those associated with Crohn’s disease. Its mechanism of action is based on the premise that the local production of tumor necrosis factor alpha (TNF-α) plays a key role in the initiation and propagation of Crohn’s disease. Infliximab binds to the precursor of TNF-α and inhibits the broad range of biological activities of TNF-α thereby helping in the healing of the fistulas [62].

SUMMARY

External fistulas, whether simple or complex, present a significant challenge to the gastrointestinal surgeon. A team approach is essential. With careful attention given to basic surgical principles and good judgment on the part of the surgeon, most patients can be restored to health and gastrointestinal continuity can be re-established.

REFERENCES

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INTRODUCTION

Enterocutaneous fistulas may occur secondary to anastomotic leaks, malignancy, radiation, diverticulitis, inflammatory bowel disease, trauma, and foreign bodies. Comorbidities may also be present, such as malnutrition, chronic disease, and diminished emotional resources. The clinical course ahead offers little hope of immediate relief for the patient, as an aggressive approach is warranted to control sepsis, deliver nutritional support, restore fluid and electrolyte balance, and control the fistula. Additionally, the presence of a fistula represents a socially unacceptable breach in the body’s integrity, over which the patient has little control. It is a formidable complication to be managed in addition to the underlying medical diagnosis. Anger, frustration, embarrassment, anxiety, and/or shame are common reactions among patients.

Nursing management of cutaneous gastrointestinal fistulas is best characterized as complex and dynamic. The technical, educational, and emotional support required to manage these patients represents one of the most difficult challenges in wound care. A high degree of flexibility and collaboration with the multidisciplinary team is required in attempting to achieve the desired outcome of providing a measure of control for the patient until the fistula spontaneously resolves or is surgically closed. As could be predicted, the level of evidence that supports methods of topical care is based upon individual case reports and expert opinion. Commonly, these reports provide a discussion of principles originating from skin and ostomy care followed by a detailed description of technique. Case reports referenced in this chapter demonstrate these attributes. This chapter empha-
sizes principles and techniques of cutaneous fistula management while recognizing that patient education and emotional support must also be provided.

CLINICAL GOALS

A fistula represents an uncontrolled, negative occurrence. However, nursing management should not duplicate this state. The trial-and-error approach to nursing care is part of a history long since replaced by effective interventions based on a sound rationale. During the stabilization phase of fistula management, early attention to skin care, output monitoring, odor control, and patient support are essential. Complications can be prevented (or limited) by early intervention.

The five primary goals in the nursing management of patients with enterocutaneous fistulas are to (1) maintain or restore periwound skin integrity, (2) contain effluent, (3) control odor, (4) support the patient, and (5) contain costs [1]. Achieving these goals simultaneously may not be possible; therefore prioritizing may be necessary. For example, in some situations, containment of effluent is achieved, but only at high cost.

PATIENT ASSESSMENT

A focused assessment is completed to identify biopsychosocial aspects and determine the patient’s support system. An abdominal assessment is accomplished to determine cutaneous characteristics of the fistula, abdominal topography adjacent to the opening, and the condition of periwound skin. The following assessment parameters provide the basis for planning care.

Source

Therapeutic approaches to manage odor, protect skin, and contain output are based on knowledge of the fistula source. If diagnostic studies are pending, the source may not be known. However, clinical judgment will usually provide a close approximation. For example, a fistula with low-volume, gassy, malodorous output is probably of colonic origin (Fig. 1). When planning care for this patient, protection of the skin is provided, but the primary problem to address would be odor control.

Duration

Fistulas may be recent in onset or may represent a long-standing problem. Identifying how long the patient has had the fistula helps to predict the possibility of spontaneous closure. If a fistula, even when properly treated,
has been present for months, the fistula tract is epithelialized and generally will not close spontaneously. When surgery is not an option, supportive care becomes the focus. Knowledge of duration of the fistula also is helpful in planning patient education and psychological support. The newly diagnosed patient has a knowledge deficit, initial fears, and anxiety—all of which are important clinical issues. For long-term situations, both patient and family may need assistance with nursing care at home and often with the management of anxiety or depression.

Characteristics

The cutaneous opening of a fistula is frequently large and irregular. To calculate the size, the widest ranges of length and width are used and, if multiple openings are present, the size of each is measured and documented. The depth of the site is measured to the visible base of the fistula. Because of the unique physical characteristics of fistulas, it is routine to see the size of the wound (i.e., length, width, and depth) accompanied by a sketch of the cutaneous opening in the patient chart.

Function and output are also identified and documented. Estimated volume and composition of the effluent provide essential information for key decision points in management. Time of day of the fistula function is useful to know in establishing schedules for dressing and pouch changes. Most patients with fistulas are NPO and receiving total parenteral nutrition, thereby decreasing fluid and electrolyte losses as well as decreasing the volume of fecal output and the amount of gastrointestinal stimulation. However, in other situations, patients may be taking nutrition by mouth. Deter-
mining patterns of fistula function in these patients is particularly important to effective and efficient pouch changing procedures.

The type of output from the fistula will indicate how aggressive peri-wound skin protection must be as well as the most appropriate type of emptying spout. Effluent from a colocutaneous fistula presents minimal risk of skin maceration, as no active enzymes are present to denude tissue. In these cases, the skin may be managed by protectants, such as ointments. However, in the presence of proteolytic enzymes from small bowel contents, a solid-form skin barrier, paste, and pouching system are recommended to protect skin and contain effluent. When effluent is semiformed or viscous, a drainable pouch with a wide spout that is considered a fecal pouch is selected.

Abdominal Topography

Assessment of the abdomen is performed with the patient supine, sitting, and standing. The ideal skin surface for management is flat, extending for approximately 3 in. around the fistula opening on the skin. However, fistulas are rarely found in ideal locations. They emerge within incisions; proximal to bony prominences, stomas, scars or the umbilicus; or under abdominal creases and fat folds (Fig. 2). Unlike the well-constructed stoma, which is properly sited on the abdomen with good protrusion (2.5 cm), the fistula lacks the benefit of preplanning. Its opening is usually flat or recessed; both of these characteristics are problematic and will require the use of additional skin barriers to fill areas and level the skin if pouching is used.

Figure 2  Enterocutaneous fistulas shown here are located in a midline incision with an ileostomy and mucous fistula.
Abdominal muscle tone is also assessed. If a pouching system is to be used, this characteristic will affect the degree of support required in the system. Distinction between a firm, soft, or flaccid abdomen is made in order to determine the level of support needed to stabilize the pouching system on the abdomen.

Periwound Skin

Integrity of the skin is assessed within a 3-in. area around the fistula opening. Initially, fistulas present with erythema and tenderness in this area, with the skin subsequently erupting to form a draining wound. Once the fistula occurs, skin is at risk. Maceration is the result of skin bathed by moisture. Skin denudation or erosion occurs secondary to the presence of active proteolytic enzymes in contact with the skin (Fig. 3). However, these processes are also observed secondary to trauma caused by the frequent removal of dressings. When periwound skin is compromised, reassessment of the current approach is warranted and restorative measures are begun.

Odor

Initial assessment should differentiate between the odor of dressings in need of change and the odor of stool. The presence of odor will vary depending on the type of effluent. On occasion, the primary rationale for using a pouch will be to contain odor.

Figure 3  Periwound skin denudation secondary to effluent in contact with skin.
**Pain**

Once the fistula has opened, drainage from the site is usually not painful. Pain is usually associated with periwound skin dermatitis or generalized abdominal discomfort from surgical procedures, abscess, or dressing changes. A pain scale is used to assess the level of pain and, if the pain is associated with procedures, premedication is necessary.

**Emotional Support**

Consistent, effective fistula management is the first step in regaining a sense of control for both the patient and the care team. However, beyond these issues, patients and their significant others have informational and emotional needs. Assessment of the patient’s knowledge may be as simple as determining whether he or she understands the terminology, anatomy, medications, and rationale for the treatment being given. Effective coping strategies are evident when the patient seeks answers, expresses concern, and participates in problem solving. Emotional support and education are two sides of the same coin. They may be required over the long term for these patients and are best provided by a multidisciplinary team.

**MAINTENANCE AND RESTORATION OF PERIWOUND SKIN INTEGRITY**

The presentation of a fistula merits aggressive, early skin protection in all patients but particularly in those with additional risk factors such as age, radiation, immunosuppression, malnutrition, and primary skin disorders. Maintaining the integrity of periwound skin is similar to the techniques used in caring for peristomal skin. Appropriate selection and use of adhesives is required. Gentle adhesive removal is performed in the direction of hair growth with a soft tissue and water or a commercially available skin solvent. Cleansing the skin, again, is accomplished by nontraumatic methods, such as use of a soft tissue and tap water or a commercially available skin cleanser. The skin is then allowed to dry prior to application of a dressing or pouching system. When the skin is at risk, a skin protectant product is needed (i.e., skin sealant, barrier, ointment).

Restoration of skin integrity requires knowledge of common dermatological etiologies resulting in periwound skin breakdown and the ability to recognize each. The three primary etiologies are contact dermatitis, trauma, and candidiasis. The precipitating factors are skin exposure to effluent and products used in care (e.g., chemicals or adhesive removal technique) [3]. Following is a discussion of these etiologies and interventions for care.

*Contact dermatitis* is defined as any pruritic, reactive skin disorder that occurs when the skin is exposed to a particular substance. There are
two subdivisions of this category that further specify etiology: irritant and allergic. **Irritant contact dermatitis** occurs secondary to contact with an offending agent. Clinical observations include erythema, vesicles, papules, patchy areas of denuded tissue, and pain at the site of contact. In the fistula patient, effluent and substances used in care are generally the offending agents. The cutaneous opening may be located at or below skin level and discharge of corrosive effluent with active proteolytic enzymes occurs directly onto dry, intact epidermis. The epidermis is additionally compromised by overhydration and contact with fluids having extreme levels of pH. Examples of other known irritants to the skin include solvents, soaps, hypochlorite (Dakin’s solution), acetic acid, and tincture of benzoin. Protection of the skin from effluent is achieved with skin barriers and skin sealants (see Table 1). Protection from other irritants focuses on removal of these agents from use and treating the skin with some form of protective barrier. If ointments and pastes are used, a suggested technique is to apply the protectant to the skin around the fistula opening, taking care not to cover the opening. (If this is occluded, the effluent will erode the skin barrier and expose the skin below without any sign that the clinician might note.) An absorbent dressing is then applied over the skin protector and changed as needed. Commonly used absorbent dressings are gauze, polyurethane foam, and calcium alginate. If a pouching system is in use, ointments are not recommended, as leakage will occur.

**Allergic contact dermatitis** occurs from exposure to an allergen or related compound that results in a hypersensitivity reaction upon re-exposure. Clinical observations include vesicles, bullae, papules, itching, erythema, or denudation at the site contact. Some level of discomfort or pain is also reported. A few common causes of allergic contact dermatitis in periwound skin care include substances such as neomycin, bacitracin, para-bens, and fragrances.

Allergic reactions exhibit acute onset, and the reaction may last up to 21 days. With re-exposure, the cycle repeats [4]. True allergic reactions are documented through the use of patch tests. The suspected agent is applied to the opposite side of the abdomen and covered. The skin is then inspected within 24–48 hr for any reaction. A cautious approach is recommended in attempting to confirm a true allergic reaction, since the arbitrary identification of an ingredient as an allergen may rule out the use of numerous skin barriers, as most are developed from similar ingredients. The optimal course of treatment is to identify and remove the allergen while continuing to protect the periwound skin. The clinician should be knowledgeable about the most common sensitizing agents and check the patient’s history for any sensitivities prior to product use.

**Traumatic periwound skin injuries** in fistula management are usually confined to skin stripping. The protective characteristics of the epidermis are removed by physically lifting away layers of the epidermis during adhe-
Table 1  Quick Reference Guide to Skin Care Products for Fistula Care

<table>
<thead>
<tr>
<th>Product function</th>
<th>Category</th>
<th>Description and use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cleanse periwound skin</td>
<td>Skin cleansers</td>
<td>Tap water, saline and commercially manufactured cleansers.</td>
</tr>
<tr>
<td>Fill irregular contours, edges, and shallow areas</td>
<td>Paste skin barrier/ strips/puddy</td>
<td>Caulking agents—most contain alcohol and may cause burning when applied to compromised skin (e.g., Stomahesive Paste, Coloplast Ostomy Paste). Apply skin barrier powder or a nonalcohol skin sealant first to minimize this affect. Strips are moldable adhesive strips for filling creases or linear contours. A variation of pastes and strips is a puddy compound that is a nonadhesive filler (e.g., Carbo Zinc).</td>
</tr>
<tr>
<td>Deep areas</td>
<td>Solid form skin barriers</td>
<td>Pectin-based wafers and sheets, used in addition to integrated skin barriers on pouching systems or used with dressings. Available in 4 by 4 and 8 by 8 in. Durable when in contact with effluent. May be used as a “platform” around fistulas, so that tape is applied to the barrier rather than the skin. May be cut and layered to fill deep areas. May be used in combination with pastes and powders (e.g., Stomahesive, Premium Skin Barrier).</td>
</tr>
<tr>
<td>Skin barrier rings</td>
<td>Pectin or silicone-based rings, moldable. May be stretched or cut to fill irregular surfaces. May be used in combination with pastes and powders (e.g., Eakin Cohesive, Adapt SoftFlex Rings).</td>
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Savage removal. The result is wet, denuded, painful skin. As a guide for clinicians, when dressings are changed three times a day, some form of skin protection is needed. If a pouching system is in use, it is usually changed every 3–7 days. Otherwise, skin stripping may result. This is particularly important if an extended-use solid-form skin barrier is used. When a pouch
<table>
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<th>Product function</th>
<th>Category</th>
<th>Description and use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protection of the skin</td>
<td>Skin barriers</td>
<td><strong>Description and use</strong></td>
</tr>
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</table>
|                   | Liquid barrier film (skin sealant) | Alcohol and non-alcohol-based products in liquid form that improve adherence of adhesives.  
- Used in combination with dressings to protect skin (Skin Prep Skin Gel). Nonalcohol products may be used on compromised skin (3M Calvilon No Sting Skin Barrier Film).  
- May be used in combination with skin barrier powder to create an artificial “scab.” |
| Absorb moisture from moist or denuded skin | Skin barrier powder      | Pectin-based powder that is dusted lightly onto denuded skin to absorb moisture and create tack. Excess powder is removed (Stomahesive Protective Powder, Premium Powder). |
| Remove adhesive | Adhesive remover           | Available in wipes and bottles. Optional product: not required to release adhesives and must be completely removed from the skin prior to next adhesive application. |
| Improve adhesion | Liquid barrier film Medical adhesive | See description above. Available in spray, liquid, and brush-on forms. |

is leaking so that a daily pouch change is required, some other form of skin protection/containment should be utilized [5].

Prevention of this problem lies with proper selection and use of adhesives. When frequent adhesive removal is anticipated, porous tapes, Montgomery straps, liquid skin barrier film, protective ointment, or a solid-form skin barrier is indicated. Adhesives are removed in the direction of hair growth while the skin is supported. For patients with friable skin, a liquid barrier film is recommended prior to adhesive application. Treatment of skin stripping usually includes the use of a skin barrier powder to absorb moisture on the skin and the application of a solid-form skin barrier or liquid skin barrier film.

*Candidal infection* is a periwound skin dermatitis observed in fistula patients because of their general condition (i.e., on antibiotics, immunosuppressed) and local conditions (i.e., moist, warm, dark periwound skin environment). The proliferation of *Candida albicans* results in observable manifestations—patchy, papular, pruritic lesions that include some satellite distribution characteristics. If dressings are in use, an antifungal protectant ointment or paste is recommended. When an adhesive pouching system is in use, an antifungal powder is recommended. A typical application technique for use of an antifungal powder on periwound skin is to dust the powder on cleansed, dried tissue. The powder is gently rubbed in and any excess is removed. Then a non-alcohol-based liquid skin barrier is applied.

**CONTAINMENT OF EFFLUENT**

Containment of effluent results in protected periwound skin, odor control, and a more accurate measurement of fluid losses. Containment with dressings does not completely achieve these objectives but may be the best approach in low-output fistulas without odor.

**Low-Volume Fistulas: Nonpouching Approach**

For the purposes of nursing management, low volume is defined as an output of less than 100 mL in 24 hr. Absorbent dressings are traditionally used in the management in these fistulas. Gauze, foam, and alginate dressing materials represent those most commonly utilized. In addition to dressing selection, however, periwound skin protection is necessary. Numerous types of skin protectants are used in combination with dressings. Liquid skin barrier films (i.e., skin preps), ointments, and solid-form skin barriers are examples of a few.

Solid-form skin barriers are useful as protective platforms when adhesive tapes are in use for a long period of time. An opening is cut in the center of the wafer to the size of the fistula opening, as in the case of a stoma. The skin barrier is applied so that the fistula opening is surrounded
by the skin barrier. Absorbent dressings are applied to the site and secured with tape that is attached to the skin barrier rather than the skin. The skin barrier is left in place during dressing procedures and changed infrequently (e.g., once a week).

When output is malodorous, an odor-absorbent charcoal dressing may be added to the protocol or a pouching system may be necessary.

In most situations, even with low-output fistulas, a pouching system is the preferred approach. It provides better protection for periwound skin and adjacent incisions as well as odor containment. Patients experience increased comfort and are usually able to assist with or independently perform routine procedures, thereby providing a sense of control and greater security. Interestingly, another benefit achieved is related to resource consumption. When fistulas are pouched, there is a significant reduction in nursing time spent on fistula care, and discharge from a care setting may be facilitated.

**Low-Volume Fistulas: Pouching Options**

Pouches used in the management of low-volume fistulas are closed or drainable with wide spouts (i.e., fecal pouches). They are usually clean rather than sterile. Closed ostomy pouches have a low reservoir capacity but patients may prefer them to wet dressings. In colostomy care, these pouches are primarily used for patients who are irrigating. They are “security pouches” that contain mucus or small amounts of stool between colostomy irrigations. When adapted to fistula care, closed pouches are effective and simple to use. They are usually changed once every 1–4 days depending upon output volume. Most pouching systems manufactured today have integrated skin barriers, with the skin barrier attached to the pouch during manufacture. However, many types of closed pouches do not. Therefore, an additional skin protectant may be needed. In theory, closed pouches are good options. In practice, they may be difficult to obtain in some care settings. It is unlikely that product formularies in acute or long-term-care settings would include these items due to low utilization. However, they are easily obtainable for outpatients.

When a drainable pouch is selected, a pediatric size (i.e., 6- to 10-in. length) or regular size (i.e., 12-in. length) may be used in these low-output situations. Drainable pouches usually include integrated skin barriers that provide skin protection. If the pouch adhesive does not include a skin barrier, a solid-form skin barrier may be attached. (If the area adjacent to the fistula requires filling or support, see Sec. V, “Preparation of Abdominal Topography,” below.) Drainable pouches are emptied when they are one-third full and changed every 3–7 days. Even though a fistula has low output, if the cutaneous opening is greater than 3 in., a wound management system may be required. These specialized pouching systems are more ex-
pensive and bulky under clothing, yet they provide the adhesive size that may be required to pouch a malodorous fistula. Occasionally, access to the fistula is required between pouch changes to advance or remove drains, inspect the wound, or perform diagnostic procedures. When access to the fistula is needed, a two-piece pouching system is recommended. Removal of the system is not required during observation; instead, the pouch is released from the skin barrier flange and reattached. Wound management systems also have attached access caps and may be indicated for low-volume fistulas with openings greater than 3 in.

High-Volume Fistulas
High-volume fistulas in nursing care are defined as having an output greater than 100 mL/24 hr. Dressings are not the first line of intervention in these situations. The preferred approach is pouching.

PREPARATION OF ABDOMINAL TOPOGRAPHY
Fistulas are frequently characterized by poor abdominal location and irregular topography proximal to the opening (e.g., retention sutures, drains, stomas, retraction, folds of fat, open wounds). Ideally, a flat skin surface for approximately 3 in. around the fistula opening is achieved in order to secure adhesives. Establishing such a flat surface may require the use of a skin barrier material to caulk creases and recessed areas. Skin barrier strips and paste are very effective for this. Solid-form skin barriers or skin barrier rings may also be layered into a recessed area for deeper filling. Solid-form skin barriers or conformable skin barrier rings may also be individually fashioned to the fistula size and then attached to the pouch adhesive [6,7]. If the skin is moist, a skin barrier powder may be dusted onto the surface, with any excess removed. This results in a tacky surface. Whatever technique is utilized, the goal is to fill in creases and recessed areas and provide a flat, dry surface for adhesives.

Beyond creases and recessed areas, abdominal muscle tone also plays a role in stabilizing pouching systems. When the muscle tone is firm, a flexible skin barrier and pouch are usually effective. The flaccid abdomen, however, will usually require additional support from the pouching system. This is available in the form of convexity or plastic gaskets on the pouching system itself [2,8–11].

SELECTING A POUCHING SYSTEM
Once abdominal topography has been adequately addressed, pouching selections are made. Most drainable pouches have integrated skin barriers
attached to provide skin protection. If the pouch adhesive does not include a skin barrier, a separate solid-form skin barrier may be attached. The pouching system is usually changed every 1–4 days, depending on the integrity of the seal. That is, the frequency with which a fistula pouch is changed is prompted by impending leakage rather than on a predetermined schedule.

Decision points about pouching systems are related to the volume of effluent and size of the cutaneous opening (see Fig. 4).

**Volume of Effluent**

Drainable pouches have either a wide emptying spout (i.e., fecal pouch) or a straight drainage spout (i.e., urinary pouch). In some situations, straight drainage spouts, tubing, and bedside collection bags may also be indicated to manage volume. However, the tubing and bedside drainage bags do not provide the level of odorproofing found in pouch materials. Therefore a liquid deodorizer may be required in the system. Most commonly, the wide emptying spout is utilized, as it accommodates variations in stool consistency. In addition to ostomy pouches, wound management systems and specialty systems are also available to meet individualized needs. The specialty pouches listed in the algorithm (Fig. 4) for this type of fistula all have straight drainage valves, so that a bedside bag may be used to increase volume storage capacity.

**Size of the Cutaneous Opening**

A fistula with an opening less than 3 in. in diameter is appropriate for a one- or two-piece drainable ostomy pouching system. The one-piece systems are usually the least expensive and provide all necessary functions except access to the fistula between pouch changes (Fig. 5).

When the size of the cutaneous opening is greater than 3 in., the pouching systems available become somewhat bulky. Large two-piece ostomy pouching systems are available, and medium- to large-size wound management systems also accommodate these larger sizes. A few ostomy manufacturers also have pouches with oversized adhesive surfaces that are actually designed for fistula management. These pouches usually include an integrated skin barrier (Figs. 6 and 7). When multiple fistulas are present in an incision, the entire incision should be pouched (Fig. 8). It is not necessary to pack the incision once the fistula is pouched (Fig. 9). The emergence of pouches with larger adhesive surfaces has obviated the need for many specialty procedures and adaptations once considered routine (Fig. 10). Saddlebagging and troughing are two such procedures. They are included here for situations where the clinician is unable to locate the larger adhesive surface pouching systems.
Figure 4  Algorithm for effluent containment.
Figure 5  Effluent containment with a one-piece ostomy pouching system.

Figure 6  Pouching system with a longer adhesive skin barrier for an enterocutaneous fistula within an incision. Paste is applied to the skin barrier.
Figure 7  Pouch applied with access cap open. Note the straight drainage spout at the bottom of the pouch.

Figure 8  The fistula and stoma within this incision are contained within one pouching system.
Figure 9  Pouching of the fistula does not require wound packing.

Figure 10  Wound drainage pouching systems with or without integrated skin barriers. Note the variation in drainage spouts.
**Saddlebagging**

This technique is designed for fistulas that require a wider adhesive on a pouch than is commercially available. Upon completion of this pouching procedure, there will be two pouches attached to the skin lying side-by-side on the abdomen. Effluent will drain into both pouches. Materials needed include two flexible drainable pouches with integrated skin barriers and large adhesive surfaces (approximately 8 by 8 in.) as well as extra paste or pieces of skin barrier to fill defects in the abdominal topography that will be under the adhesive. The pouches are aligned side by side on a table with the adhesives facing up, and the paper covering the adhesive is removed. The inside edges of the adhesive surface on both pouches are folded together in a narrow strip of approximately 1 in. so that the adhesives are permanently stuck together in this area. The paper backing is replaced onto the adhesive surfaces and flatten out on the table. A pattern the size of the cutaneous opening of the fistula is traced on the surface of the paper backing and cut out. The paper backing is then removed. Defects in the abdominal topography are filled as per the usual protocol and the pouching system is applied to the skin.

**Trough Procedure**

This technique is used when the midline incision must be included in the pouching system or when the length of the fistula exceeds that of commercially available adhesives [12]. Upon completion of this pouching procedure, the incision will be covered with a series of transparent dressings, culminating at the bottom of the incision with regular-size ostomy pouch. Effluent in the incision drains down to the ostomy pouch and is collected in that device. Materials needed include large transparent film dressings, solid-form skin barriers (4 by 4 in. or 8 by 8 in.), and a drainable ostomy pouch. Skin barriers are applied in pieces to the periwound skin to surround the wound and provide a platform. Several transparent film dressings are then applied so that at least 2 in. of adhesive extend onto the skin barrier platform beyond the opening to the incision. At this point, the entire incision is covered with the film dressings. An opening is cut in film at the lower portion of the incision and an ostomy pouch is applied over the opening to collect output.

**Access**

Occasionally access to the fistula is required between pouch changes to advance or remove drains, inspect the wound, or perform diagnostic procedures. When access to the fistula is needed, a two-piece pouching system or a wound management system is recommended. Removal of the system is not required during observation; instead, the pouch is released from the skin barrier flange and reattached. In the wound management system, the access window is opened during observations and then snapped back into place.
Catheter Access
When a tube or a drain is inserted into the fistula site or is located near the area to be poched (e.g., sump), it may be necessary to pouche the tube with a fistula (Fig. 11). A catheter access port is then used to deliver the tube through the front of the plastic pouch. This device also seals off potential sources of leakage from the opening made in the plastic [13].

Suction
When poching fails, there is a greater risk of mechanical injury to the skin, increased expense, and increased patient frustration. In these situations, the use of suction may be useful. Effluent must be predominately liquid, since the catheter can become clogged with viscous output. A gauze dressing or a wound contact dressing is placed over the fistula and a suction catheter over the dressing so as to avoid contact with the wound. Suction may be intermittent or continuous. A transparent film dressing is then applied that covers the entire system [14–16]. (Suction is an option in acute care settings. It is not the same type of suction as the vacuum-assisted closure device that is used to manage large draining wounds.)

POUCHING TIPS AND TECHNIQUES
Selection of a pouching system requires knowledge of available equipment and indications for its use. Not to be minimized, however, is application technique (see Fig. 12). Patient positioning during procedures can deter-

Figure 11  The access port for a drainage catheter is seen here attached to straight drainage.
The procedure for changing a fistula pouch is as follows:

1. Gather equipment and assemble supplies before removing the pouch.
   a. Pouching system and skin barrier
   b. Paste
   c. Measuring guide and pattern
   d. Closure clip
   e. Scissors
   f. Wicks and/or suction
   g. Water and basin
   h. Clean gloves
   i. Disposal bag

2. Prepare the pouching system.
   a. If a drainage spout is in use, close the spout with a closure clip.
   b. If the pouching system has been changed before, use the pattern and follow
      directions for changing at the bedside. If the system is being refitted, proceed to the
      next step.

3. Remove the pouch.
   a. Wear clean gloves to moisten the adhesive with 4 x 4-inch sterile pads or
      cottonballs. Support the skin while the adhesive is being detached.
   b. Discard the used system and save the closure clip.
   c. If the clip is soiled, wash it in soap and water before reusing it.

4. Fit the pouching system.
Figure 12 Procedure for changing a fistula pouch. The pouching system must be changed (1) when leakage occurs or (2) on a scheduled basis (e.g., every 3–7 days). Impending leakage is signaled by a skin barrier that appears to be waterlogged or by a patient’s complaints of burning or excessive itching. For scheduled pouch changes, a time of the day when function is minimal should be selected. If necessary, suction should be kept on hand to control output. Otherwise, wicking drainage away with 4-by 4-in. sterile pads is effective. If the protocol is expected to be painful, arrangements should be made for analgesia. The analgesic agent should be administered 1 hr before the procedure or topical lidocaine should be available. This is a clean procedure and does not require a sterile setup. The patient is placed in a supine position to smooth out abdominal contours and create flat surfaces.

a. Measure the opening from its farthest points and fashion a pattern on a piece of paper or plastic. This pattern will be dated and used again. Trace the pattern onto the skin barrier and cut the skin barrier so that it is slightly larger than the pattern. If a separate pouch is in use, cut the pouch 1/8 inch larger than the skin barrier.

b. When a one-piece pouching system is in use, simply remove the paper backing that covers the adhesive surface. When a two-piece system is being used, remove the paper backing on the pouch and attach the skin barrier to the pouch. Remove the paper backing on the skin barrier.

5. Apply the pouch.

a. Rinse the skin with clear water and dry. Continue to control output so that the skin is dry when the pouching system is applied.

b. Apply additional skin barriers, adhesives, etc., as determined at this point, to provide a flat skin surface.

c. Apply the pouching system and hold it in place for a few minutes. Holding it steady will allow the pectin skin barrier and other adhesives to conform and attach well to the abdomen.

d. Instruct the patient to lie flat for 5 to 30 minutes, depending on the complexity of the situation. This step allows additional setup time before the patient does any bending.
mine the difference between an intact pouch or leakage. Similarly, it is fundamental to understand that using too much adhesive or paste will impede rather than strengthen a seal. Close patient monitoring is key to establishing a workable solution and recognizing when the fistula has changed and technical adjustments are needed.

Pouch leakage may occur as a result of several factors. When pouches leak prematurely, abdominal topography is frequently the cause. Contours of the abdominal surface and abdominal muscle tone supporting the pouching system may require reconsideration. Other causative factors are related to the application and maintenance of an intact pouching system by the caregiver. Technique during pouching procedures may be new to the caregiver. For example, abdominal fistula pouching procedures are done with the patient lying flat. If the patient is in a semi-Fowler’s position during pouch application, skin creases will usually be present when the adhesive is applied. Leakage will be the result. Adhesives require time to “set up” after procedures are completed. If the patient moves immediately after the adhesive is applied, the skin will become creased and leakage will result. Therefore patients should be instructed to lie flat for 20–30 min following a procedure with one hand held over the pouch to make sure that the seal is well secured. Ironically, the simple activity of emptying the pouch may be the cause of pouch leakage. Pouches should be emptied when one-third full and will become detached from the skin if overfilling occurs. Caregivers need specific instructions on when and how to empty pouches.

Concern may arise that patients who are confused, medicated, or exhausted may not be able to alert the nursing staff to empty a pouch. If this becomes a problem, a straight drainage system may be helpful. A pouch with a tube spout (i.e., urinary or wound management pouch) that connects to straight drainage tubing and a bedside collector may be useful. Effluent must be liquid, however, to avoid clogging the tube. Deodorizers may be necessary when urinary pouches and straight drainage systems are used, as they are odor-resistant rather than odorproof.

Pouching a fistula is a procedure that requires the use of gloves and clean technique. Use of sterile technique and equipment means an added expense that has not been supported in the literature.

**ODOR CONTROL**

Odor control is a concern with patients who have fecal fistulas. It is routinely the most common patient complaint, because the odor is pungent and tends to linger. When a dressing is being used to contain effluent, there is no odor barrier. A charcoal-impregnated dressing may be placed over the gauze dressings to control odor. A distinction must be made between pouches with odorproofing vs. odor-resistant characteristics. Most pouches
are odorproof. However, urinary pouches and some large fistula drain pouches are odor-resistant. In either case, offensive odors require attention. Deodorants may be taken orally (e.g., bismuth subgallate, chlorophyllin), placed in pouch (e.g., liquids, powders), or sprayed in the room. The preferred methods are pouch deodorization and room sprays, which avoid the risk of potential systemic interactions. Deodorants used in the pouch must be instilled after every pouch emptying in order to be effective. Room deodorizers should neutralize rather than mask odors (Fig. 13).

Simple, often overlooked methods of odor control are related to hygiene. When pouches are in use, the spouts should be rinsed with water and wiped dry after each emptying and the seal on the pouch checked frequently, as leakage is a cause of odor. Soiled pouches or dressings are disposed of according to the agency health care setting’s infection control policies. However, they should be removed from the room after procedures. At home, pouches and dressings should be disposed of in a plastic bag and put in the trash.

Some pain may be procedure-related for individual patients. Efforts should be made to reduce the time required to perform the procedure and to use techniques that will minimize patient discomfort. Patients who experience pain with the procedure should be medicated 30 min prior to a pouch change.

Figure 13 Products used to deodorize effluent include charcoal-impregnated dressing, room spray, tablet and liquid deodorizers that are instilled into the pouch, and a charcoal filter for a pouch.
PATIENT SUPPORT

Patients with enterocutaneous fistulas are faced with numerous psychosocial issues, important among which are independence, control, and concerns about the future. Coping strategies used by these patients are varied. Intellectualization, denial, confrontation, isolation, and rationalization are only a few. Supportive counseling is a useful intervention for helping the patient to cope because it decreases the patient’s anxiety and some of his or her sense of isolation.

Effective technical management of the fistula is primary to patient adaptation. Patients who have leakage and odor associated with their pouching systems are anxious and embarrassed. Therefore securing the pouching system is the initial step toward patient support. Once the containment system has been made secure, mobility and esthetic issues can be addressed. Mobility is restricted when some pouching systems are used. An example is that of the patient who is using suction to collect exudates. Immobilization may lead to the secondary problems of pneumonia or pressure ulcers. Attention to respiratory activity and pressure reduction on the bed are critical in preventing these problems. Suction or straight drainage can be disconnected during ambulation. However, the ongoing need for suction should be re-evaluated frequently in order to respond to the concerns of patient dignity and mobility. When pouching systems are used for fistulas over long periods of time, opaque pouches or fabric pouch covers may be used. This intervention decreases the perspiration associated with plastic and removes the soiled pouch from view.

Restricted mobility and ongoing treatment threaten the patient’s independence and lead to concerns about the future. All patients worry about their ability to function normally. In addition, they are concerned about freedom to interact in relationships with others. Loss of love and approval from significant others is another important issue. The employed person may be worried about loss of position and future income. Prolonged or numerous hospitalizations threaten the person’s independence, finances, and emotional stability. In response to these needs, supportive counseling with consistent caregivers is most helpful. The collaborative approach also helps the caregivers, because the primary physicians and the ET nurse become primary support resources as they help one another. In addition, a mental health professional is a useful support to patients, whether for the short or long term.

Issues of control are common concerns for patients with fistulas. In order to respond to these needs, patients and significant others are included in teaching sessions from the outset. When patients understand the rationale for interventions and participate in procedures, they recover a measure of control. Initially, patients are encouraged to inform the nurse when the pouch requires emptying. Later, they are asked to participate in skin care and dressing changes or pouch assembly. When such physical participation is not possible, the patient may take on the role of overseer and supervisor of care. At discharge, the caregiver, whether patient or significant other,
provides, in turn, a demonstration of these skills for the nurse. Follow-up appointments for ongoing evaluation are scheduled with the ET nurse.

COST CONTAINMENT

This chapter has presented goals in care and approaches to management of the fistula patient. Any discussion of cost recognizes that cost is a direct result of resource consumption. Two of the most expensive resources in the topical care of fistulas are product and labor. Critical decision making has been recommended in order to avoid the trial-and-error method of product selection. The trial-and-error approach usually produces half-used boxes of numerous types of products stacked on a shelf in the patient’s room, while other products are currently being tried. By making the best choices on the basis of a sound rationale product usage and the labor required to complete procedures will generally be decreased. A rule of thumb is to simplify. Clinicians may approach fistula management as a challenge to demonstrate complex skills. While this may indeed be the case, the experienced clinician knows that the most elegant solution is the simplest. Use of ostomy pouching equipment is usually the most inexpensive approach to managing fistulas. However, this may not be the best option for low-volume, odorless fistulas. From a cost perspective, dressings changed three times a day are inexpensive on a unit cost basis. However, the cumulative cost of product is greater than applying an ostomy pouch and changing it every 3–7 days. Further, the patient in hospital for 4 days will require 1 pouch change versus 12 dressing procedures from the nurse.

When the clinical situation presents a fistula with a large cutaneous opening and high-volume output present, the cost of care will increase. An access cap for a pouch and large adhesive surfaces dictate wound management systems. Few alternatives exist that are appropriate and each is an expensive choice per unit.

CONCLUSION

Intestinal fistulas present a complex problem for patients, nursing staff, and physicians. These problems are often chronic in nature and involve both inpatient and outpatient management. Integrated management led by the enterostomal therapist will minimize patient suffering, decrease complications, and often hasten fistula healing.

REFERENCES


ADDITIONAL RESOURCES

Convatec, Inc. http://www.convatec.com
Diagnosis and Treatment of Peristomal Skin Conditions

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**INTRODUCTION**

There are over 1.5 million patients with intestinal stomas in the United States, and 100,000 new stomas are created yearly. Of these, 51% are colostomies, 35% ileostomies, and 12% urostomies [1]. The development of increasingly sophisticated stoma appliances and adhesives has mirrored a growing interest in the dermatological complications associated with long-term stoma management. Intestinal effluent, particularly ileostomy drainage, can be caustic and irritating. Chronic dermal exposure to proteolytic enzymes, high alkaline content, and constant moisture leads to peristomal skin damage. Ostomy trauma, folliculitis, and minor peristomal erythema from exposure to adhesives are the most common complaints. Less common and perhaps more serious are peristomal problems stemming from underlying disease. Pyoderma gangrenosum and peristomal varices exemplify cutaneous manifestations of serious illnesses. Good peristomal skin care starts with appropriate patient selection, knowledgeable stoma site marking to avoid creases and folds, patient education, and treatment or correction of underlying disease. Unfortunately, even strict adherence to these principles may not eliminate all problems. Prompt and early recognition of small breaks in the skin may allow the initiation of corrective measures that minimize damage. Good surgical technique in most nonobese patients ensures that a generous lip or protective nipple of mucosa is present on ileostomies. Severe peristomal skin excorlation and ulceration may result from absence of this protective feature. The consequences of a flush colostomy are not quite as dire but can make appliance placement and sealing very problem-
atic, thereby leading to skin breakdown or irrigation from excessive manipulation. In this chapter, important dermatological issues are discussed with a focus on their diagnosis and proper management.

PERISTOMAL IRRITATION

Chemical Irritation

Stomal effluent leaking onto peristomal skin is the most common cause of chemical irritation and peristomal dermatitis in general. Poorly functioning ostomy devices and face plates, lack of proper patient education, and flush or improperly placed stomas are the main culprits. Although the etiologies of allergic contact dermatitis and chemical irritation are different, the results are the same. The peristomal skin appears reddened, itchy, weeping, and excoriated, progressing to frank ulceration if left unchecked. The process may be escalated by the patient’s scratching and infection can rapidly ensue (Fig. 1). Ileostomy effluent has a high fluid component, is highly alkaline, and contains a corrosive mix of proteolytic enzymes [2]. Even slight imperfections in the fit of the stoma’s face plate can allow chyme to seep under it and become trapped in contact with the skin. Placement of the wafer over scars or creases is the usual problem and can be avoided by preoperative marking of the stoma. Persistent oversizing of the wafer hole can also contribute. A protective powder to ensure adhesion of the appliance over moist skin or a light application of corticosteroid spray to areas

Figure 1  Ileostomy with extensive skin corrosion caused by leaking stoma appliance.
of erosion may be helpful in alleviating the pruritus and burning associated with inflammation. Use of a skin sealant with a copolymer or plasticizing agent without alcohol provides a thin protective film on the skin surface, helps prevent skin stripping of the epidermis during adhesive removal, and acts as a moisture barrier [3]. Skin barriers in the form of powders, pastes, rings, and wafers are used to protect the peristomal skin from effluent, create a level pouching surface, and treat peristomal skin loss. In severe, moist, irritant dermatitis, meticulous skin cleansing with normal saline, liberal application of a skin protectant ointment with dimethicone, and the use of a convex wafer and pouch held in place with a belt may help facilitate healing of the inflamed skin, especially when an adhesive barrier will not stick.

It can be quite difficult in some patients to create a viable stoma with a good lip of mucosa protruding above the skin. Obesity can create length problems and make it difficult to bring loop stomas through the thick abdominal wall, resulting in flush, retracted stomies (Fig. 2). Tension can result in ischemia and stomal retraction. Good surgical technique is imperative in avoiding these pitfalls. Formation of a Brooke ileostomy for both loop and end stomas is preventive. Adequate intestinal mobilization of well-vascularized intestine minimizes retraction. Unfortunately, even successful surgery can have troublesome consequences. Rapid or excessive weight gain can recess the stoma into fatty tissue folds, resulting in a flush, hard-to-pouch ostomy. There have been a number of reports of the use of local peristomal liposuction in this instance to create a “platform” on which to

**Figure 2** Failure to maintain a seal around a flush stoma has resulted in irritation of the peristomal skin.
place the wafer [4]. Using semiflexible pouches with varying degrees of convexity is probably the best initial step and is the most common solution to slightly retracted or just-visible stomas [5]. Stomas that are severely retracted or not amenable to convex pouching need to be surgically revised either locally or by laparotomy. Local revision is accomplished by incising the stoma at the mucocutaneous junction, dissecting circumferentially down to the fascia while avoiding injury to the mesentery, freeing up the intestine from the surrounding fascia, and pulling up additional bowel to fashion a new, longer stoma. Unfortunately, adhesions, an unmobilized splenic flexure, and a foreshortened mesentery can conspire to prevent adequate local mobilization, thus necessitating laparotomy.

Urostomies are associated with special problems requiring both systemic and local solutions. Urine normally contains no proteolytic enzymes and is slightly acidic. Therefore skin damage from urine is caused by pooling of the urine on the peristomal skin, which results in maceration. Alkaline urine, however, when in prolonged contact with the skin, causes encrustations—around the mucocutaneous junction, on the stoma itself, or inside the bag—consisting of triple phosphate (calcium, magnesium, and ammonium phosphate) or uric acid crystals [6,7]. Such crystals formation can cause small lacerations at the mucocutaneous margin [7]. The treatment is simply a combination of increased fluid intake and acidification of the urine with vitamin C (up to 8 g/day) and the administration of cranberry juice or cranberry pills. The crystals themselves can be gently removed using washes or compresses or half-strength vinegar until they are gone [7,8].

**Allergic Contact Dermatitis**

Allergic contact dermatitis results from a reaction to a specific allergen in an ostomy product [9]. Severe contact dermatitis may occur from the adhesive material on one-piece appliances or from the adhesive tape, powders, pastes, clamps, and belts. An allergic dermatitis can usually be confirmed whenever an area of inflammation corresponds to the area covered by a particular product. Allergy is manifest by cutaneous erythema and blister formation with severe pruritus or burning (Fig. 3). The condition can be treated with topical corticosteroid sprays and oral antihistamines for relief of itching. Systemic steroids may be indicated for severe reactions [6,7]. Patients with pre-existing and established allergies to food, medications, or other topical agents should be skin tested for possible sensitivity to ostomy products prior to surgery [3].

**Trauma (Mechanical Irritation)**

Denuded, inflamed skin may result from abrasive cleansing techniques, friction, and pressure from ill-fitting equipment, belts that are too tight, or
poorly fitted wafers. Skin breakdown and epidermal stripping may also occur from excessive rubbing to remove old paste or from traumatic tape removal. The affected skin is painful, and the moist, bleeding areas undermine the pouch seal, resulting in frequent pouch changes and exacerbation of the problem [3]. Factors that contribute to mechanical trauma include weight gain, weight loss, peristomal hernia, and prolapse. When such trauma occurs, reassessment of the patient’s pouch removal technique, skin care, and length-of-wear time is warranted. Appliance wear time should be at least 4 and preferably 5–7 days. Re-education—including correction of improper technique—is essential. Denuded areas may require skin barrier powders and alcohol-free skin barrier wipes to create an effective adhesive seal [9].

**Folliculitis**

Inflammation within the hair follicle is caused by trauma due to careless appliance removal, too frequent or too close shaving of peristomal hair with a blade-type razor, or excessive rubbing or cleansing. Erythematous, pinpoint, pustular lesions appear at the bases of the hair follicles around the stoma. These lesions may suggest yeast infection, but they are usually caused by *Staphylococcus aureus*. Antibacterial powders can be prescribed. The problem is best prevented by cutting the peristomal hair with scissors or using an electric razor. Depilatory agents are seldom recommended because of the high incidence of allergic reaction to these products [3].
DERMATOSES

Pyoderma Gangrenosum

Pyoderma gangrenosum (PG) is a debilitating, idiopathic dermal manifestation of underlying chronic disease. Although it is most commonly described as affecting those with inflammatory bowel disease, it can be seen in patients with polyarteritis nodosa, hepatitis, rheumatoid arthritis, and underlying malignancies [10]. Peristomal PG can occur in Crohn’s disease as well as ulcerative colitis, occurring in 2% of cases treated by stoma [11]. Because it is so uncommon, it may go unrecognized and therefore underreported. On physical examination, the lesions are characterized by small pus-tules that enlarge and break down, forming burrowing, deep-seated pyogenic ulcers with necrotic centers and serpiginous borders (Fig. 4). The rapidity of its development and spread is considered a hallmark of the lesion [10, 12]. Histologically, biopsies of the lesions are quite nonspecific, showing only evidence of acute and chronic inflammation with no granulomas or fungus [11].

In a number of small case series and reviews, patients suffering from peristomal PG are slightly more likely to be females suffering from Crohn’s disease. A number of these cases have occurred in the presence of active disease—especially active proctitis [10]. Diagnosis of PG is facilitated by prompt recognition of the rapidly spreading peristomal serpiginous lesions
in patients with irritable bowel disease (IBD) and by maintaining a high index of suspicion. Treatment of the lesions can be difficult. As with all peristomal dermatoses, ulcers cause difficult pouching problems. Most regimens include good local wound care. Ulcer irrigation, dressing of the wound with gauze, isolating the ulcer from effluent, and use of hydrocortisone creams have been described [10,12]. Others promote the use of hydrogels, calcium alginate, and hydrocolloid in the topical care of the ulcers. If the ulcers cover an area greater than one-third the circumference of the peristomal region, a nonadherent pouching system of belts and gaskets can aid healing by reducing irritation, trauma, and pressure [13]. The cornerstone of treatment, however, seems to be intravenous and oral steroids. Initial high-dose therapy (20–100 mg/dL) is quickly tapered to an oral dose, on which the patient is maintained until the ulcers are well on their way toward healing. Intralesional injection of steroids, particularly triamcinolone acetonide (30 mg/mL), is reported to speed healing and is suggested as an initial measure [14]. Even with rigorous wound care and systemic therapy, most surgeons report slow wound healing times ranging from 6 weeks to 6 months [11]. It has been recognized anecdotally that persistent ulcers may heal promptly when, with treatment, the underlying disease becomes quiescent, particularly in the case of Crohn’s proctitis. Completion proctectomy and resection of persistently inflamed bowel is noted to cause prompt regression of peristomal disease; however, local surgical interventions, including ulcer excision and stoma revision, seem to worsen the problem and may cause exacerbation of PG at distant sites. They are therefore contraindicated [15,16].

**Bullous Pemphigoid**

Bullous pemphigoid is a well-recognized skin condition rarely reported at colostomy or ileostomy sites. It is characterized by tense blisters of varying size on either normal or reddened skin. The blisters occur on both mucosal and keratinized skin, typically with extensive body surface involvement in the elderly [17]. Histological examination of the involved tissue reveals separation at the dermoepidermal junction, the presence of an intact epidermis, an underlying subepidermal bulla, and a large number of eosinophils [18]. Direct immunofluorescence demonstrates IgG and C3 at the level of the epidermal basement membrane (dermoepidermal junction) [17–19]. Patients are often initially misdiagnosed with a contact dermatitis, folliculitis, or even peristomal abscesses. Biopsy and histopathological examination are necessary to make the diagnosis. Clinically, the lesions, when ruptured, contain clear, not purulent, fluid. They tend to recur and do not respond well to local therapy alone. Localized bullous pemphigoid (LBP) may occur in areas of trauma (Köbner phenomenon), although this association is somewhat speculative.
Treatment of LBP is facilitated by prompt histological diagnosis. Topical steroids (clobetasol propionate) and oral tetracycline (1–2 g/day) for 2 months results in resolution of the bullae [20].

**Pseudoverrucous Lesions (Epidermal Hyperplasia)**

This condition involves overgrowth of peristomal epithelial tissue chronically exposed to moisture. The area appears moist and red with heaped up edges. The term *pseudoverrucous* refers to the fact that the excrecences look like HPV-induced condylomate (Figs. 5 and 6). The lesions are typically painful and are caused by ill-fitting ostomy appliances with oversized wafer openings, resulting in exposure of large areas of skin. Urostomies and high-output stomas are most commonly affected [13]. The thickened, wart-like skin may require surgical removal or treatment with silver nitrate in the office [8,21]. Preventive maintenance is the best approach to this problem. Properly fitted stoma face-plate apertures that hug the mucocutaneous junction provide a permanent solution.

**Psoriasis**

Individuals vulnerable to psoriasis and eczema in other areas of the body may develop peristomal manifestations of the disease. Trauma to the peristomal skin caused by repeated appliance manipulation may be the instigating element responsible for the development of psoriasis. Manifestations of such a traumatic etiology constitute the *Köbner reaction* and are de-
Figure 6  Peristomal epithelial hyperplasia adjacent to an ileostomy placed in a skin crease. The seal between the skin and the appliance cannot be maintained.

scribed in a number of other dermatoses as well, including lichen sclerosis [22]. Clinically, peristomal psoriasis is characterized by flaking, scaling, white or red lesions in patients with a history of psoriasis in other, more typical areas such as the elbows, intragluteal clefts, mammary folds, and pretibial areas (Fig. 7). Treatment options include topical corticosteroids, methotrexate, topical retinoids, and ultraviolet light exposure [23]. Special attention to atraumatic pouching options such as the nonadhesive karaya ring pouch with belts may be necessary to avoid initiation of the lesions.

Uncommon Peristomal Dermatoses—Hidradenitis Suppurativa and Lichen Sclerosis

A review of the recent literature reveals rare reports of peristomal manifestations of relatively common dermatoses. A complete differential diagnosis of peristomal complaints should include these problems and, although rare, they should be considered because they are easily diagnosed and treated.

Hidradenitis suppurativa is a very common, chronic, suppurative, cicatricial cutaneous disease exhibiting cystic, inflamed, and infected lesions arising in keratin-blocked hair follicles of the axilla groin, and perianal area. The lesions emit a foul, purulent material when incised and heal by granulation. Typically, however, they recur with a course marked by cycles of recurrence, eruption, and scarring. Subcutaneous tunneling is the hallmark of hidradenitis suppurativa and surgical unroofing of the tracks aids
healing and reduces recurrence. Case reports of peristomal hidradenitis suppurativa include descriptions, obtained by Gastrografin study or on visual inspection with a fiberoptic scope, of typical lesions connected by subcutaneous tunnels that fail to connect with the lumen of the bowel [24]. Although Church’s group has reported the presence of an association between perianal Crohn’s disease and hidradenitis suppurativa, Crohn’s disease with peristomal fistulization must be ruled out [25]. The possible coexistence of these conditions, however, should be considered. The etiology of the problem is unclear. Genetically predisposed individuals have a defective keratin maturing process that results in follicular blockage and bacterial overgrowth. Others have reported the problem following occlusion of axillary skin with tape [26]. The presence of the disease in the peristomal area may result from occlusion of follicles with appliance adhesives. Treatment involves incision and drainage of infected unruptured cysts, unroofing of subcutaneous tracks, good wound care, systemic antibiotics when indicated, and avoidance of face plates secured by tape.

Lichen sclerosis most commonly occurs (85%) on the genital area of elderly patients and is characterized histologically by atrophic epidermis, hyaline changes in the dermis, and a dense, band-like infiltrate of lymphocytes [27]. Extragénital lichen sclerosis has been described on skin underlying tight clothing, on injection sites, and in areas affected by sunburn [28]. In case reports of peristomal lichen sclerosis, the elderly patients affected have concomitant vulvar lesions. The lesions have a thickened white plaque-like appearance. Lesions have been treated successfully by ensuring proper appliance fit, reducing peristomal skin exposure, and topical application of
0.05% clobetasol propionate. Regression of lichen sclerosis can be expected in 1–12 months [28].

MALIGNANCY

Adenocarcinoma at the mucocutaneous junction is uncommon, but a number of case reports exist in the literature. Stomal polyps are more common and can occur on both ileostomies and colostomies. The histopathology of stomal polyps differs from those encountered on routine colonoscopy. Histologically, they possess elongated, hyperplastic crypts with a characteristic inflammatory infiltrate and underlying fibrosis or granulation tissue. Both polyps and adenocarcinomas are long-term stoma complications, most commonly occurring after 15–20 years [29]. Cold forceps biopsy followed by electrocautery removal is effective therapy for these polyps, which are theorized to develop as a consequence of long-term mucosal exposure to chemical and physical trauma. Most patients presenting with adenocarcinoma have a history of pain and bleeding associated with a mass or ulcer at the periphery of the stoma (Fig. 8). Ileostomy adenocarcinoma is specu-

Figure 8  Primary adenocarcinoma in an ileostomy: A late complication of surgery for ulcerative colitis. (From Ref. 30.)
lated to occur as a result of a number of factors. Of the cases described, over half the reports note colonic metaplasia with dysplasia in the mucosa surrounding the excised adenocarcinoma [30]. Chronic irritation, physical and chemical trauma, and, perhaps, exposure to ileostomy effluent with colonic flora may be responsible for this change [31].

Diagnosis of mucocutaneous adenocarcinoma is best made by biopsy. Computed tomography of the abdomen and pelvis can help define the extent of both local and distant disease. Because reported cases are few, prognosis is unclear, but wide local en bloc resection of the stoma and surrounding skin and abdominal wall with resiting of the stoma seems to be the best treatment option [30].

RADIATION

Irradiated intestine should be avoided in selecting bowel for a stoma. However, it may be impossible to avoid placing the stoma through skin that has received radiation. Radiated skin can appear thin and shiny. Radiation to the dermis causes damage to small vessels and ischemia; moreover, the dermis can then easily be traumatized by removal of skin adhesives associated with the stoma appliance. Modern high-energy radiotherapy devices minimize scatter and reduce the skin damage seen in earlier times. If the stoma is included in the treatment field however, the stoma appliance can cause scatter and damage the underlying skin. Therefore the appliance should be removed when radiation is being delivered. The use of lateral ports helps to reduce the incidence of stoma involvement. It is mandatory for patients receiving radiation treatment to wear a nonadherent karaya ring between treatments until completion, to avoid adhesives, and to be inspected closely during treatment [7,21].

INFECTION

Candidiasis

The most common cause of peristomal skin infection and colonization is the monilial yeast Candida albicans. Yeast infections can occur around all types of stomas and are usually caused by leaking, poorly adherent appliances, creating a warm, moist microenvironment under the stoma wafer. Other factors contributing to the problem include the use of oral or parenteral antibiotics and local peristomal skin care routines and products that violate natural barriers and extinguish the normal dermal flora. Candidal infections are more common in debilitated, immunocompromised patients. The affected skin appears bright red and moist and is surrounded by erythematous satellite papular lesions (Fig. 9). Severe itching and burning are commonplace. The condition is usually diagnosed and treated empirically,
but definitive diagnosis can be made by treating dermal scrapings with 10% potassium hydroxide and observing them under light microscopy for budding yeast and hyphae. Treatment consists of dusting nystatin powder over the infected skin with each pouch change [7,32].

**Bacterial Infection**

Peristomal cellulitis of bacterial origin is uncommon. The organisms present are skin flora, with *Staphylococcus aureus* predominating. Treatment with systemic antibiotics like dicloxacillin or amoxicillin/clavulanate (Augmentin) is aimed at gram-positive organisms. Cultures of the erythematous plaques or effluent can be taken for sensitivities if the cellulitis does not clear with oral antibiotics alone. Occasionally, severe cellulitis may warrant hospital admission and parenteral antibiotics, depending on the patient’s underlying disease, comorbidities, and presentation.

Peristomal abscesses are not uncommon in patients with Crohn’s disease. Peristomal fluctuance, pain, and erythema occur and spontaneous rupture at the mucocutaneous junction is common. The organisms present represent intestinal flora principally, because these abscesses result from fistulas that may or may not be obvious at the time of incision and drainage. All stomas that present with peristomal abscesses should be incised and drained as close to the mucocutaneous junction as possible so as to obviate pouching problems that can result from close approximation of the wound and the stoma. A computed tomography scan, Gastrografin study through the
stoma, and mucosal biopsy are additional tests that may be useful depending on the patient’s underlying disease and symptoms [33].

These tests can demonstrate associated undrained collections, inflammatory masses, and fistulas, thus aiding in diagnosis and treatment.

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Unusual Problems in Stoma Management

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INTRODUCTION

Challenging problems in the management of stomas vary from fairly common parastomal dermatological conditions to unusual complications related to the stoma representing diagnostic and therapeutic dilemmas. Three of these latter entities—parastomal pyoderma gangrenosum, parastomal varices, and carcinoma arising in an ileostomy—are the subject of this current review.

PARASTOMAL PYODERMA GANgrenosum

Pyoderma gangrenosum is an indolent, painful ulcerative process of the skin of unknown cause. In 1930, Brunsting and associates [1] first described this entity; since then, pyoderma gangrenosum has been considered an extraintestinal manifestation of both ulcerative colitis [2,3] and Crohn’s disease [4]. The estimated incidence of pyoderma gangrenosum in association with inflammatory bowel disease varies from 0.5–5% [5–7]. Erythema nodosum [7,8], the other serious cutaneous extraintestinal manifestation of inflammatory bowel disease, may occur in patients with pyoderma but both rarely occur at the same time.

Although these lesions may be seen in healthy persons, most are associated with an underlying debilitating condition. In addition to inflammatory bowel disease, pyoderma gangrenosum has been described in association with blood dyscrasias, Hodgkin’s disease, other malignancies, and chronic active hepatitis [2,8].

The cause of pyoderma gangrenosum is obscure. The original description [9] of the disease suggested a primary bacterial origin; it is now accepted that bacterial contamination is a secondary phenomenon. Although
current concepts suggest a primary immunological mechanism [8], it is unclear whether this is directed specifically at the skin or is part of a more generalized autoimmune response to the underlying systemic disease.

Clinically, the lesion begins as a number of pustules that erupt and quickly coalesce into the classic painful ulcer with a violaceous border and undermined edge (Fig. 1). Most often, the lesion affects the pretibial region of the lower extremities. Multiple lesions are the rule rather than the exception [7,10,11]. An associated history of trauma to the affected area preceding the development of pyoderma has been reported in 10–27% of patients [7,10,11]. Pyoderma gangrenosum has also been described in association with surgical incisions [12].

Parallel activity of the intestinal aspect of the inflammatory bowel disease in pyoderma gangrenosum continues to be a source of debate, as is the response of the skin lesions to medical and surgical therapy of the underlying ulcerative colitis or Crohn’s disease [4,6,7,11]. Most physicians agree that the clinical course of pyoderma often correlates with the degree of intestinal inflammation; however, pyoderma is also seen in patients with inactive bowel disease and has been noted after surgical extirpation of ulcerative colitis. When pyoderma gangrenosum develops in a patient with clinically

![Figure 1](image_url)  
Figure 1  Typical pyoderma lesion with a deep punched-out ulceration, undermined edges, and violaceous border.
inactive Crohn’s disease, the intestinal tract should be reevaluated for evidence of recrudescence of intestinal disease activity. Successful medical therapy of the inflammatory bowel disease has been associated with the healing of pyoderma in approximately two-thirds of patients [11]. Bowel resection has been suggested for patients with refractory pyoderma; however, when all of the disease is removed, healing of the skin lesions is seen in less than half of patients without additional treatment of the pyoderma itself. In patients with mild ulcerative colitis, prolonged delays in healing of the skin lesions may occur; whereas in patients with severe inflammatory bowel disease, the cutaneous lesions tend to heal promptly with medical treatment [6]. Persistence or recurrence of pyoderma may be related to an operative procedure that leaves residual diseased bowel, such as subtotal colectomy for ulcerative colitis or a bypass procedure for Crohn’s disease [7]. Because healing cannot be guaranteed after resection and pyoderma may appear de novo in the postoperative period after removal of the diseased bowel, the surgeon should be cautious in recommending operation solely on the basis of the presence of refractory pyoderma gangrenosum.

Surgery for inflammatory bowel disease often results in the creation of an ileostomy. Margoles and Wenger [13] were the first to report an association between peristomal pyoderma and ulcerative colitis. McGarity and associates [14] established the association between peristomal pyoderma and Crohn’s disease. Last and colleagues in 1984 [15], in a discussion of parastomal ulcers and Crohn’s disease, presented a differential diagnosis of these lesions, including infected hematomas, stitch abscesses, fistulas, and reactivation of Crohn’s disease. Parastomal pyoderma gangrenosum was not mentioned as a separate entity. A later series [16] reported that half of refractory parastomal ulcers were pyoderma gangrenosum.

Clinical presentation of peristomal pyoderma may be confusing. Fistula and abscess at the suture line may be indistinguishable from the early pustules of pyoderma, with a prodrome of pain, erythema, and tenderness. When the typical ulcer has formed, the diagnosis becomes more apparent (Fig. 2).

Particular problems with parastomal pyoderma are pain under the appliance and an inability to maintain a seal between the appliance and the skin. The goals of therapy must be to address local management of the ulcer and the underlying illness predisposing to the complication. In most series, debridement is rarely successful and increases the size of the peristomal ulceration that must be dealt with [17]. Local wound care of the ulcer is a necessity in managing these patients. When the ulcer is small, with minimal exudate, the granulating base is covered with Telfa (Kendall Company, Boston, MA), and the existing pouching system is replaced. A composite foam can be used to contain a moderate amount of exudate; this foam provides for a painless removal of the flange and less trauma to the wound bed. Daily changes are required to remove the exudates and prevent under-
mining of the adhesive wafer [15]. Other forms of local treatment include Domeboro compresses (Miles Pharmaceutical, West Haven, CT), topical antibiotic ointments, and corticosteroid creams [18]. Although topical preparations are not typically recommended because they interfere with pouch adherence, the above measures do play an important role in the treatment of pyoderma.

When the ulcer is large, with considerable wound seepage, hydroactive materials may be used to promote healing in a moist environment. Acquacel (Convatec, Princeton, NJ), a hydrofiber wound dressing, is soft, absorbable, and comfortable [17]. This dressing, when interacting with wound exudates, forms a soft gel that maintains a moist environment while facilitating removal of the pouching system [19]. Due to the high volume of moisture, a Duoderm wafer over the Acquacel is used to achieve a seal of the appliance. Methods of moist wound healing combined with topical steroids have been used with some success [18].

When the disease is severe, the ulcer surrounds the stoma and leaves no usable skin surface for the pouch. Under these circumstances, the Perry model 51 pouch (Perry Products, Minneapolis, MN) may be beneficial. It is a nonadhesive collection device that may be changed frequently to permit daily wound care [15]. Protrusion of the stoma is a prerequisite for success of this system; when the stoma is flush or retracted or when local manage-

Figure 2  Parastomal pyoderma gangrenosum bordering an iloeostomy.
ment of the ulcer is not successful, relocation of the stoma must be considered.

Topical application of disodium cromoglycate, an antiallergy medication that stabilizes mast cells and thus hinders histamine release, has been used to treat pyoderma gangrenosum in association with inflammatory bowel disease [20,21]. Although the mechanism of action is unknown, speculation based on the drug’s action on mast cell function suggests that the drug reduces the inflammatory response, leading to healing. In conjunction with the department of dermatology at the Lahey Clinic, a protocol of Domeboro compresses to the ulcer and twice-daily application of both disodium cromoglycate and topical steroid cream to the edge of the ulcer has been developed. The lesion is then covered with Telfa to help provide a dry environment. This protocol has resulted in the most consistent healing of parastomal pyoderma gangrenosum.

Intralesional injection of steroids was first successfully reported by Moschella [22]. Other authors [23] have reported success with injections of triamcinolone around the periphery of the lesions, usually in combination with systemic or topical corticosteroids. The Lahey Clinic experience with this regimen has resulted in a satisfactory response in approximately 50% of patients [4]. Many patients with pyoderma gangrenosum are already being treated with steroids for inflammatory bowel disease. Increasing the dose may result in dramatic improvement of the pyoderma. Whether this is a primary effect on the skin is speculative.

Newer systemic therapies include the use of cyclosporine, which can be administered intravenously [24], orally [25], or both. Reports indicate a very high healing rate with the use of this drug, with considerable improvement in some patients with active intestinal disease as well. Immunosuppression can also be accomplished with FK506 (tacrolimus), which may be used topically or systemically [26]. This drug has been reported to have utility even in patients with failure of cyclosporine, with the added advantage that it can be applied topically with persistent beneficial effects.

Peristomal pyoderma gangrenosum requires prompt and aggressive management of the parastomal ulcers as well as the underlying inflammatory bowel disease. Failure to control either may mandate surgical intervention. Resection of all actively inflamed bowel may permit healing of the pyoderma. Management often requires close cooperation among surgeons, gastroenterologists, dermatologists, and enterostomal therapists to resolve this unusual but debilitating complication.

**PARASTOMAL VARICES**

Creation of a stoma in a patient with underlying liver disease may be complicated by the development of parastomal portal systemic venous shunts. Presumably these shunts are a result of anastomoses between mesenteric
veins and systemic subcutaneous veins. Paracolostomy varices were first reported by Resnick and colleagues [27], who noted that coincident esophageal varices did not bleed in patients with this parastomal collateral pathway. Paracolostomy varices were first noted by Eade and colleagues [28] in patients undergoing proctocolectomy for inflammatory bowel disease. These authors applied the term *caput medusae* to the characteristic appearance of dilated veins around the stoma (Fig. 3). Varices have also been described [29] around ileal conduits created for treatment of various urological conditions. The sole symptom of this rare condition is hemorrhage, which may be life-threatening.

In a review of all reported cases from 1962–1989, Conte and associates [30] analyzed 72 cases, of which 49 involved bleeding from an ileostomy, 15 from a colostomy, and 8 from an ileal conduit. Ulcerative colitis was the most common reason for ileostomy, whereas carcinoma of the rectum or bladder was the most frequent reason for colostomy or ileal conduit. Primary sclerosing cholangitis was the most frequent underlying liver disease in patients with an ileostomy. In a series of 72 patients undergoing surgery for ulcerative colitis with sclerosing cholangitis, parastomal varices occurred in 25% of patients undergoing proctocolectomy and none of 40% of patients undergoing ileal pouch anal anastomosis [31]. This observation

**Figure 3** Caput medusae surrounding an ileostomy.
must be considered in evaluating patients for surgery. Metastatic liver disease was the most frequent cause of parastomal varices in patients with a colostomy. Alcoholic cirrhosis was the most common predisposing liver condition. The interval between creation of the stoma and the subsequent development of varices varied between 2 and 348 months. The clinical presentation in nearly all patients was recurrent episodes of painless gastrointestinal tract bleeding.

Early experience with the management of parastomal variceal hemorrhage indicated that local pressure, sometimes with the addition of topical hemostatic agents, should be the initial procedure of choice [32]. Correction of circulating blood volume and clotting abnormalities should be accomplished as expeditiously as possible. When local pressure is insufficient, suture ligatures may be placed peripheral to the mucocutaneous junction. Mucocutaneous disconnection, in which the stoma is circumferentially detached from the skin and subcutaneous tissue to the level of the fascia with ligation of the varices, has also been successful [32–34]. When these measures are unsuccessful, relocation of the stoma may be necessary.

Because of the success of sclerotherapy in the treatment of patients with esophageal varices, sclerosing solutions have been injected into parastomal varices [35,36]. The technique involves injection of a sclerosant into the tissues peripheral to the mucocutaneous junction rather than injection directly into a discrete varix, which is usually not identifiable. Sclerotherapy can be repeated as necessary in an attempt to obliterate the varices and to lengthen the intervals between bleeding episodes.

These local procedures must be implemented with careful attention to the details of the stoma pouching procedures. Bleeding at the site of the stoma can be aggravated by a pouching system that is too small for the stoma. The enterostomal therapist must teach the patient how to measure the stoma, using the guides provided by the manufacturers of ostomy equipment. A one-piece appliance cut ¼–⅛ in. larger than the stoma should be recommended. Stomahesive paste (Convatec Inc., Princeton, NJ) can be used to protect visible skin when the appliance is cut larger than the stoma [37]. After the proper size of the equipment is determined, the patient must discontinue the use of ostomy belts and rigid face plates. These products can cause friction, local trauma, and erosion at the mucocutaneous junction, which may aggravate bleeding. Patients must also be instructed in the proper gentle removal of the appliance to minimize trauma. Optimal integrity of the parastomal skin must be maintained to avoid further episodes of bleeding and protect against further injury. The patient must also be instructed regarding methods of digital local control for emergency situations.

These local measures are designed to reduce the frequency of bleeding episodes. In the review by Conte and associates [30], digital pressure alone was accompanied by rebleeding in 98% of patients within 10 months. Suture ligature, mucocutaneous disconnection, and revision of the stoma were
accompanied by a rebleeding rate of 100%, necessitating further surgery in many patients. Sclerotherapy yielded similar results.

Controversy regarding the role of portosystemic shunting has existed since the original description of this approach in 1970 [38]. A central splenorenal shunt was reportedly [39] successful in three patients with parastomal varices, as evidenced by no recurrent bleeding and no hepatic encephalopathy. In the collected series [30] of 72 patients, 27 were treated by portosystemic shunting. Most patients had had multiple procedures before portal decompression was attempted. A central splenorenal shunt was commonly used, followed by an end-to-side portocaval shunt. A distal splenorenal shunt was successful in controlling bleeding in two of three patients in the Lahey Clinic series [34]. Rebleeding was seen infrequently after portosystemic shunt procedures, with an acceptable operative mortality rate and absence of encephalopathy. Before a shunt is considered, all patients should be evaluated with biochemical testing, mesenteric angiography, and liver biopsy when appropriate.

Transjugular intrahepatic portosystemic shunt (TIPS) is an angio- graphic technique in which an expandable metal stent is introduced via the hepatic vein through the hepatic parenchyma into the portal venous system. This innovative procedure avoids abdominal surgery in patients who are frequently systemically ill while preserving the portal anatomy for subsequent surgery. It has been successfully applied to patients with parastomal varices [40,41] and should be considered as a viable and perhaps preferred alternative to portosystemic shunt by laparotomy.

Despite the potential severity of recurrent bleeding from parastomal varices, few patients die as a direct result of this complication. Rather, life expectancy is determined by the nature and severity of the underlying liver disease. Consequently, treatment planning must be based on long-term status and function of the liver, including the possibility of hepatic transplantation. When portal hypertension is the result of metastatic liver disease or when severe benign liver disease precludes safe performance of portosystemic shunting or liver transplantation, local measures must suffice. If, on the other hand, the patient is a potential candidate for transplantation, local measures should be used to temporize the problem until deterioration of liver function justifies liver transplant. If local measures are unsuccessful, a distal splenorenal shunt or some other peripheral shunt is preferred to a central shunt, which may render transplantation technically difficult or impossible.

**ADENOCARCINOMA IN AN ILEOSTOMY**

Adenocarcinoma arising in an ileostomy is still rare enough to be described in isolated case reports. Since the original description in 1969 [42] through
1993, a total of 16 cases had been reported [43–52]. An additional case of adenocarcinoma arising in an ileostomy was thought to be secondary to residual rectal carcinoma after resection of an ileorectal anastomosis with creation of an ileostomy [53].

The majority of reported cases of adenocarcinoma arose in an ileostomy originally performed for chronic ulcerative colitis, although in approximately one-third of patients the primary diagnosis was familial adenomatous polyposis. Delay between construction of the ileostomy and subsequent carcinoma in the ileostomy varied between 9 years and 38 years, with a median of 23 years. Presenting symptoms included bleeding, parastomal ulceration, and a change in the appearance of the stoma. Pain and obstruction have also been observed, although less frequently.

Pathologically, the tumor is usually a well-differentiated or moderately well-differentiated mucin-producing small bowel adenocarcinoma arising at the mucocutaneous junction. Variable amounts of invasion of the skin and subcutaneous tissue have been described. In only one patient was mesenteric adenopathy reported to be present [51]. Of potential importance is the description of ileal mucosal dysplasia associated with carcinoma in five patients [43,45–47,50].

The clinical presentation of paraileostomy carcinoma should suggest the diagnosis. Inspection of the parastomal skin reveals an ulcerated mass (Fig. 4); a biopsy should be obtained under local anesthesia. Sampling error may result in diagnostic inaccuracy. Consequently, when the clinical suspicion is strong, further biopsies should be obtained; this may require general or regional anesthesia. Definitive surgical management is excision of the ileostomy and the distal small bowel with a wide margin of the abdominal wall resected in continuity. The stoma should be translocated to an alternative site, with closure of the primary abdominal wall defect. No reported cases have required major tissue transfer, although prosthetic mesh may be necessary for abdominal wall reconstruction [51]. In two reports [42,47], metastatic disease to the liver was the cause of death in two patients. Recurrence of disease in the abdominal wall is a consideration, but adjuvant radiotherapy has not been advocated. In one report [49], a recurrent pelvic adenocarcinoma was managed successfully by radical resection. Follow-up data are not sufficient to indicate a definitive prognosis in these patients.

Speculation regarding the cause of paraileostomy carcinoma is based on the association of backwash ileitis and dysplasia noted in many of these patients. One report [54] suggested an association between backwash ileitis and subsequent ileal dysplasia and ileal carcinoma. If this were true, one might undertake a routine prospective surveillance program with ileoscopy and biopsy in all patients having undergone construction of an ileostomy for either ulcerative colitis or familial polyposis. The rarity of this clinical entity, however, may not justify such an aggressive approach. Rather, regu-
Figure 4  Invasive adenocarcinoma arising in an ileostomy.

lar inspection of the stoma by a physician or enterostomal therapist with selected biopsy of abnormal areas is probably sufficient.

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The creation of an intestinal stoma is a nearly purely technical endeavor. In most situations it is relatively simple and can be well performed by any experienced surgeon. However, under some circumstances, creating a well-perfused, properly placed colostomy or ileostomy can be very difficult. These include the placement of stomas in patients who are morbidly obese, those who have had multiple surgeries, those requiring two intestinal stomas, and patients with spinal cord injury.

This chapter suggests preoperative planning strategies and technical tips that will hopefully make even difficult stoma creation safe and satisfying.

In creating temporary stomas, thoughtful considerations of future stoma take-down will make the ensuing surgery safer and less difficult. This chapter offers insight into the creation of temporary stomas, which do not require subsequent laparotomy for take-down. In addition, it offers several methods of making a “Hartmann take-down,” often a very challenging endeavor, less difficult.

Even in the best of circumstances, some stomas will develop postoperative ischemia. This chapter includes methods of assessment for evaluating the degree of the ischemia in the early postoperative period. Treatment algorithms are also included, which will help determine appropriate treatment for various degrees of stomal ischemia.

Overall, this chapter offers some relatively simple, straightforward technical advice that will lead to the creation of the well-perfused, properly placed intestinal stomas which, if necessary, will last a lifetime.

INTRODUCTION

On having read this chapter, the reader should be able to understand situations where the creation of an intestinal stoma is technically challenging.
Further he/she should be aware of many technical tips which will make difficult stoma creation simpler and safer.

TECHNICAL TIPS FOR THE DIFFICULT STOMA

An intestinal stoma, commonly created at the end of a long and complex operation, is often the greatest predictor of long-term postoperative quality of life. They are often left to be completed by junior residents with little functional knowledge of stoma creation and even less clinical experience. Each stoma represents an intestinal anastomosis and all principles that apply to creating any intestinal anastomosis similarly apply to stoma creation. The need to avoid tension and preserve blood supply is no less important in stoma creation. Keeping that in mind, the following chapter hopefully elucidates techniques for creating properly placed, well-vascularized stomas without undue tension, even under difficult circumstances.

Many times the creation of a well-vascularized stoma without tension is a relatively simple process. However, in the obese patient, the patient with multiple surgical scars, or in individuals with a short, thick mesentery, it can be very challenging. The following paragraphs provide a summary of technical tips for creating healthy, functional stomas in these adverse situations. In addition this chapter also details other technical pearls for creating temporary stomas, which will lead to easier stoma take-down and often avoid the need for a second laparotomy.

PREOPERATIVE PREPARATION

A significant percentage of stoma-related complications are due to improper placement. Peristomal hernias and stomal prolapse are more commonly associated with stomas placed outside the rectus abdominis, while peristomal leakage and poorly fitted appliances are associated with stomas placed too close to incisions, bony prominences, or large skin folds. Nearly all these complications can be prevented by proper preoperative marking and stoma placement. Elective cases allow the luxury of time; therefore an enterostomal therapist, if available, can mark patients preoperatively. Emergency cases require urgent marking either in the emergency room or the patient’s hospital room. In all but the most unstable of patients, a few minutes to identify an appropriate site for an intestinal stoma will go a long way toward avoiding postoperative complications.

The marking sequence should require 1 or 2 min (see Fig. 1). The anterosuperior iliac spine, pubic tubercle, and umbilicus are identified, as is the lateral aspect of the rectus muscle. Following this, the patient’s belt line is marked. With this information, a stoma site (right side for ileostomy, left side for colostomy) can be identified. The stoma should pass
through the rectus abdominis muscle and be 5 cm away from bony prominences, skin folds, old incisions, and the umbilicus. If possible, once the site is marked, the patient should be asked to sit up, to ensure that large skin folds do not develop at the previously marked site. Individuals with disabilities should be marked in the position in which they spend the majority of their time. For example, a patient with a spinal cord injury who is wheelchair-dependent should be marked while seated in his or her chair. Often these individuals, as well as individuals with significant abdominal obesity, will be better served with a stoma above the umbilicus.

Stoma marking is particularly important in patients who require multiple stomas, who have had prior stomas, or who have had multiple abdominal incisions. It is important to remember that the both the left and right upper quadrants are potential stoma sites as well as the umbilicus and the midline in the suprapubic region. These are all much less commonly employed than the right- and left-lower-quadrant transrectus stoma sites but may in some circumstances allow the creation of a well-functioning stoma in an individual with a difficult abdominal wall. In rare instances the often forgotten but once popular lumbar colostomy can also be used (see Fig. 2).
CHOOSING THE APPROPRIATE INTESTINAL SEGMENT

Many times the intestinal segment is dictated by the surgical pathology, such as a sigmoid colostomy following abdominoperineal resection for rectal cancer or an ileostomy following total proctocolectomy for inflammatory bowel disease. However in some cases, particularly with temporary stomas, several intestinal segments may be available for stoma creation. Regarding both the small intestine and the colon, the more distal the stoma, the better the function (i.e., a sigmoid colostomy is superior to a right transverse colostomy). However this is not always true. For example, an ileostomy may be tolerated far better than a right transverse colostomy. The following principles should serve to help determine stoma placement:

1. If the stoma is temporary and re-establishment of continuity is likely, the preservation of bowel length should take precedence over creating the optimal stoma—i.e., if a left colectomy is performed for an obstructing descending colon carcinoma, it is preferable to create a midtransverse colostomy with plans for later
anastomosis between the transverse colon and the rectosigmoid rather than excising the remaining colon and creating an end ileostomy.

2. If the stoma is likely to be permanent (based on clinical judgment at the time of the operation), emphasis should be placed on creating a stoma that will function well for the remainder of the patient’s life; i.e., in an elderly individual undergoing left colectomy for ischemic colitis, it is often wiser to perform a total abdominal colectomy with end ileostomy than to preserve the right colon and leave the patient with a right-side transverse colostomy.

Finally, when a diverting stoma is required, often to protect a low pelvic anastomosis or to treat an Anastomotic leak, a loop ileostomy is far superior to a transverse loop colostomy. Transverse loop colostomies are associated with substantially higher complication rates and substantially lower patient satisfaction than are loop ileostomies [1,2]. Transverse loop colostomies are to be avoided at nearly all costs as they are prone to stoma-related complications such as prolapse and hernia, are difficult to pouch, and are often associated with odor and leakage problems.

PREPARING FOR OSTOMY TAKE-DOWN

Except for those performed as planned diversions proximal to intestinal anastomoses, most temporary stomas are created under emergency conditions, often in the presence of intra-abdominal sepsis and/or hemorrhage. This can lead to extensive intra-abdominal adhesions making repeat laparotomy and subsequent stoma takedown exceedingly difficult. The classic example of this is a Hartmann take-down following sigmoid resection and end descending colostomy for emergency surgery for complicated diverticular disease. At the time of original stoma creation, thoughtful consideration of the second stage can often make reoperation easier. The thought process should be as follows:

1. Can an intestinal stoma be safely avoided?
2. What maneuvers can be performed at the time of this operation to increase the ease with which the second operation can be performed?
3. Can a stoma be created in which laparotomy is not required to re-establish intestinal continuity?

The issues surrounding avoidance of a stoma are beyond the scope of this chapter and have been thoroughly discussed in the literature on colon and rectal surgery. They are not further discussed here.

Several maneuvers can be performed to improve the ease of stoma take-down and decrease operative complications. The most challenging
cases of this nature involve establishing continuity after a Hartmann procedure, usually performed in the emergency treatment of diverticulitis or obstructing rectosigmoid cancer.

At the first operation, several maneuvers can make the second stage simpler and safer:

1. The extraperitoneal planes surrounding the rectum should not be dissected.
2. If possible, the distal rectal stump should be brought to the anterior abdominal wall.
3. If it is long enough, the rectal segment should be placed underneath the abdominal wall adjacent to the end sigmoid colostomy.
4. If this is not possible due to the segment’s length, the rectal stump should be sewn to the underside of the inferior aspect of the abdominal incision.
5. Often the rectal stump is too short to reach anywhere on the abdominal wall. In that case, one should consider tacking the rectal stump up to the sacral promontory. Following a Hartmann procedure, the rectal stump often recedes low into the pelvis and is adherent to the sacral hollow. This makes its identification difficult. In addition, it is often impossible to advance the endoluminal stapler to the proximal portion of the rectum due to tortuosity. Suturing the upper portion of the rectosigmoid to the sacral promontory prevents the regression of the rectal stump into the sacral hollow, making it easier to identify. In addition, the rectal stump is often less tortuous and allows for easier transanal passage or the endoluminal stapler. Finally, the rectosigmoid staple line should be marked with long, nonabsorbable sutures in order to allow for easier identification. It is common at the second-stage operation to find multiple loops of small bowel adherent to the pelvis. Identification of the rectal stump via these marking sutures often minimizes the extent of pelvic dissection, decreasing the risk of injury to the small bowel.

The performance of these additional maneuvers at the time of the primary surgery is simple, safe and not time-consuming. These maneuvers will bring substantial benefits later on, in minimizing the complexity and complications associated with subsequent stoma take-down.

**AVOIDANCE OF SUBSEQUENT LAPAROTOMY**

End loop stomas [3] have been used for both simple upstream diversion of intestinal anastomoses and also for the creation of a single stoma using remote intestinal segments. Creation of an end loop stoma allows for subse-
The Difficult Stoma

quent take-down without the need for laparotomy. An example would be a patient who has sustained a right colon injury necessitating right hemicolectomy. Because of extensive fecal soilage, a primary anastomosis is not felt to be appropriate. Under these circumstances, an end loop stoma can be created following intestinal resection. This is done by preparing the terminal ileum as for standard end ileostomy. The hepatic flexure and proximal transverse colon are mobilized as well. At a previously chosen stoma site, a slightly oversized stoma trephine is created. The terminal ileum is brought through the abdominal wall, as in creation of a standard ileostomy. Following this, the antimesenteric corner of the previously stapled proximal transverse colon is brought through the upper aspect of the same stoma site (see Fig. 3). Subsequently the ileostomy is matured in routine fashion. The antimesenteric corner of the staple line is excised, and the entrotomy subsequently created in the antimesenteric corner of the transverse colon is matured primarily to the skin without eversion (see Fig. 4). The creation of an end loop stoma has two significant advantages: (1) The patient recovers

Figure 3  End loop stoma. Both proximal and distal limbs are brought through one stoma site.
Figure 4  End loop stoma. Fully matured Brooke ileostomy and noneverted, primarily matured distal colotomy.
with only one intestinal stoma and (2) laparotomy is not required for subsequent stoma take-down.

At the time of second surgery, an incision is made around the stoma site; then the proximal transverse colon and the terminal ileum are brought through the wound and mobilized appropriately. An intestinal anastomosis is created and dropped into the peritoneal cavity. The wound is closed appropriately. Thus, the intestinal continuity can be restored without the need for laparotomy.

This can similarly be done at other sites in the colon or small bowel as appropriate. The only criteria for performing this type of end loop stoma is that both the proximal and distal ends will reach the same, appropriate stoma site on the anterior abdominal wall. Creation of these end loop stomas may be slightly more difficult at the time of the primary operation but will avoid the need for repeat laparotomy and often extensive adhesiolysis at the time of stoma take-down and re-establishment of the intestinal continuity.

CREATING DIFFICULT STOMAS

Aside from finding the appropriate stoma site in patients with multiple stomas or with complex anterior abdominal walls, nearly all difficulty occurring in creating intestinal stomas results from the need to create a well-perfused stoma that reaches and protrudes through the anterior abdominal wall. The following factors predispose to difficult stoma creation:

1. Emergency surgery
2. Obstructed/dilated bowel
3. Thickened short mesentery
4. Thick, fat-laden abdominal wall

In these difficult situations, maintaining perfusion and creating a stoma without tension are often at odds. Extensive mobilization of the bowel with resection and thinning of the mesentry can nearly always lead to the creation of a protruding stoma with no tension whatsoever. Unfortunately, this comes at a price. Mobilization and particularly mesenteric resection often result in subsequent ischemia of the terminal stoma. The technical difficulty lies in creating an appropriate compromise, thereby producing a well-perfused stoma without undue tension. The following paragraphs hopefully illustrate several “tricks” to achieve this goal.

THE DIFFICULT COLOSTOMY

In most obese individuals, the abdominal wall is substantially thicker below the umbilicus, consistent with the characteristic American panis or “beer
belly.” Often, the abdominal wall above the umbilicus is relatively free of extensive adipose tissue. This discrepancy can be used to the surgeon’s advantage for creating a stoma in obese individuals. Further, stomas created below the umbilicus are often difficult for obese individuals to care for. Upon standing and sitting, they often disappear below the abdominal panis, making visual stoma care nearly impossible, while stomas above the umbilicus stay upright are easily visualized and cared for. For these reasons supraumbilical stomas are often the ostomies of choice in obese individuals (see Fig. 5).

The classic scenario leading to the creation of a difficult stoma is as follows. An extremely obese male requires emergency surgery for complicated diverticular disease. The abdominal wall is muscular and is covered with a large apron of adipose tissue. The sigmoid mesentery is thickened and short due to inflammation associated with the diverticulitis. These factors make creation of end sigmoid colostomy or end descending colostomy difficult.

The following factors should be considered in order to achieve the desired results:

1. Is there any safe alternative to colostomy creation? That is, in some individuals a primary anastomosis may in fact be safer than creation of a difficult left-sided colostomy (a diverting ileostomy can be considered following creation of an anastomosis if necessary).
2. All inflamed sigmoid colon should be excised.
3. The segment of colon used for the colostomy should be free of inflammation, thickening, or edema.
4. The lateral peritoneal reflection should be taken down completely, leaving the left colon attached only by its midline mesentery.
5. Medial peritoneal attachments at the base of the colonic mesentery should be transected in order to increase mobility.
6. The splenic flexure should be fully mobilized.
7. The inferior mesenteric artery proximal to the takeoff of the left colic artery can be ligated, if necessary, to provided additional length.
8. “Windows” can be created in the medial and lateral aspects of the mesocolon in order to increase length.
9. The mesentery adjacent to the terminal left colon can be trimmed provided that a 1-cm segment of mesentery containing the marginal artery is left attached to the colon wall.
10. An oversized abdominal trephine will often allow passage of a thick colonic mesentery, preventing venous congestion and subsequent stomal ischemia.
11. A stoma site above the umbilicus, as previously mentioned, will decrease the thickness of the abdominal wall through which the colon must pass and will often further decrease tension, as mobilized left colon reaches most easily to the abdominal wall above the umbilicus.

Use of these tips or tricks will nearly always result in a well-profused end colostomy reaching the abdominal wall without undue tension. In rare circumstances, despite all these maneuvers, it will be impossible to create
a well-tempered sigmoid colostomy. In this circumstance, although rare, a “pseudoloop” colostomy can be created using the antimesenteric border of the left colon (see Fig. 6). After all the previously mentioned maneuvers have been performed, the distal aspect of the left colon is “stapled closed” and left in the peritoneal cavity. The antimesenteric border of the colon just proximal to its terminal end is then brought to the anterior abdominal wall. A colotom is made in the antimesenteric border and is matured primarily to the abdominal wall. This situation is less than ideal but often results in a functional left-sided colostomy, allowing the patient to recover from emergency surgery. The stoma can either be revised later, if necessary, or taken down if appropriate.

**THE DISTENDED COLON**

In the obstructed colon, distention creates two problems: (1) the distended colon is less likely to reach the anterior abdominal wall without tension and (2) a distended colon can cause compressive venous obstruction as it passes through the abdominal fascia, resulting in potential ischemia.

In these circumstances, decompression of the distended colon often solves both problems. The colon becomes more mobile and reaches the abdominal wall tension-free. In addition, once the luminal pressure has been

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**Figure 6** The “pseudo-loop” colostomy can be employed in rare cases when no other stoma can reach the abdominal skin.
The Difficult Stoma

relieved, there are less compressive effects secondary to constriction at the fascial level, resulting in less venous congestion. For these reasons it is best to decompress the colon and mature the stoma prior to closing the abdominal incision (as opposed to the traditional approach, where the abdominal incision is closed first and the stoma is matured secondarily). This will allow evaluation of stomal perfusion following decompression but prior to closure of the abdominal wound. If the stoma appears viable, maturation can be completed. If it still appears ischemic or under tension, further maneuvers may be necessary in order to create a successful stoma.

THE DIFFICULT ILEOSTOMY

Difficulty with undue tension and stomal ischemia is much less common with end ileostomy than with end colostomy. This is based on the more redundant nature of the small bowel mesentery, the improved perfusion of small intestine, and the decreased size of the small intestinal lumen. However, situations do exist where creation of the end ileostomy can be challenging. The following steps should be helpful in ensuring a tension-free, well-perfused stoma:

1. Supraumbilical placement, particularly in the obese individual, is often beneficial.
2. Mobilization of the small bowel mesentery to the base of the duodenum, as done for the ilea-pouch anal anastomosis, often results in substantial mobility.
3. The ileocolic artery can nearly always be ligated at its origin without subsequent stomal ischemia.
4. An oversized abdominal wall trephine is beneficial in decreasing tension and improving perfusion in thickened bowel with short mesentery.
5. Although not ideal, a “noneverted” ileostomy can be created in an emergency situation.

These maneuvers once again will nearly always lead to the creation of a well-perfused ileostomy without undue tension. However, in the rare case that an end ileostomy cannot be safely created, once again a “pseudo-loop” ileostomy may be necessary. All the maneuvers previously described in the creation of a pseudolooop colostomy are performed. The end of the terminal ileum is stapled closed and the antimesenteric border of the bowel just proximal to the terminal portion of the terminal ileum is brought through the anterior abdominal wall. Once this has been completed, an enterotomy is made in the antimesenteric ileal wall and the bowel is matured primarily without eversion to the abdominal skin (similar to the “pseudo-loop” colostomy see Fig. 6). This results in a less than ideal stoma, but it can be revised at a later date or taken down as appropriate.
POSTOPERATIVE EVALUATION OF THE MARGINAL STOMA

In the early postoperative period, essentially all stoma-related complications are secondary to ischemia. Difficulty at this point revolves around proper evaluation and treatment. Ischemia can be divided into several categories: First, superfascial vs. subfascial ischemia and, second, mucosal vs. full-thickness ischemia. Mucosal ischemia is most commonly self-limiting and results in mucosal sluffing and regeneration, with no long-term consequences. Muscular ischemia, which is superfascial and usually confined to bowel, results in stomal stenosis or separation. This leads to a stenotic retracted stoma that is difficult to manage but does not require urgent surgical treatment. Finally, subfascial full-thickness ischemia, if untreated, will lead to intestinal necrosis, intraperitoneal soilage, and potential intra-abdominal catastrophe.

For these reasons it is important to distinguish between mucosal and full-thickness ischemia and between subfascial and superfascial ischemia. This is done in the following ways. A pediatric test tube is lubricated and inserted into the stomal lumen. This can be illuminated with a penlight or an ophthalmoscope. Due to its optics, the ophthalmoscope allows for better viewing. If pink mucosa is identified above the fascial layer, no further treatment is necessary. If ischemic mucosa is identified subfascially, further treatment may be necessary. In order to assess muscular perfusion, an 18-gauge needle is used to prick the site of mucosal ischemia. If bright red blood is seen emanating from the puncture site, the muscle is well perfused and observation is appropriate. If no bright blood emanates, this may be indicative of muscular ischemia.

If muscular ischemia exists below the level of the fascia, then in all circumstances stoma revision is required. If muscular ischemia is confined to the subcutaneous tissues, then either surgery or observation may be appropriate. If the ischemic stoma was designed to be temporary, then perhaps observation with subsequent stomal take-down rather than revision is appropriate. This, however, will often result in a stoma that is difficult to pouch, but it will be a short-term problem resolved with eventual stoma take-down. However, if the stoma was a created as a permanent stoma, then revision in the early postoperative period may be most appropriate, as muscular ischemia, even at the superfascial level, will result in significant stomal stenosis, requiring revision at some time in the future.

CONCLUSIONS

Intestinal stomas represent intestinal anastomoses, and all principles important in the creation of any anastomosis should apply to their creation. The
success of their creation will often be a major determinant of the individual’s quality of life following major abdominal surgery. Their creation should not be relegated to junior members of the surgical staff with limited clinical knowledge and less practical experience.

Preoperative marking, particularly in the multiply operated or disabled patient, is most important in preventing postoperative complications and improving quality of life. In creating temporary stomas, it is best to consider the implications of stoma take-down and do what is possible at the primary operation in order to decrease the morbidity and mortality of secondary surgery.

The previously mentioned “technical tips,” applied judiciously, should result in the creation of a well-perfused, tension-free stoma in even the most difficult circumstances.

REFERENCES

INTRODUCTION

Creation of intestinal ostomies in children is required for the treatment or palliation in a variety of disease processes. Pediatric patients with intestinal ostomies continue to be a management challenge. These patients differ from adults both in indications and technique. Successful care of the pediatric patient with an intestinal ostomy can be a complex and lengthy process requiring family education and support. The underlying disease processes, acquired or congenital, place stress on the patient, family, and caretakers. Both ostomy creation and closure are considered major interventions and are not without complication: complication rates exceeding 50% have been observed. Good management and prevention of complications requires close follow-up and high-quality care at home. Fortunately most pediatric ostomies are temporary and can be closed after resolution of a disease process or after additional reconstructive surgery.

The use of ostomies in infants and children has been changing. Historically, ostomies were used more frequently in the pediatric population. Indications once common are now changing, as in infants with cystic fibrosis complicated by meconium ileus. The major indications for ostomies in the pediatric age group are discussed in this chapter. Current trends in the literature, which are also presented, offer alternatives to the traditional creation of an ostomy, particularly in the management of necrotizing enterocolitis and Hirschsprung’s disease.

NECROTIZING ENTEROCOLITIS

Background

Necrotizing enterocolitis (NEC) is predominantly a disease of premature infants, with those of lower gestational age and birth weight being at the...
highest risk. Until resection with ostomy formation became the standard of care, surgical management of NEC was not often successful. Sporadic cases of necrotizing enterocolitis have been described in the literature since 1826 [1]. The first report of a neonate successfully treated surgically for NEC was in 1943 [2], and NEC continues to be a frequent cause of morbidity and mortality in the premature infant, occurring in 1–3 of every 1000 births [3]. The average weight of infants with NEC is 1676 g [4].

The pathology in NEC is full-thickness coagulation (ischemic) necrosis and perforation of the bowel wall. The pathogenesis of NEC still remains unclear, although many factors have been implicated. Indomethacin treatment and cocaine exposure are particular pharmacological risk factors. The incidence of NEC in infants who have never been fed is quite low. Some authors have suggested that feeding may either cause or at least stimulate the development of NEC in infants predisposed to this condition [5]. Molecular biological evidence has implicated a number of cytokines in NEC. Both platelet activating factor (PAF) and tumor necrosis factor (TNF) are found in high levels in the blood of neonates with NEC and are believed to play major pathophysiological roles [6,7]. An unknown stimulus is believed to set off a chain of events leading to activation of inflammatory factors, low-flow state, ischemia, bacterial infiltration, and necrosis. NEC is not always a one-time event but has a recurrence rate of 4–6% [8].

**Management**

The three most common findings are abdominal distention (70–98%), blood per rectum (79–86%), and high gastric residuals after feeding (>70%) [8]. Nonspecific signs include lethargy, temperature instability, and apnea [9]. Thrombocytopenia, neutropenia, metabolic acidosis, and coagulopathy portend poor outcome [10]. Radiological findings in NEC can vary from a nonspecific ileus pattern to the more specific signs including pneumatosis intestinalis, portal vein gas, pneumoperitoneum, intraperitoneal fluid, and persistently dilated bowel loops (Fig. 1).

Once recognized or diagnosed, NEC is treated with cessation of feeds, gastric drainage, intravenous hydration, and broad-spectrum antibiotics. When indicated, colloid, platelets, and fresh frozen plasma are given. More than 50% of those patients can be managed nonoperatively [11]. Evidence of pneumoperitoneum on left lateral decubitus or cross-table lateral abdominal films is an absolute indication for surgery. Clinical deterioration, declining platelet counts, and either increases or decreases in the white blood cell count can be indicative of a turn for the worse. Metabolic acidosis and a severely depressed platelet count may be indicators of ongoing intestinal necrosis. Discoloration of the premature neonate’s thin abdominal wall is a sign of peritonitis. A diagnostic peritoneal tap may be performed to prove perforation.
Figure 1  Pneumoperitoneum. Preoperative film of a premature neonate with perforated necrotizing enterocolitis. Free air is visible beneath both diaphragms. The gas pattern overshadowing the liver is suspicious for pneumatosi.

Preoperative management includes correction of hypoxia and hypovolemia and maintenance of the neonate’s body temperature. The operative approach in these infants is a right supraumbilical transverse incision. This incision avoids the possibility that the newborn’s large liver will obstruct the exposure or become injured during the procedure. The entire gastrointestinal (GI) tract is inspected for evidence of perforation and necrosis. A resection with primary anastomosis can rarely be done and is indicated only in extremely localized disease, most commonly involving the terminal il-
en. In 44% of cases, both the large and small intestines are involved. The colon alone is involved in 26% of cases, while 30% of cases have disease limited to the small intestine [8]. The process can be localized, segmental, or diffuse, without clear demarcation. White or gray areas usually indicate full-thickness necrosis. Lack of tone and peristalsis are ominous signs. Discoloration secondary to intramucosal hemorrhage can make delineation of the disease process more difficult.

The principles of operative management in NEC are resection of all the gangrenous bowel and exteriorization of the questionably viable ends to minimize the length of resection [12]. The length of residual bowel should be measured on its antimesenteric border and recorded. NEC may involve a short isolated segment (near 100% survival), multiple segments (>50% survival), or panintestinal involvement (NEC totalis, <25% survival) [8]. Intraoperative decisions are directed at minimizing resection and preserving, if possible, the ileocecal valve. Short gut syndrome may occur in up to 23% of NEC survivors who have undergone a resection; thus every attempt must be made to preserve bowel length [8]. Short gut syndrome is a major risk in these patients if more than 40–50% of the small bowel has been removed [13]. If the ileocecal valve can be salvaged and at least 20–30 cm of small bowel remains, total enteral feeds may eventually be possible.

In infants with isolated disease, the approach is straightforward. Necrotic and/or perforated intestine is resected and a proximal ostomy with a distal mucous fistula is created. In selected cases, in order to save the ileocecal valve, the distal bowel is oversewn if the line of demarcation is close to the valve. A primary anastomosis is not created because the ends of resection may have a tenuous blood supply and progress to necrosis. Shock and peritonitis are contraindications to a delicate, time-consuming anastomosis. The ostomies are exteriorized through the incision to accommodate the expected thickened and shortened mesentery and to prevent additional compromise to the blood supply (Fig. 2). As opposed to placement of adult stomas, ostomy placement in the laparotomy incision is very acceptable, since it is temporary and will facilitate dissection at the time of ostomy closure. One centimeter of intestine is exteriorized and no attempt to mature the ostomy is made. This may further diminish the blood supply to the ostomy and is ultimately unnecessary. It also allows the visualization of ongoing NEC insults. The ostomy serosa is fixed to the fascia using interrupted sutures [8]. Single-layer fixation often results in early ostomy prolapse. Therefore these ostomies are fixed in two layers, peritoneum and fascia, with fine, nonabsorbable, braided polyester suture, carefully avoiding blood vessels (Fig. 3). Securing the ostomy in one layer using full-thickness bites through the entire abdominal wall has also been described [15]. The pediatric surgical literature does not demonstrate statistically sig-
Figure 2  Spontaneous stoma maturation. This neonate, about 2 weeks after ileal resection for necrotizing enterocolitis, had both stomas brought through the incision. Both stomas have matured spontaneously.

significant differences in the complication rate between these methods [15]. Once they are fixed, formal maturation of these ostomies is not needed but will occur spontaneously in about 2 weeks.

In newborns with multisegmental disease, several options are available to minimize gut loss. Necrotic bowel is resected with the creation of multiple ostomies (rarely more than four). Resections with primary anastomoses may be created if they are protected by a proximal jejunostomy. The jejunostomy can be brought through a separate site below or above the transverse incision. This approach has been described to maximize gut salvage and minimize the number of ostomies [16,17]. As expected, proximal
jejunostomies generally are poorly tolerated by these newborns with inevitable nutritional, fluid, and electrolyte losses.

An alternative technique to improve bowel salvage and avoid ostomy creation in these desperately ill babies is, as described in Vaughan’s 1996 report, to “clip and drop-back” [18]. Vaughan recommends removing the obvious segments of necrotic bowel and then closing all of the ends with titanium clips or staples. At a second-look operation in 48–72 hr, additional resection is performed if required, and all segments are reconstructed to establish continuity (Fig. 4).

In 1989 Moore first described his technique of “patch, drain, and wait” [19], and he recently published a promising follow-up on his experience [20]. In Moore’s procedure, no resections are performed. The surgeon identifies all perforations and closes them with a single layer of transverse sutures (patch). Two Penrose drains exit from the lower quadrants of the abdomen (drain). Following this, commitment is made to long-term total parenteral nutrition, which can even be continued at home as the patient improves (wait). The drains are not removed until all fecal drainage has stopped. With spontaneous autoanastomoses in these infants, 70% of his patients did not require re-exploration and fecal drainage stopped in less than 2 months [20].
Figure 4  Clip and drop back. This figure, adapted from Vaughan’s original paper in 1996, depicts the use of surgical clips to isolate and resect necrotic pieces of bowel.
Unfortunately, 19% of infants with NEC present with panintestinal involvement, often with catastrophic consequences. The decision to forgo treatment in these patients was made based on an expected fatality rate of nearly 100% [8]. However, techniques with potential benefit have been described in the literature. Creation of a high jejunostomy without resection in a patient with massive necrosis of the small and large bowel has been described by Martin and Firor [21,22]. Recently, Surgarman and Kiely reported a 50% survival rate in a series of 113 patients utilizing a high jejunostomy with re-exploration and reconstruction 6–8 weeks after the original procedure [23].

In newborns described as extremely ill from intestinal necrosis and/or perforation, the risks of laparotomy are feared to be prohibitive. Some have been successfully treated with peritoneal drainage. Penrose drains are used to create controlled enterocutaneous fistulas. The peritoneal cavity is drained in the setting of the neonatal intensive care unit under local anesthesia with a small Penrose drain. This technique was first described by Ein et al. in 1977 [24]. Survival rates as high as 74% are reported [25]. Some authors have reported survival rates higher than that of traditional laparotomy, most specifically in premature newborns weighing less than 1000 g [25,26].

Stomal closure of the enterocutaneous fistula is typically performed 2–4 months after recovery. A high ostomy output often requires earlier closure. Closures before 4–6 weeks are prohibitory due to residual inflammation. A complete distal bowel contrast study is necessary before closure to ensure that there is no distal obstruction or stenosis. Areas of stenosis form in as many as 20% of cases as a result of the scarring from partial-thickness necrosis [27,28]. If distal stenosis is present, a resection should be done at the time of reconstruction.

Complications

Overall postoperative survival in NEC in the recent literature ranges between 65 and 81% [8]. These neonates are usually premature and quite frail, predisposing them to serious complications. Horwitz et al., in a multicenter review, reported a total complication rate 47%. The most frequent complications were sepsis and stricture [11] (see Table 1).

Resections for NEC are done with an effort to conserve as much bowel as possible, occasionally leaving ostomies with a tenuous blood supply. This predisposes the ostomies to ischemia and necrosis followed by retraction (10–18%). Mucous fistulas re-epithelialized after necrosis without adverse effect. However, if the functional ostomy necrosis extends deep to the skin, revision is necessary to prevent stricture [29]. Ostomy closure may be considered as opposed to revision, depending on time course and clinical situation. Other common complications are peristomal hernia (10–12%) and prolapse (<5%) [15]. Both of these complications may force re-
Table 1  Complications in Necrotizing Enterocolitis

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<tr>
<td>Sepsis</td>
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<td>Wound infection</td>
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<td>Disseminated intravascular coagulation</td>
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<td>Intraabdominal abscess</td>
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vision of early closure. An externally draining intestinal fistula from a seromuscular suture penetrating the mucosa is not serious. However, a perforation draining into the peritoneal cavity obviously necessitates emergency revision.

Fecal incontinence is a major problem for children who suffer congenital anomalies such as spina bifida, Hirschsprung’s disease, imperforate anus, or trauma and tumors resulting in spinal cord damage. Chronic constipation is another process that affects many children. Patients and their parents must learn to cope with these most unpleasant situations. In helping these families, the ultimate goal is to maximize the patient’s independence, bowel predictability, and cleanliness. Traditional measures to handle fecal incontinence and constipation include dietary regimens, laxatives, digital disimpactions, and enemas. Since these patients may be insensitive to normal colonic peristaltic flow, the most effective way to manage incontinence is regularly scheduled colonic emptying.

Management

In 1987, Shandling and Gilmour introduced the enema continence catheter (ECC) [30]. This specially designed catheter allows for the administration of an enema without an immediate return. The catheter is placed in the rectum and a balloon is inflated. The enema is secured in place with the baffle secured against the anal skin, thus preventing leaking of enema contents prior to removal of the catheter.

Based on Shandling and Gilmour’s report, Malone described a new operative technique using antegrade colonic washouts to empty the colon—the Malone antegrade continence enema (MACE) (Fig. 5). In Malone’s
Antegrade continence enema. While the child sits on the toilet, a red rubber catheter is inserted into the appendicostomy and the colonic washout solution is instilled by gravity. An older child can do this without assistance, usually within an hour.

Subsequently that particular appendiceal approach was abandoned [32]. Currently, the cecum is fixed to the anterior abdominal wall and the closed end of the appendix is brought though the right-lower-quadrant anterior abdominal wall (Fig. 6). A horizontal Y-shaped skin incision is made in the right lower quadrant, leaving a triangular skin flap. The appendix is opened along its antimesenteric wall for a distance comparable to the length of the triangular skin flap. The tip of the triangular skin flap is then sutured with absorbable suture to the apex of the antimesenteric slit and continued circumferentially so the flap resembles a gutter. This buries the appendiceal mucosa. The skin and subcutaneous tissue is then closed separately leaving
Figure 6  Appendicostomy anatomy. The skin flaps both protect the appendiceal mucosa and create a continent valve through which there is rarely soilage.

A Y shaped suture line with the mucosa of the appendix protected (Fig. 7). An indwelling 8, 10, or 12F Foley catheter stents the appendicostomy for 2–4 weeks. The ostomy then provides a continent stoma through which anterograde colonic washouts can be administered, thus preventing soilage. The site is eventually managed with little or no dressing.

The stoma can be placed in the crease of the umbilicus for concealment to improve patient self-esteem (Fig. 8). Patient satisfaction with this procedure exceeds 90%. Since a skin flap is not created with this modification, plication of the cecum over the base of the appendix is necessary to prevent leakage. With plication of the cecum, as many as 85% of patients will have no leakage from their stoma and thus no need for a dressing [33].

Patients are started on postoperative day 1 with a daily regimen of saline enemas, 50 mL twice daily, which is increased to 100 mL per year of age by 1 week postoperatively. A period of time is then required to determine the appropriate volume of enema; the solution administered which includes tap water, normal saline, phosphate solution, or Go-lytely;
Figure 7  Appendicostomy. A. Externalization of the appendix through the Y-shaped incision. B. The immediate postoperative appearance of the appendicostomy with a Foley catheter in place. C. A young teenager self-catheterizing. D. The low-profile appearance of a healed appendicostomy.

Figure 8  Umbilical appendicostomy. This teenage boy has his appendicostomy hidden within his umbilicus. A. Stoma catheterized for irrigation. B. With removal of the button, the site is practically invisible.
and the frequency of administration to achieve full colonic cleansing. Long term, patients are maintained on a daily or every-other-day enema regimen. Modifications are made to the content, amount, and frequency of enemas based on individual results.

Malone’s follow-up in 1995 discussed 21 children, 12 of whom had no further soilage and 3 who were without soilage 95% of the time [32]. The most successful children had meningomyelocele as the cause of incontinence. The MACE is an effective method of colonic cleansing in patients with fecal incontinence and intractable constipation. This procedure should not necessarily replace standard medical therapy for these conditions, since most children will respond to these therapies. Patients selected for the MACE procedure must be carefully selected on the basis of age, underlying disorder, commitment of the parents, and the patient’s desire to be independent. Failure secondary to noncompliance is most often seen in children less than 5 years of age [34]. This procedure has also been attempted on the left colon (LACE procedure), but it was less successful [34a].

Developments over the last 11 years include the laparoscopic approach to the MACE procedure [35,36]. Results from these reports indicate success rates comparable to those from the open procedure.

For patients who have had an appendectomy, a tube cecostomy can be used. Various techniques have been described [37,38]. In 1996, Fukunaga placed a Bard gastrostomy button into the cecum with purse-string sutures to invert the cecal wall. The button is exteriorized through a stab incision, and the cecum is fixed to the anterior abdominal wall. Also in 1996, Shandling published a technique for a percutaneous tube cecostomy. A rectal tube is inserted and air is pumped into the large bowel until the cecum is distended. With the help of fluoroscopy, the position of the cecum is marked on the patient’s abdomen. Under local anesthetic, cecal access is obtained percutaneously using a retention suture needle. Contrast is injected through the needle to confirm the position in the cecum. A guide wire is passed through the needle, followed by dilators. Subsequently, a pigtail catheter is placed with the cecum now secured to the anterior abdominal wall via a second retention suture. Various low-profile devices such as the trapdoor device and button gastrostomy can then replace the catheter [39] (Fig. 9). Alternatively, a neoappendicostomy can be created using a vascularized cecal flap tubularized over a feeding tube [40]. This is exteriorized similarly to the natural appendicostomy. Plication of the cecum over the base of the neoappendix is important, because this technique has a higher incidence of leakage at the skin than the natural appendicostomy.

MACE surgery allows children a great deal of independence. They can effectively and cleanly eliminate bowel incontinence. The child can self-catheterize and administer the washout solution while sitting on the toilet, and this entire process can be completed in less than an hour.
Figure 9  Percutaneous cecostomy. This is a minimally invasive alternative to a surgical appendicostomy. With this procedure, a tube always remains in place.

Complications
The two most frequently found complications of the MACE procedure are stoma breakdown and stenosis. In Malone’s initial 21 patients, stoma breakdown was reported in 5 [32], while 5 others required balloon dilatation for stenosis. Other reported complications included wound infection, obstruction, pain with enema, and phosphate overdose. Curry et al. recommended that all conservative measures of management—such as laxatives, diet modification, suppositories, and enemas—be exhausted prior to undertaking the MACE procedure [41]. They also offered the suggestion that surgery at a young age (<5 years), and/or a diagnosis of a gastrointestinal motility disorder may be bad prognostic indicators.

HIRSCHSPRUNG’S DISEASE
Background
Hirschsprung’s disease, or congenital aganglionic megacolon, is a disorder characterized by abnormal motility of the intestine. The pathology begins at the anus and reaches proximally to involve variable lengths of bowel. The rectosigmoid segment is involved in approximately 80% of cases, and another 5–10% will have involvement reaching to the small intestine
The defect is due to an incomplete migration of neuroblasts distally along the intestinal wall, resulting in absence of ganglion cells in Meissner’s submucosal and Auerbach’s myenteric plexuses. The affected segments lack the ability to appropriately relax and undergo peristalsis.

The incidence of Hirschsprung’s disease is about 1 per 5000, with a male-to-female ratio of 4 to 1. Up to 90% of affected children present in the neonatal period, while most of the remaining patients will present before the age of 2 years. A very small number of cases will not be detected until adulthood [8]. The most common clinical presentation is failure to pass meconium within 48 hr of birth. Approximately one-half of affected neonates present with abdominal distention and bilious vomiting. Less frequently, enterocolitis is the presenting symptom. A small proportion of these babies may be detected during evaluation for chronic constipation later in infancy, particularly if they were breast-fed newborns, who typically produce very soft stools.

The diagnosis in the newborn may first be suspected by distended proximal bowel loops on plain abdominal radiographs as well as on unprepared barium enema (Fig. 10). The latter study will often reveal the transition zone between normal and aganglionic colon, with a diagnostic accuracy reported as high as 92% [42]. This boundary may not be obvious in neonates. The diagnosis of Hirschsprung’s disease is based on pathological verification of the absence of ganglion cells in the intestinal wall. A suction rectal biopsy is obtained at the bedside or as an office procedure and can provide diagnostic certainty in close to 100% of cases when examined by an experienced pathologist. With this procedure, first described by Dobbins [43] and Noblett [44], a small biopsy probe tip is inserted into the rectum and directed posteriorly; suction is then applied with a simple hand pump. When the biopsy device is engaged, a sample containing mucosa and submucosa is removed, ensuring an adequate amount and depth of tissue for diagnosis.

Management

Hirschsprung’s cases most often present as partial or complete distal obstruction in children less than 2 years of age. Patients may also present with explosive diarrhea, dehydration, and shock when signs are complicated by enterocolitis. When Hirschsprung’s disease is clinically suspected, the diagnosis is proven with a suction rectal biopsy. The classic approach has been surgical decompression with a colostomy. Some authors place a loop colostomy in the proximal transverse colon [45], while others prefer the most distal portion of normal intestine (i.e., transition zone) [8]. The transition zone between dilated proximal ganglionic bowel and decompressed distal aganglionic bowel may be seen intraoperatively, though the development of this is infrequent in the newborn. This area of transition is no more than...
Figure 10  Barium enema reveals dilated proximal colon with a tight rectal tapering segment, corresponding to the transition zone.

a couple of centimeters in length. The location of the transition zone must be confirmed by serial frozen sections of seromuscular biopsies (Fig. 11). An ostomy placed within aganglionic bowel will not empty properly, leading to recurrent obstruction.

A loop colostomy, most commonly sigmoid, involves minimal disruption of the mesenteric vasculature, thus assuring adequate blood supply to the anal anastomosis at the definitive reconstructive procedure. The creation of the colostomy involves two layers of seromuscular sutures to the peritoneum and the muscular fascia. Precise suturing of bowel wall to peritoneum and fascia prevents parastomal hernia formation. Seromusculature suture placement prevents intestinal fistulas. There is no need to suture the intestinal wall to the skin. A red rubber catheter resting without tension on the skin surface is passed through the mesentery at the elbow of the loop and
is coiled to form a circle around the ostomy. This stabilizes the loop, fits easily within the colostomy bag, and is removed after 2–3 weeks (Fig. 12). Alternatively, a bridge consisting of skin, anterior and posterior rectus sheaths, and peritoneum may be brought together under the loop.

The intra-abdominal portions of the efferent and afferent limbs are sutured together for a short length to provide protection against prolapse. The fascial defect should be snug for this reason as well. In the past, the colostomy was opened at least a day following surgery, allowing the incision to seal so as to prevent fecal contact and subsequent infection. Currently, the ostomy can be safely opened in the operating room by performing a longitudinal incision with electrocautery, extending more proximally than distally. Prolonged placement of the rubber catheter may lead to effective defunctionalization of the distal intestine by directing the two limbs away from one another. In the rare patient with disease reaching the right colon, cecum, or small intestine, an ileostomy or jejunostomy may be necessary. Multiple intraoperative seromuscular biopsies may be required to determine the exact length of involved intestine.
After the ostomy has been created, the definitive pull-through repair is planned in 3–12 months, depending on the degree of proximal bowel dilatation, the patient’s age and size (typically 6–12 months and 20 lb.), and the surgeon’s preference. The recent literature has recommended a definitive repair at an earlier age rather than later, averaging approximately 3 months in one study [46]. The Swenson (Fig. 13), Soave (Fig. 14), and Duhamel (Fig. 15) are the three popular pull-through techniques for coloanal anastomosis after resection of the involved segment. The use of a more proximal decompressing ostomy, necessitating a third procedure for take-down at a later date, has become less common.

Recently, several authors have described the use of a single-stage procedure without the creation of an ostomy [47–49]. These techniques have compared favorably with their classic two-stage counterparts, though Teitelbaum found a higher rate of postoperative enterocolitis in the single-
staged group. This was attributed only to improved diagnosis and recognition of enterocolitis in recent years [50,51]. These procedures are reserved for healthy infants without evidence of preoperative enterocolitis or severe colonic dilatation. The full extent of disease must be known at the time of repair to ensure appropriate bowel resection. One-stage laparoscopic approaches have also been developed, with good results and comparable complication rates [52–55]. Finally, in another attempt to minimize the invasiveness, several groups have been performing the colorectal resection and coloanal anastomosis using a one-stage, fully transanal approach [56–58]. Operating times and blood loss are significantly decreased as compared to the traditional transperitoneal approach [59].

Figure 13 The Swenson procedure. A. Colonic division with stapler above transition zone and eversion of rectal stump. B. Bringing the proximal colon into position. C. Colorectal anastamosis. D. Final result after reduction.
Figure 14  The Soave procedure. A. Colonic division above transition zone, with dissection of rectal muscular cuff. B. Opening of everted distal rectum. C. Pull-through of proximal colon, with anastamosis. D. Reduction of colon, with fixation of muscular cuff to colon. E. Final result.
Figure 15  The Duhamel procedure. A. Manual dissection of posterior rectum. B. Enterotomy in distal recum, with positioning of proximal colon. C. End-to-side colorectal anastomosis. D. Stapled division of rectum and colon to create pouch. E. Final result.
Complications

The ostomy created for Hirschsprung’s disease is prone to the same problems as other ostomies in this age group. However, the frequency of complications is less since the ostomy is temporary. In a study of 146 children with colostomies (mean age 2.1 years, ranging from 1 day to 22 years), 69 patients (47%) had stomal complications. Seventy (48%) of the colostomies were performed for Hirschsprung’s disease, followed by 46 (32%) for imperforate anus. The most common long-term problem involved skin excoriation, accounting for 42% of the complications. This was followed by prolapse (25%), stenosis (13%), retraction (7%), colocutaneous fistula (7%), and peristomal hernia (3%). Major early complications occurred in 16% of the patients and included postoperative sepsis in 14 cases, evisceration or herniation of small bowel in 4, and wound infections in 2. The sigmoid loop colostomy had a significantly lower complication rate when compared to the transverse colostomy (39 vs. 79% p < 0.01) [60]. In a similar group of patients, Brenner and Swenson found that reoperation was required in 7 of 48 (15%) colostomies, specifically for evisceration in 3 cases, loop necrosis in 2, and stenosis in 2 [61].

IMPERFORATE ANUS

Background

An imperforate anus is found in 1 of 4000–5000 births and represents a wide variety of anorectal malformations, from anal stenosis/perineal fistula (low lesions) to anorectal agenesis (high lesions), with or without a fistula (rectourethral in males, rectovaginal in females) [8]. In 1710, Littre first suggested a colostomy in the treatment of imperforate anus [62]. His idea was not implemented until 1783, when Dubois was the first to attempt this procedure [63]. Prior to Dubois, the treatment of children with an imperforate anus was rupture of the obstructing membrane followed by serial dilations until healing was complete [8].

Some families have a predisposition toward anorectal malformations. There is a male predominance (55–65%), suggesting the possibility of sex-linked inheritance. Imperforate anus may occur as an isolated malformation, with other abnormalities, or in association with several syndromes including tracheoesophageal fistula/esophageal atresia, Down’s Syndrome, and Cat’s eye syndrome [64,65]. Commonly associated cardiovascular abnormalities (12–22%) are ventricular septal defect and Tetralogy of Fallot. Duodenal obstruction secondary to annular pancreas, duodenal atresia, or Ladd’s bands with malrotations may also occur [8]. Urinary tract abnormalities are especially common in babies with high lesions. A thorough evaluation and examination are necessary to determine the presence of urinary reflux, renal agenesis/dysplasia, and cryptorchism.
Imperforate anus covers a spectrum of anorectal malformations. In theory they may result from the abnormal formation of the urorectal septum or absence of the dorsal cloacal membrane [8]. There have been numerous classification systems for imperforate anus. None have gained widespread acceptance. Patients are typically placed in two groups high (mid/supralevator) lesions requiring colostomy and low (infralevator) lesions not requiring colostomy (Fig. 16). The initial evaluation of a neonate with imperforate anus focuses on identification of associated anomalies and determining the necessity of an ostomy. The absence of a midline crease, a “flat bottom,” or the absence of external sphincter contraction are often indicators of a high lesion. Sacral anomalies are associated with high lesions. Careful serial examinations of the newborn over the first 24 hr of life can reveal important clues. The appearance of meconium in the urine and the passage of flatus from the penis are signs of a high lesion with a colourethral fistula in males. In females, lack of any externally visible fistula indicates a high lesion. A small spot of meconium appearing in the perineum indicates a low lesion with a fistula. Newborns with high defects will need a colostomy. Infants with a perineal fistula or a thin membrane with visible meco-
rium may be treated with dilation or anoplasty and usually do not require a colostomy.

Ultrasound and plain radiographs help identify the level of the lesion. At 24–36 hr of age, air on a prone cross-table lateral abdominal film can provide adequate confirmation of the defect’s level. The distance between the skin and air within the distal colon is measured. In addition, ultrasound can be used to measure the distance from the perineum to bowel. In general, a distance of 1 cm or more by either modality is considered a high lesion and will require a colostomy. In male newborns, a VCUG or a precolostomy cystoscopy can confirm a colourethral fistula and prove the diagnosis of a high imperforate anus.

For patients with low defects, primary reconstruction can be done in the immediate newborn period. Babies are placed in the lithotomy position at the time of surgery using infant stirrups or some other support device. The anal sphincter must be clearly identified using electrical stimulation. In the case of anal stenosis, simple dilation, as first performed by Scultet in 1660, will usually suffice [66]. For low lesions in the correct position but without a fistula, a cutback to the anus with placement of skin-to-mucosa sutures provides satisfactory results [67]. In babies with low lesions, the following technique may be employed. After the anal sphincter is mapped, a Fogarty catheter is fed into the rectum using a 16-gauge angiocatheter. Once the balloon is inflated, the Fogarty catheter can be used as traction to bring down the rectum and a cutback can be performed. Mucosa-to-skin sutures are then placed circumferentially. (Personal communication with Richard Courtney, Pediatric Surgical Services, Inc., Springfield, Massachusetts, USA.)

In newborns with high lesions, a proximal colostomy is created as a first step. This decision must be made within the first 48 hr of life. The proximal sigmoid colostomy leaves an adequate length of distal colon for reconstructive purposes. A loop colostomy may be constructed if a definitive repair is anticipated within the first 8–10 weeks of life. If reconstruction is not anticipated for several months, an end colostomy with mucous fistula tends to be a better choice for more long-term diversion [8]. The approach is an oblique left-lower-quadrant incision through the lateral left rectus and oblique musculature, avoiding the umbilicus and iliac crest. For a diverting sigmoid colostomy, the bowel is divided and brought out through opposite ends of the wound. The functional end is exteriorized laterally and the distal end medially, leaving sufficient distance between the two stomas to allow satisfactory appliance placement on the proximal stoma. Both ends are deliberately exteriorized with a snug fuscial closure in order to prevent prolapse. The distal loop is irrigated to remove as much meconium as possible at the time of surgery or shortly thereafter. Urinary tract infection from fecal contamination can be difficult to control, especially if it is associated with vesicoureteral reflux. Urine reflux into the colon can produce a hyper-
chloremic acidosis. This complication is seen with more proximally placed ostomies due to prolonged contact of urine with the colonic mucosa.

Reconstruction is then performed when the baby is older, within the first year of life. The posterior sagittal approach originally described by deVries and Pena can be used to repair nearly all anorectal malformations [45,68]. Ostomy closure after reconstruction becomes the third and final stage.

Complications
Colostomy formation in neonates with anorectal anomalies is associated with a high incidence of complications (32%). The most frequent mechanical ostomy complication is prolapse, which is observed in 16.3%. These ostomies are created with dilated obstructed bowel. Once vented, the bowel shrinks to a normal caliber predisposing to prolapse. Intestinal obstruction secondary to adhesions, intussusception, and volvulus has been reported in 14.3% of cases. Skin dehiscence has a 6.1% incidence [69].

Following reconstruction, anal stenosis and constipation are by far the most common complications. A 20-year follow-up study published by Nixon in 1977 described 14 of 47 cases developing anal stricture [70]. In the same study, rectal mucosal prolapse was observed almost as frequently, 11 of 47 patients. These children also have a remarkably high rate of urinary tract infections: 31 of 47 patients. Strict attention to technique is extremely important [71].

FEEDING JEJUNOSTOMY
Background
The need for enteral access exists in many situations in pediatric surgery. For neurologically impaired children, feeding access is a special concern. The goal in these children is to provide a route of access that is convenient for the parent and child, has a low complication rate associated with the procedure and access maintenance, and provides the patient with a safe and effective means of nutrition. Nasogastric, nasoduodenal, and nasojejunal tubes are temporary access devices. The traditional route of long-term enteral feedings is via a Stamm gastrostomy. More recently, the percutaneous endoscopic gastrostomy (PEG) has been widely accepted to fulfill this role.

The Witzel-type jejunal catheter is employed for patients who cannot tolerate gastric feedings. While the Witzel-type jejunal catheter may be used long term, it is rarely a stable permanent solution. In children who cannot tolerate gastric feedings due to primary gastric motility disorders or prior upper abdominal surgery, a Roux-en-Y feeding jejunostomy is constructed for permanent feeding access.
Management

Permanent enteral access via the jejunum using a Roux-en-Y feeding jejunostomy was originally described by Maydl [72]. In Maydl’s procedure, the Roux limb, which is approximately 25 cm in length, is brought out to the skin as a permanent stoma. This stoma is then catheterized with a Foley catheter when feedings are to be started. Feedings usually begin 48 hr after surgery.

More recently, DeCou et al., Yoshida et al., and Gilchrist et al. have described modifications to the Maydl and Ballantine Roux-en-Y jejunostomy [73–75]. These modifications involve various methods of securing a mushroom or balloon catheter at the end of the Roux limb [73–75]. The catheter is brought through the abdominal wall, with the jejunum secured to the anterior abdominal wall (Figs. 17 and 18) Thus, a Roux-en-Y jejunostomy is created, but instead of a stoma flush with the skin, a catheter is present. This catheter can be replaced at a later time with a button catheter to provide a more convenient and more socially acceptable appearance.

Complications

Yoshida’s series compared the original stoma technique with the modified catheter jejunostomy [74]. The nine patients with the permanent stoma jejunostomy had the expected complication of stoma leakage. One child had such significant skin breakdown as to require conversion to a tube jejunostomy. A second child also had conversion to a tube jejunostomy for stoma prolapse. None of the 22 patients with the modified tube Maydl Roux-en-Y jejunostomies had any significant complications. Several children had their tubes changed to button-type tubes without complication.

BUTTON JEJUNOSTOMY

In 1989, Stellato and Gauderer described a technique to access the jejunum with a button device to create a permanent and continent feeding jejunostomy [76]. For this less complicated procedure, the button is placed through the antimesenteric border of the jejunum approximately 10–60 cm from the ligament of Treitz, depending on patient size and age. A button is used instead of a red rubber catheter because it is more stable and secure [77]. The jejunum is sutured to the undersurface of the abdominal wall and the button exits to rest on the skin surface, where it can be used when the postoperative ileus resolves (Fig. 19) Once the wound has healed completely, changes to the button catheter can be made in the home or office setting.
Figure 17  Ballantine tube jejunostomy. This demonstrates a Roux-en-Y feeding jejunostomy combined with gastric decompression.

OTHER INDICATIONS

Gastroschisis is characterized by a defect in the abdominal wall lateral to the umbilicus, usually measuring 2–5 cm in size. Herniation of the abdominal contents occurs, most commonly involving the large and small intestines and less frequently the stomach and liver. The incidence varies from
Figure 18  The modified Maydl operation. In this procedure the feeding tube is advanced beyond the Roux-en-Y anastomosis, allowing earlier postoperative feeding.

Figure 19  Button jejunostomy. Both the balloon and sutures hold a loop of jejunum firmly against the abdominal wall, leaving little chance for leakage.
Pediatric Intestinal Stomas

1 in 1500–1 in 20,000 live births in the United States, with a male-to-female ratio of about 1:1 [8]. Management consists of protection of the eviscerated intestines within a sterile bag, thermal maintenance, fluid and electrolyte replacement, and then surgical repair. In the majority of cases, complete reduction and closure is accomplished in one operation.

Intestinal atresia complicating gastroschisis has been reported to occur in 5–23% of cases in recent series [78–80]. This has been attributed to vascular compromise secondary to compression at the opening in the abdominal wall. The management of this complication has been quite variable, including resection of the affected segment with primary anastomosis or creation of a proximally diverting ostomy followed by definitive repair at a later time [78]. The primary anastomosis in gastroschisis is often prohibited by the thick, rubbery nature of the intestinal wall, which is not encountered in simple cases of intestinal atresia. One group has described success with replacing the atretic segment into the abdomen, performing primary abdominal closure, and re-exploring in 1–3 weeks to establish bowel continuity through resection and primary anastomosis. The intestines appeared healthier and more robust after this period of recovery, allowing for a safer repair [80]. However, a proximal decompressive ostomy is recommended in cases of severe bowel dilatation or perforation.

The original abdominal wall defect is a convenient site for an end ostomy in uncomplicated cases of atresia with gastroschisis [29]. After contrast study of the entire distal bowel, closure can be carried out in a few weeks.

Cystic fibrosis can present with lower bowel obstruction secondary to meconium ileus. Historically, enterostomies were created for the purpose of decompression and antegrade irrigation. The two most common procedures were either the Bishop-Koop or Santulli enterostomy (Fig. 20) Alternatively, a T tube was placed in the cecum for irrigations. Today medical management (enemas and/or irrigation with diatrizoate or N-acetylcysteine) minimizes surgical interventions. When surgery is needed, the bowel is evaluated, opened, irrigated, and then closed without an ostomy. In the case of complicated meconium ileus, obstruction progresses in utero to perforation, peritonitis, calcification, and pseudocyst formation, resection of the devitalized bowel and pseudocyst with intestinal diversion may be the necessary and safest approach.

Biliary atresia, a cause of neonatal jaundice, requires surgical intervention. The standard procedure is a Roux-en-Y portoenterostomy (Kasai procedure). Variations of the Kasai have included exteriorization of the bile conduit to decrease the risk of ascending cholangitis, quantify bile output, and facilitate endoscopic instrumentation of the portoenterostomy site if bile flow stopped [81,82]. However, exteriorization of the bile conduit is rarely necessary today.
STOMA CARE

Children with stomas have problems with their self-image and self-esteem [83]. Positive feeling and reactions conveyed by the parent on a regular basis help to combat this.

The stoma and appliance cover a greater proportion of the infant’s abdomen compared to that of an adult (Fig. 21) This can impair a good seal with the appliance if a properly sized device is not selected. Involvement of an enteral stomal therapist early in the patient’s care is important. A variety of appliances are suitable for children and infants. Premature neonates can be maintained with the two-piece system available from Incutech Inc., called Preemie Pouch (Fig. 22) With this system, a skin-protective layer is applied first. The pouch is then affixed to this layer with the aid of stomahesive. Multiple vendors that provide pediatric appliance lines from the major trademarks, such as ConvaTec and Hollister can be identified on the Internet. The systems available are one-piece, two-piece, or two-piece with a flange.

Infants and toddlers will tend to play with the appliance, causing leaks and appliance failure. A one-piece jumper is helpful in keeping the child’s hand away from the appliance. However, children should not be discouraged from taking part in the care of their stoma. A toddler may be able to help collect the appliance supplies, while a preschooler can learn to help empty the pouch. By the age of 10–12 years, most children can take over

Figure 20 Procedures described by Bishop-Koop (Panel A) and Santulli (Panel B) once commonly performed for the decompression or distal irrigation of infants with Meconium Ileus are now rarely performed.
most of their own stoma care. Children should be encouraged to play and take part in normal activities. Bathing can be performed with the pouch on or off, based on personal preference. Water will not harm the stoma, but bubble bath may be irritating. A stoma usually does not dictate a special diet. However, the family may find that some foods are more likely to cause diarrhea and gas. Some trial and error will be necessary to determine the response and function of childhood stomas.

In newborns and infants, it can be a challenge to produce a good appliance seal. With distal colostomies producing formed stool, some parents may elect not to use an appliance and instead to use topical protective skin ointments and diapers. With a proximal colostomy or ileostomy, a properly fitting appliance is important to protect the peristomal skin. Moniliasis and skin excoriation are significant problems. Topical antifungal agents should be employed at the first sign of skin irritation [8].
Figure 22  Stoma care supplies. The Preemie Pouch system is applied in two pieces. Once the stoma site has been cleaned the skin barrier is measured, cut, and placed around the stoma. Stomahesive bonds the Preemie Pouch (also needs to have the opening measured and cut) to the skin barrier. The use of a 3cc syringe as a “caulking gun” allows the precise placement of a fine line of adhesive around the stoma.

CONCLUSION

In babies and children, intestinal stomas are used in a variety of capacities. They are created in combination with intestinal resections, as purely decompressive procedures, or as conduits for innovative treatment modalities. The indications can vary from necrotizing enterocolitis in the premature infant to fecal incontinence in an adolescent. Although in some instances percutaneous devices have obviated the need for intestinal exteriorization, stomas remain an integral part of the treatment of surgical diseases in children.

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71. Reference deleted.
Appendix A

United Ostomy Association, Inc.

UOA CHAPTERS

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The following list includes every local chapter of the United Ostomy Association. Each chapter or satellite is displayed with its chapter number, a contact person, and a phone number. Also, chapters that have their own websites are displayed with a www notation. A complete list of these websites may be found at [http://www.uoa.org/chapters_websites.htm](http://www.uoa.org/chapters_websites.htm)

Mission Statement: The United Ostomy Association is a volunteer-based health organization dedicated to providing education, information, support and advocacy for people who have had or will have intestinal or urinary diversions.
### ALABAMA

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<td>Birmingham AL Chapter</td>
<td>7</td>
<td>Lyn Hayes</td>
<td>205-408-0886 www</td>
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<td>Dothan AL Chapter</td>
<td>494</td>
<td>Teri Clark</td>
<td>334-794-5000</td>
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<td>Betty Schriver</td>
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<td>Virginia McCracken</td>
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<td>Phillip C. Davis</td>
<td>334-272-2814 www</td>
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<td>Gloria Rose</td>
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<td>Roxanne Machac RN</td>
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<td>Ernest Remsnyder</td>
<td>520-750-1910 www</td>
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<td>Amy Stilley RN BSN CWOCN</td>
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<td>Billy Shelton</td>
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<td>87</td>
<td>Webb Goodman</td>
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Appendix A

ARKANSAS

Batesville Area AR Chapter #644
Leo Rainey
870-698-2154
Deborah Fulmer, RNET
501-484-8838
Wayne Durfee
501-922-5999
Margaret Scott
870-928-2228
Walker Dickison, SR
501-636-6992
Evelyn Oshorn
870-424-3069

Fort Smith AR Chapter #392
Deborah Fulmer, RNET
501-484-0838
870-928-2228

Hot Springs AR Chapter #766
Wayne Durfee
870-922-5999
Margaret Scott
501-636-0892

Little Rock/Central AR Chapter #314
Margaret Scott
501-636-6992

Northwest AR Chapter #81
Walter Dickinson, SR
501-221-2020

Twin Lakes AR Chapter #492
Evelyn Oshorn
870-424-3069

CALIFORNIA

Chico CA Chapter #316
Vee Weather
530-865-7979

Contra Costa Co. CA Chapter #541
Harry Tse
925-682-1303

West Contra Costa Co. CA Satellite Chapter #515
Judy Collignon
626-333-0512

Downey-Whittier Area CA Chapter #558
Margaret Macko
415-664-4443

Golden Gate CA Chapter #14
Annita Allen
909-652-8775

Henret-San Jacinto CA Chapter #19
Judy Brown
949-443-1266

Inland Empire CA Chapter #642
Geradine Guadlo
760-943-3508

Laguna Hills CA Chapter #738
Joyce Elza
562-422-2856

Los Angeles CA Chapter #738
Joyce Elza
562-422-3056

Monterey CA Chapter #376
James Brown
831-442-2930

Napa Valley CA Chapter #17
Dorothy Lohman
707-226-6110

Orange County CA Chapter #542
Michael Hood
760-674-1967

Pomona/Ontario CA Chapter #542
Bob Paquet
760-982-9507

Palm Springs/Dessert CA Chapter #542
Dorothy Weber
562-698-8039

San Diego CA Chapter #662
Dorothy Bollinger
562-674-1967

San Francisco CA Chapter #662
Bob Paquet
760-982-9507

San Lachino CA Chapter #662
Cathy Lam
562-674-1967

San Luis Obispo CA Chapter #662
Cathy Lam
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San Mateo CA Chapter #662
Cathy Lam
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San Jose CA Chapter #662
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Santa Clara CA Chapter #662
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Santa Cruz CA Chapter #662
Cathy Lam
562-674-1967

Sonoma Valley CA Chapter #662
Cathy Lam
562-674-1967

Ventura County CA Chapter #662
Cathy Lam
562-674-1967

USA

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Appendix A

CONNECTICUT
Bridgeport CT Area Chapter
Barb Perkowski
203-924-1771
203-628-8291

Danbury CT Chapter
Enrico Potenziani
860-748-1352
860-746-8173

Hartford CT Chapter
Mary Banett
860-568-9117
860-646-9117

Manchester CT Chapter
Constance Callahan
860-563-5025
860-455-6715

New Haven CT Chapter
Mary Sexton, RN
203-327-1169
203-432-6203

Waterbury CT Area Chapter
Shirley Harkins, RNET
203-573-6203

DELAWARE
Wilmington DE Chapter
Frank Hough
302-239-5907
301-360-9260

DISTRICT OF COLUMBIA
Washington DC Chapter
Anastasia Johnson
954-527-7662
941-742-6345

FLORIDA
Broward Co (Fort Lauderdale) FL Chapter
Wendy Leeder
941-436-3023
941-436-3023

Charlotte Co (Punta Gorda) FL Chapter
Elaine Trott
727-392-8189
727-392-8189

Citrus County FL Chapter
Betty Boudavine
352-346-5000
352-346-5000

Clearwater Area FL Chapter
Earl Ferris
941-436-3023
941-436-3023

Collier Co (Naples) FL Chapter
Joan McNamara, RN, CETN
352-346-5000
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Gainesville FL Chapter
Nelson Griffiths
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| Jacksonville FL Chapter | Jacksonville | Brenda L. Holloway | 904-282-8181
| Key West-FL Keys Chapter | Key West | Christina Knowles | 305-376-8703 |
| Lake County FL Chapter | Lake County | John A. Young | 352-750-4982 |
| Lee Co (N. Fort Myers) FL Chapter | Lee County | Seymour Blechman | 941-481-2124 |
| Ocala FL Chapter | Ocala | Shirley Dowdy | 352-694-3082 |
| Orlando FL Chapter | Orlando | Roger Murray | 407-977-6241 |
| Palm Beach FL Chapter | Palm Beach | Richard Norman | 561-784-4496 |
| Jupiter FL Satellite | Jupiter | Trish Brickley | 561-626-1976 |
| Panama City Area FL Chapter | Panama City | Kathy L Denton | 850-639-9789 |
| Pensacola FL Chapter | Pensacola | Robert Miller | 251-961-3430
| Okaloosa-Walton-Santa Rosa Co FL Satellite | Okaloosa-Walton-Santa Rosa Co | James Story | 850-897-2025 |
| Polk Co (Lakeland) FL Chapter | Polk Co | William Schmidt | 863-858-7583 |
| S Palm Beach FL Chapter | S Palm Beach | Rose Onorato | 561-738-7098 |
| Sara-Tee (Sarasota) FL Chapter | Sarasota | Maurice J. White | 941-798-2056 |
| South Brevard Co (S. Melbourne) FL Chapter | Brevard Co | Robert F. White | 321-725-2435 |
| Space Coast (Melbourne) FL Chapter | Space Coast | Rose Curran | 321-632-0615 |
| St. Lucie/Martin FL Chapter | St. Lucie | Robert Otto | 561-335-5901 |
| Tallahassee FL Chapter | Tallahassee | John McKenna | 850-487-3227 |
| Tarpon Springs FL Chapter | Tarpon Springs | Alice Bolio | 727-799-8153 |
| Venice FL Area Chapter | Venice | Robert Cohen | 941-484-0607 |

### GEORGIA

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<td>Royden Yamasato</td>
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<td>Victor Librizzi</td>
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<td>Earl Silverstein</td>
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<td>Eastern ID Chapter</td>
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<td>Rick Turnage</td>
<td>208-523-0421</td>
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<td>#131</td>
<td>Lisa Hansen, RN CWOCN</td>
<td>801-398-2976</td>
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<tr>
<td>Lewiston-Clarkston ID Chapter</td>
<td>#497</td>
<td>Edward Porten</td>
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<td>Joseph Rundle</td>
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<td>Francis Irvin</td>
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<td>Rita Northrop</td>
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### INDIANA

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**KANSAS**

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<td>Helen Conard</td>
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<td>Gary Jeffrey</td>
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**KENTUCKY**

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<td>Paducah KY Chapter</td>
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<td>Glenda Dye</td>
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**LOUISIANA**

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### MAINE
- **Androscoggin ME Chapter** #254 Gerald Bouffard 207-782-3663
- **Aroostok ME Chapter** #259 Joanne Tardif Cote 207-435-6273
- **Central ME Chapter** #88 Susan Gurney 207-872-1471
- **Eastern ME Chapter** #89 Barbara Sproul 207-989-5772
- **Portland ME Chapter** #87 Paul T Brady 207-284-8531
- **Sanford ME Satellite** #86 Jerra-Marie Sullivan 207-363-7632

### MARYLAND
- **Anne Arundel Co MD Chapter** #295 Ken Hertz 410-761-8045
- **Baltimore MD Chapter** #91 Ann Louise Stoner 410-243-0751
- **Cumberland MD Chapter** #92 David Latimer 301-722-4251
- **Frederick County MD Chapter** #380 Marion Zebovitz 301-662-4052
- **Harford/Cecil Co MD Chapter** #522 Margaret Mather 410-838-8307
- **Cecil Co/Elkton MD Satellite** #88 Susan Prior, RN MS CETN 410-398-4000
- **Metro MD & Youth Group Chapter** #312 Horace Saunders 301-434-2647
- **Southern Maryland Chapter** #374 Peggy Goldsmith 301-645-5564
- **Washington Co MD Chapter** #308 Olive Heinbaugh 301-733-9548

### MASSACHUSETTS
- **Berkshire County MA Chapter** #326 Jane Carmel RN 413-443-0000
- **Boston MA Chapter** #93 Lucy Mercurio 617-924-2809
- **Alternate Procedures Satellite** #97 Donna Loehner RNET 781-273-5100
- **Attleboro MA Satellite** #138 Debbie Florio 508-286-4155
- **Boston MA Satellite** #118 Diane Bryant RNET 617-732-5656
- **Framingham MA Satellite** #17 Beth Powers 508-383-1238
### MASSACHUSETTS

**Boston MA Chapter (Continued)**

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MISSOURI
Cape Girardeau MO Chapter        #397        Ruth Boxdorfer        573-243-0085
Columbia MO Chapter              #410        Joseph Greco        573-443-5090
Randolph Co. MO Satellite        #100        Mrs. Glen Pierce        660-263-0274
Pike Co MO Satellite             #128        Linda Ince        573-754-4209
Joplin MO Chapter                #106        Jimmy Jones        417-623-8422
Kansas City MO Chapter           #107        Corey Lundgren        816-228-9829
    Leavenworth Kansas MO Satellite #14        Eileen Welch RN ICU        913-682-3721
Springfield MO Chapter           #271        Curtis Hays        417-282-5114
St. Louis MO Area Chapter        #105        Susan Burns        636-926-2737
    Rolla MO Satellite            #83        Retta Sutterfield, RN, CWOCN        573-364-8899

MONTANA
Great Falls MT Chapter           #109        Darlene Sanford        406-761-2033
Northwest MT Chapter             #757        Leona Geldrich        406-892-2447
Southwestern MT Chapter          #550        Lu Anne Houser        406-933-8755

NEBRASKA
Kearney Area NE Chapter          #741        Lamoine Fulmer        785-282-6384
Lincoln NE Chapter               #111        Arleen Giger        402-466-2886
McCook Area NE Chapter           #744        Redonda Latta        308-276-2157
North Platte NE Chapter          #671        Cindy Einsphar        308-532-5539
Omaha NE Chapter                 #112        Clayton Hakenson        712-323-9812
    Atlantic Iowa Satellite      #103        Janet Tinker, RNET        712-243-3250
    Shenandoah Iowa Satellite    #13        Norma Sigler        712-623-9473
NEVADA
Reno NV Chapter #113 Joan Mason 775-746-8858
Southern NV Chapter #114 Bonnie Moe 702-897-3838

NEW HAMPSHIRE
S New Hampshire NH Chapter #117 Janet Prince 603-598-3388
Sullivan-Grafton NH Chapter #666 Jeanne Smith, RN 603-826-4487

NEW JERSEY
Audubon NJH Area Chapter #335 Linda Aukett 856-854-3737
Bergen County NJ Chapter #377 Robert H. Vlack 201-796-0967
Burlington Co NJ Chapter #466 Harvey Shatz 856-795-2449
Cumberland Co NJ Chapter #532 Roy Wright 856-327-3262
Essex Co NJ Chapter #123 Paula Von Rosendahl 973-239-1616
Hudson Co NJ Chapter #118 Lillian Baklarz 201-823-3101
Middlesex Co NJ Chapter #122 Charles McDevitt 732-572-3298
Morris Co NJ Chapter #121 Robert Fahy 973-361-0891
Ocean Co NJ Chapter #309 Tom Sauer 732-901-9411
Passaic Co NJ Chapter #599 Johan Van Rossen 973-835-8281 www
Salem Co NJ Chapter #382 Anna Mae Both 856-935-5671
Somerset Co NJ Chapter #124 Edward Wheeler 908-534-7897
Warren Co NJ Chapter #641 Pat La Faso 908-852-2475

NEW MEXICO
Albuquerque NM Chapter #125 Lothar D Hoeft 505-298-2065
## NEW YORK

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<td>James Brady</td>
<td>518-283-3322</td>
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<td>Auburn NY Chapter</td>
<td>Richard Cowell, RNET</td>
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<td>Harold Rosenblum</td>
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OKLAHOMA
Ada OK Chapter #732 Darrell Wood 580-436-6479 www
Bartlesville OK Chapter #714 Sharon Lankford 918-336-0394 www
Lawton-Ft Sill OK Chapter #449 James Rice 580-429-8810 www
Muskogee OK Chapter #623 Dorothy E. Bode 918-682-2536 www
Oklahoma City OK Chapter #165 Harold Johnson 405-842-0172 www
McAlester OK Satellite #115 Sue Baggett 918-423-6740 www
Stillwater-Ponca City OK Chapter #569 Bill Drew 405-372-3464 www
Tulsa OK Chapter #232 Alice Bowman 580-765-5854 www

OREGON
Douglas Co OR Chapter #472 Edith Hope 541-673-6307 www
Lane County OR Chapter #216 Sally Hanna 541-485-9633 www
Mid-Columbia OR Chapter #631 Donna Mollet 541-298-8779 www
Portland OR Chapter #166 Caroline Uphill 503-644-5331 www
Willamette Valley OR Chapter #238 Virginia McCraw 541-926-5300 www

PENNSYLVANIA
Armstrong Co PA Chapter #710 Robert T Higginson 724-548-4623 www
Beaver PA Area Chapter #168 Violet R Ruff, ET, RN 724-846-1787 www
Central PA Chapter #170 Samuel Adams 814-943-5168 www
Delaware Co PA Chapter #225 Stanley Malis 610-353-2683 www
Dubois PA Area Chapter #528 Clair Foulks 814-265-8066 www
Gettysburg PA Chapter #506 Helen I Dayhoff 717-334-2051 www
Greensburg-Keystone PA Chapter #220 Paul Bizub 724-925-7138 www
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Brownwood TX Satellite #117
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Central TX (Waco) Chapter #300
Corpus Christi TX Chapter #337
Dallas Area TX Chapter #185
Ft Worth Area TX Chapter #187
Denton TX Satellite #42
Golden Spread TX Chapter #278
Houston TX Chapter #186
J-Pouch Connections Satellite #91
NW Houston TX Satellite #98
Longview Area TX Chapter #318
Midland-Odessa TX Chapter #590
West Texas Satellite #126
San Antonio TX Chapter #188
Highland Lakes TX Satellite #101
Kerrville TX Satellite #130
Northeast San Antonio Satellite #112
Sherman Area TX Chapter #289
South Plains (Lubbock) TX Chapter #465
Texarkana TX Chapter #423
Tyler TX Chapter #321
Wichita Falls TX Chapter #297

Carol Laubach 512-339-6388
Darrel Gilbertson 512-864-7473
Stanley Hall 409-883-4497
Norman “Rusty” Duryea 915-698-9477
Joan Countess 915-643-5820 www
Sharon Murray 409-836-3001
Ted Hodges 254-771-3846 www
Dick and Mary Brown 361-853-3356
Dave Darnell 972-931-9651
Connie Dankesreiter 817-244-3311
Monica David 817-686-2463
Hal Houston 806-355-2818
Clarice Kennedy 281-685-7016 www
Charlene Randall RN BSN 713-791-4459
Helen Lowery 281-350-1015
Barbara Williams 903-759-9830
Weldon Dawson 915-550-6462 www
Eddie Everidge 915-651-9394
Frankie Miller 210-681-5814
Gayle Shirley 915-388-4746
Joy Smith 830-257-5665
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