Essentials of Septorhinoplasty

Philosophy—Approaches—Techniques

Second Edition

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Preface

The cover of this textbook shows the face of Athene protecting a young hero. The statue is located on the Schlossbrücke (Castle Bridge) in the center of Berlin. Based on a design by Karl Friedrich Schinkel, it was created by Gustav Bläser in 1854 in Carrara marble in the neoclassical style. Athene is the goddess of wisdom, art, battle, and strategy.

Like Athene, this book should encourage young surgeons to adopt well-considered strategies and make effective surgical decisions, and sensitize them to the artistic aspects of rhinoplasty as a complex and integral part of facial plastic surgery. At the same time, let us ask the goddess for good fortune, which is essential for every surgeon.

Fourteen years after publication of the successful and award-winning first edition of Essentials of Septorhinoplasty, we are pleased to present you the second edition. A very warm thank you goes to our readers for their sustained interest in our book, which was the most important precondition for a second edition.

It was a pleasant experience that all authors of the first edition immediately agreed to participate in preparing this new edition, which was achieved in a short period of concentrated work. Several new authors joined us, adding new and important topics.

My personal, special thanks go to my coeditor M. Eugene Tardy Jr. for his formative influence, support, and friendly collaboration over the last 15 years— in the first and second editions of this book, in joint dissection courses in the Institute of Anatomy of the Charité University Hospital, and in other long-term projects. Retrospectively, I realize how crucial his philosophy, surgical conservatism, sensitive approach to this field of medicine, and high demand foratraumatic surgery influenced my personal technique of rhinoplasty.

It is my firm belief that the ideal outcome in rhinoplasty can only be achieved with a twofold goal: preserving the physiological elasticity of the nose as a flow body and maintaining the appearance of a natural, individual nonoperated nose. To achieve both goals, closed and open techniques are required in the repertoire of a well-trained rhinoplasty surgeon.

Additional thanks go to the artists Bob Brown, Katja Dalkowski, MD, and Vincent Mosch, who gave this edition an irresistible charisma.

My sincere thanks go to our patients who generously agreed to the publication of their portrait photographs.

A major share in the realization of this new edition goes to Mr. Stephan Komry, my editor at Thieme, and Ms. Nidhi Chopra, who, although working from far away, was always closely involved in the preparation of this new edition.

We hope that the new edition of Essentials of Septorhinoplasty will again find many interested readers and help them achieve many successful and beautiful rhinoplasty outcomes.

Hans Behrbohm, MD, PhD

*The Young Hero (statue on the left of Athene) illustrates the cover of Behrbohm et al. The Nose—Revision and Reconstruction (Thieme, 2016).

With permission from Neo Rauch; Courtesy Galerie EIGEN+ART Leipzig, Berlin; Gallery David Zwirner New York, London; Photo Uwe Walker, Berlin; © Neo Rauch; VG Bild-Kunst.
Rhinoplasty is a public performance. The stage is the everyday life. Sometimes it is a great theatre—quite often a poem. The human face is the most fascinating thing in this world, and it has to be handled with great care.

The question of whether aesthetic surgery can make people happy or not is controversial and disputed. Everyone has their own definition of happiness. Most candidates of rhinoplasty come to us because they hope to be happier by becoming more attractive. The hope of becoming both happier and more attractive is in fact justified, because patients tend to be more self-confident and content following a successful operation. In this sense, a positive result of a rhinoplasty can make people happy.
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Chapter 1
The Dual Character of Nasal Surgery

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1 The Dual Character of Nasal Surgery

1.1 Introduction

Young sailors in the International Optimist class trim their sails with the help of a tensioning pole called a sprit. The stronger the wind, the more tightly the sprit is set. The lower the tension on the sprit, the more the sail will billow open. This change in the shape of the sail is clearly reflected in the adjacent top triangles.

A similar mechanism is at work in the nose. The height and tension of the anterior septum significantly affect the aperture angle of the nasal valve and the tension and shape of the tip and supratip area.

The goal of any structure-conserving surgery of the nose, as in the spritsail, is to change the shape of the internal and external nose by altering the tension and traction on specific structural elements (Fig. 1.1).

The nose performs a variety of functions. It is a respiratory and sensory organ and has a special aesthetic importance as a central feature of the face. It is a reflex organ and adds resonance to phonation. The functional and aesthetic aspects of the nose are inseparably linked in a morphological sense.1 It is our experience that functional and aesthetic problems of the nose almost always coincide. Rhinosurgery aimed exclusively at improving function will very quickly reach its limits if it disregards external form. This is clearly illustrated by the “tension nose,” deviated nose, and saddle nose.

Conversely, rhinosurgery that is done purely for aesthetic goals forfeits valuable opportunities, as in the cases where the presence of septal deviation coexisted with a deformity of the external nose.2,3 Goldman found that in more than 70% of his cases, the presence of septal deviation coexisted with a deformity of the external nose.4 Meyer performed a concomitant septoplasty in 80% of his primary and secondary rhinoplasties.5 Masing explained the importance of external nasal shape in respiratory function by noting the smaller cross-sectional areas of the external nose compared with the internal nose.6 Farrior states that surgical correction of the external nose is often the prerequisite for normal, unobstructed nasal breathing.7 Our own experience confirms the results of Schulz-Coulon,8 who addressed the question of whether rhinoplasty is a predominantly aesthetic or functional procedure.9 When statistical analysis was applied based on patients’ motivations for surgery and their satisfaction or dissatisfaction with the outcome, this question could not be answered in terms of a predominantly aesthetic or functional operation. This led the author to agree with Haas that both terms should be discarded in favor of the more accurate term, corrective rhinoplasty.8,10

But the concept of functionality does not apply just to the improvement of nasal breathing. It includes the following aspects as well:

- Peripheral olfactory disturbances.
- Recurrent and chronic sinusitis.
- Middle ear ventilation problems.
- Rhinogenic headache.
- Poor vocal quality.
- Nasal ventilation problems due to rhonchopathy.

Functional–aesthetic rhinoplasties are among the most demanding procedures in facial plastic surgery. In themselves, they pose a significant challenge to the rhinosurgeon. It is logistically and technically feasible to include the above indications without getting lost in too many details while still addressing the patient’s desire to solve multiple problems in a single operation.11

Surgeons should have all the techniques and approaches of rhinoplasty and endoscopic endonasal microsurgery in their repertoire. We caution against the current trend toward the exclusive use of the open approach, because the advantage of clear operative exposure is offset by a substantial increase in tissue trauma and subcutaneous scarring. Circumstances will dictate the best choice from among the available options: the cartilage-splitting approach, delivery approach, or open approach (Fig. 1.2). To avoid drawback of a limited overview of the depth of the surgical field in the closed techniques, the desire arose to adopt endoscopic surgical procedures in septoplasty and rhinoplasty for both functional and aesthetic indications.

The approach should be as effective as possible and as invasive as necessary. Minimizing surgical trauma is of key importance, as it is the best means that the surgeon has for influencing postoperative wound healing and scar formation. While surgeons can directly alter the size and position of cartilage and bone, they can influence wound healing, and ultimately the definitive outcome, only by workingatraumatically in the appropriate favorable surgical planes, creating small and appropriate graft beds, and reducing bleeding by preserving the muscular and vascularized planes of the nose (Fig. 1.3).

Besides selecting the approach, surgeons can choose from among several techniques (incision, suturing, or grafting) to achieve the desired goal in various ways. Nevertheless, most techniques are rarely of equal suitability. The technique of choice will depend upon skin type, connective-tissue type, and factors such as the age of the patient and the resiliency of the cartilage.

Fig. 1.1 As in a sail, the shape and function of the nose can be influenced by altering (cartilage) tensions.
1.2 Historical Review

1.2.1 Origins of Plastic Nasal Surgery

Partial or complete loss of the nose causes severe disfigurement of the face. This kind of trauma injures not just the human body, but also the mind. The destruction of the aesthetic and psychological integrity of a personality is among the cruelest testimonials of bygone eras. Many ancient sculptures bear witness to this act in symbolic form.1,2

Cutting off the ears and nose as a form of punishment motivated the earliest attempts at reconstructive plastic surgery in India approximately 1,500 years ago.3–5 The Indian rhinoplasty was performed with a midline forehead flap in a concept that resembles methods still in use today. This technique was described by Sushruta in approximately 600 BC. Galenus mentioned that the Egyptians performed nasal operations, but they kept their methods a secret.6

Much later, around 1430, the Branca family (first the father, later the son) developed a procedure for reconstructing the nose with a flap from the upper arm.7

Gaspare Tagliacozzi (1545–1599), writing in the first textbook on plastic surgery, described techniques for nasal reconstruction that he adopted from Branca and refined. Although that occurred about a century after the Brancas used the upper arm flap, Tagliacozzi is still considered the founder of Italian rhinoplasty.8–10

The human desire for the aesthetic rehabilitation of traumatic or congenital disfigurement, with an opportunity for social reintegration, was definitely the original motivation for reconstructive rhinoplasty.

The age of corrective aesthetic rhinoplasty was inaugurated by John Orlando Roe (1848–1915), an otorhinolaryngologist from Rochester, New York. This surgeon corrected saddle nose deformities through an endonasal approach.11 In 1891, Roe also used intranasal approaches for dorsal hump removal. Innovations in the functional aspects of rhinoplasty were later introduced by Mink, van Dishoeck, Cottle, and others.12–14

1.2.2 The Development of Plastic Surgery in Berlin and at the Charité Hospital from the 18th to 20th Centuries

Surgeons and rhinologists who practiced in Berlin from the 18th to the 20th centuries greatly influenced the subsequent development of functional–aesthetic rhinosurgery.

Carl Ferdinand von Graefe (1787–1840) was appointed from Wilhelm von Humboldt (1767–1835) as a first professor in ordinary of the Institute of Clinical and Ophthalmological Surgery at the newly founded Friedrich-Wilhelm University in Berlin in 1810 when he was just 23 years old. He was a skilled surgeon who had a keen interest in plastic surgery of the face and jaws. He performed the first successful repair of a cleft palate in 1816. He became internationally known through his first strabismus operation and numerous monographs. Along with Guillaume Dupuytren of France, Ashley Cooper of England,
and Nikolai Pirogof of Russia, Dieffenbach was among the greatest surgeons of his time and is considered the founder of plastic surgery\textsuperscript{22–24} (Fig. 1.6).

The following episode helped to establish Dieffenbach's special reputation in 19th-century Berlin: A charming young woman who attended society balls in 1831 and 1832 attracted considerable attention by always hiding her face behind a golden mask. Elvira Tondeau's secret was that her face had been disfigured by deep ulcerative lesions of the nose, presumably a result of tuberculosis cutis luposa. Dieffenbach was able to reconstruct her nose in several sittings. One year later, Elvira entered into a much-publicized engagement. Dieffenbach's accomplishment was immortalized in a contemporary folk song that claimed that “... he makes the nose and ears like new.”\textsuperscript{22}

General anesthesia was developed in 1846, making painless surgery a reality. In 1878, Robert Koch published his paper “Studies on the etiology of wound infections.” Joseph Lister (1827–1912) paved the way for germ-free operations. Berhard von Langenbeck (1810–1887) was Dieffenbach’s successor at the Berlin Charité Hospital, specializing in plastic surgery.

Langenbeck’s successor, Ernst von Bergmann (1836–1907), was one of the most influential surgeons of his time, introducing the principle of asepsis to surgery. His guiding rule was that everything that came into contact with the operative field and especially with the surgical wound had to be absolutely sterile (Fig. 1.7).

Jakob Lewin (Jacques) Joseph (1865–1934) was a pioneer of modern rhinoplasty. He studied medicine in Berlin, graduated in Leipzig in 1861, and opened a private practice in Berlin. Shortly thereafter, he joined the Berlin University Orthopedic Hospital, headed by Julius Wolff (1836–1902), where he received extensive surgical training. In 1896, he was referred to the hospital for the correction of prominent ears.\textsuperscript{12}

In 1898, Joseph performed the first reduction rhinoplasty at his office, using an external approach. He also did pioneering work in several other areas, including the treatment of both morphological and functional abnormalities in one sitting, the use of intranasal approaches, and the establishment of aesthetic surgery as a medical specialty.

It is “not vanity which is the driving motivation, but the feeling of being disfigured and, conversely, the aversion to...”
1.2 Historical Review

Rhino-plasty “seeks to cure psychological depression by restoring a normal shape to the nose. Its social importance is beyond question, and it represents a significant branch of surgical psychotherapy.”

In 1904, Joseph reported on the first operation in which the intranasal removal of a dorsal hump was combined with correction of the anterior septum. At that time, intranasal operative techniques were considered “unsurgical” procedures that were handicapped by poor exposure and a high infection risk.

From 1916 to 1921, Joseph was director of the Department of Facial Reconstruction at the Charité Ear and Nose Clinic in Berlin, headed by Passow (1859–1926). At that time, he worked mainly in the plastic reconstructive surgery of extensive facial injuries that were sustained during World War I.

Owing to his great success, Joseph received an honorary professorship in 1919. Later, he started his own hospital and specialized in aesthetic surgery with an emphasis on rhinoplasty and mammoplasty. His colleagues included Gustav Aufricht and Joseph Safian.

Jacques Joseph is considered the founder of modern rhinoplasty. Curiously, three professors named Joseph were working in Berlin at the same time. The nasal surgeon among them was popularly known as “Noseph” to distinguish him from his gastroenterologist and dermatologist colleagues.

Aufricht later traveled to America, published numerous works, and became a respected nasal surgeon in the United States. He died in New York in 1984.

Joseph summarized his experience in an atlas and textbook with the lengthy title “Rhinoplasty and Other Facial Plastic Surgery with an Appendix on Mammoplasty and Several Other Operations in the Area of External Plastic Surgery.”

Joseph was buried in the Jewish Cemetery in Berlin-Weissensee, not far from our hospital. His grave site was destroyed by bombs during World War II and considered as given up for many years. Joseph’s wife, Leonore, emigrated to the United States, where she died at a grand old age, impoverished, in 1968.

In 2003, Walter Briedigkeit, a retired professor of pediatric cardiology from Berlin, found the destroyed grave site and remnants of the gravestone of Joseph’s grave (see Fig. 1.9).

During the international course “Essentials of Septorhinoplasty” in the same year, he initiated a worldwide campaign for collecting money for the restoration of the grave site. The project was generously sponsored by many personal gifts and donations and by scientific societies such as the American Academy of Facial Plastic and Reconstructive Surgery and the European Academy of Facial Plastic Surgery. Great support during all activities of rebuilding the destroyed gravestone by the Privat-Institut für Medizinische Weiterbildung und Entwicklungen auf dem Gebiet der HNO-Heilkunde e.V Berlin (www.imwe-berlin.de) came from Gene Tardy Jr.

On October 17, 2004, Joseph’s gravestone was consecrated by a ceremony in the Jewish Cemetery in Berlin-Weissensee (see Fig. 1.10). The stone reflects the eventful history of the grave: on the front is the new inscription on polished Swedish granite. The back of the stone has been left just as it was when it was found—broken, overgrown, damaged, with fragments of the original inscription.

1.2.3 History of Surgery of the “Internal Nose”

Diseases of the “internal nose” have their own history. The oldest documented record of medical treatment in which the patient and physician were named is that of the ancient Egyptian rhinologist Ni-Ankh Sekhmet, the physician to King Sahura, who presumably suffered from nasal polyps.

For centuries, efforts were made to improve the dreaded, bloody techniques for the operative treatment of nasal diseases, especially nasal polyps. New instruments, approaches, and techniques were constantly devised for that purpose. This
brought no real improvement, however, because surgeons knew little about the actual location and origin of the diseases.

During the Renaissance, intense study was devoted to the anatomy of the skull, including the nose and paranasal sinuses (Leonardo da Vinci [1452], Vesalius [1514], Highmore [1651]).

Many new discoveries were made about the human skull. In the late 19th century and early 20th century, the anatomical studies of Zuckerkandl (1882), Onodi (1893), and Grünwald (1925) yielded precise information on the anatomy of the nose, facial bones, and paranasal sinuses.

In 1925, Zuckerkandl supplied the first accurate information on the structural anatomy of the nose and paranasal sinuses.

The principle of the submucous resection was later abandoned because the over-resection of cartilage from the anterior septum tended to cause unfavorable late sequelae. Destroying the supportive function of the septum between the rhinion (keystone area) and the anterior nasal spine often led to depression of the cartilaginous nasal dorsum and retraction of the columna, with the functional and aesthetic problems of a saddle nose and hidden columella.

Corresponding mucosal lesions or poor vascularization of the scarred mucosal layers led to perforations. When the supportive function of the cartilaginous septum is withdrawn, there is a general tendency for the mucosa to become dry and atrophic. Although the septal layers are located near the midline and the nose appears broadened, the rhinitis sicca still causes a subjective feeling of nasal stuffiness. Another problem is the “septal flutter” that occurs during forced respiration and phonation.

In 1884, Sir Morrell MacKenzie founded the specialty of otorhinolaryngology when he published his first standard work on rhinology and laryngology.

Rhinology began to be established as a separate field in the early 20th century. When the anatomical studies of Emil Zuckerkandl supplied the first accurate information on the structural anatomy of the nose and paranasal sinuses in the late 19th century, interest also grew in using endoscopy to explore the complex spaces of the nose and its connections with the paranasal sinuses.

The first instruments used for this purpose were cystoscopes, because special endoscopes for the nose were not yet available. In 1901, A. Hirschmann first examined the maxillary sinus endoscopically through an enlarged dental alveolus, also examining the middle meatus.

Despite the progress made in optical examinations, these initial steps in nasal endoscopy did not lead at once to new approaches in diagnosis and treatment.
Substantial progress in these areas was not made until the postmortem studies of Walter Messerklinger on mucous transport in the human nose and paranasal sinuses. Such studies are possible because the respiratory epithelium continues to show ciliary activity for up to 48 hours after death. Messerklinger discovered that secretions from the large paranasal sinuses are transported along specific pathways to the ostia and flow from there through narrow passages in the lateral nasal wall to the mucosa of the nose.

The nose and sinuses constitute a physiological and morphological unit.

This principle seems obvious today, but before it was discovered, textbooks devoted separate chapters to diseases of the nose and diseases of the paranasal sinuses.

In recent years, the nasal mucous blanket has again attracted special interest because of its central role in the hypothesis of fungus-induced sinusitis. Fungal spores are trapped by the two layers of the mucous blanket. They penetrate the mucus and reach the epithelial surface, where they evoke an eosinophilic reaction. A mucosal inflammation is incited by major basic protein and other cytokines, leading to polyposis.

On July 16, 1959, a patent for the “rod lens system” was filed by its inventor, the English physicist Harold Horace Hopkins. It attracted considerable attention when unveiled as a new optical system at the Photokina photo exposition in Cologne. Karl Storz recognized the innovative potential of the invention for medicine and signed a licensing contract with Hopkins in 1965. The Hopkins rod lens system employs special glass rods with optically finished ends that replace conventional lenses. This has distinct advantages over a conventional lens system: better resolution and contrast, a wider viewing angle, superb clarity and brilliance, and an extremely fine depiction of details over the entire visual field.

Messerklinger used the new endoscopes to examine the lateral nasal wall, where he observed both normal and abnormal mucosal findings. He discovered that recurrent and chronic sinusitis had a rhinogenic cause in the great majority of cases. This led him to develop an endoscopic diagnostic strategy for the nose and paranasal sinuses.

Endoscopy could reveal the often subtle signs of mucosal inflammation, septal deformities located in the deeper areas of the nose, as well as anatomical factors predisposing to sinusitis. The pathways for the spread of rhinogenic sinusitis could be traced by endoscopic visualization.

One challenge at this point was to make this optical pathway accessible for a new type of surgery. The endoscopic surgeon would be able to reach the pathogenic nidus of recurrent or chronic-hyperplastic sinusitis and, by restoring ventilation and drainage, create the conditions necessary for the hyperplastic epithelium of the functionally dependent sinuses (maxillary and frontal) to heal.

The operative techniques and indications for this type of surgery have been constantly expanding along with the development of increasingly fine instruments and new endoscopes.

1.3 Phylogenesis

Phylogenetically, the necessity of having a nose is based upon the transition from aquatic to terrestrial life. Originally, all vertebrates breathed through gills, but this type of respiration was preserved only in lampreys (agnathians) and fish. Ectothermic amphibians marked the metamorphosis from gill-breathing to lung-breathing animals, with only a few water-dwelling forms continuing to breathe with gills. Amphibians have other mechanisms of respiration through their gland-studded outer skin and oral mucosa. Reptiles are obligate lung breathers that have become independent of aquatic life and have adapted to various environments. Some groups, like the sea turtles, have returned to life in the water. The development of choanae, which are the morphological prerequisite for nasal breathing, first appeared in primitive amphibians and later arose in all vertebrates.

This development is reflected in human ontogenesis. Through active growth, the epithelium of the nasal mucosa leads to the formation of the lateral nasal wall in the third month of fetal development. The rudiments of the nasal turbinates and paranasal sinuses also appear at this stage.

Over the course of evolution, the human nose has developed into a highly efficient aerodynamic body with specialized functions.
1.4 The Nose as a Respiratory Organ

Only nasal breathing is physiological in humans. Mouth breathing tends to dry out the lower respiratory tract, predisposing to various diseases (pharyngitis, laryngitis, bronchitis, bronchial hyperreactivity, asthma).

The nose has an immense regulatory capacity. Although the mucociliary apparatus is affected by the temperature and humidity of the inspired air and by the pH and osmolarity of the surrounding medium, air entering the nose is warmed to a relatively constant 31 to 34°C in the epipharynx. This occurs largely independently of the external temperature.74 The nose also humidifies the inspired air to a relative humidity of 90 to 95%.75

Most warming and humidification takes place in the anterior part of the nose.26 Both functions are linked to the ability of the nose to undergo rapid changes in cross section.

The nasal mucosa is the “front line” of the human immune system. With each breath, it responds to and defends against a variety of antigens and allergens. The mechanisms of this response include nonspecific (e.g., interferon, protease inhibitors) and specific humoral reactions (immunoglobulins A, M, and G), as well as cellular reactions by macrophages, mast cells, and granulocytes. At the same time, entirely different reactions such as absorption and secretion can take place on the mucosa.

The phylogenetic development of the upper and lower airways accounts for their functional interrelationship. The upper and lower airways form a functional unit. The mucosa, submucosa, and vascularity are similar in both regions. Also, the biochemical control mechanisms in the upper and lower airways have the same mediators. The mucosa of both the upper and lower airways responds to allergic and physical stimuli, chemical irritants, and inflammatory microbial irritants with cellular infiltration (mostly eosinophilic granulocytes), mucosal edema, and increased mucus production.77,78

The time required for a mucosal disease to “change levels” by spreading to the posterior wall of the pharynx, trachea, and bronchi varies in different individuals. The rhinologist should always keep in mind the principle of one airway, one disease29 (Fig. 1.15).

1.5 The Nose as a Sensory Organ

1.5.1 The Olfactory Sense

The area of respiratory epithelium located in the human olfactory groove measures approximately 2 × 5 cm. This area is many times larger in numerous mammalian species. In the speechless world of animals, the olfactory sense is the most important means of communication next to vision. Humans have approximately 10 million olfactory cells. These are bipolar sensory cells with an elongated cell body and a short process, the dendrite, with numerous cilia extending into the nasal mucous blanket. At the opposite end of the cell is a long neural process, the axon. The olfactory cells are classified as primary sensory cells.

The axons pass through the basement membrane of the olfactory epithelium and join to form the fila olfactoria. These filaments pass through the cribriform plate to enter the olfactory bulb in the brain. There they synapse with the dendritic tree of the mitral cells. Approximately 1,000 olfactory cells converge toward one mitral cell.

The processes of the approximately 60,000 mitral cells form the olfactory tract, which passes to the olfactory cortex, the primitive rhinencephalon. Information is relayed from there to the thalamus, hypothalamus, and amygdala. This intimate contact with the hypothalamus, which controls behavior patterns such as eating, drinking, sexual behavior, hormonal regulation, and the perception of emotions, probably explains why olfactory stimuli have rapid and direct access to the deepest centers of human emotion. Information is relayed from the thalamus to the neocortex, where the pathways terminate in old, nonspecific brain regions.79,80 The human olfactory sense is less rooted in the conscious mind than seeing and hearing, for example.

Generally speaking, olfaction must still be considered the “neglected” sense. The analytical perception of visual and auditory stimuli is constantly being trained and reinforced, whereas the processing of odors is a more intuitive process.2,81 Cortical representation in the phylogenetically old brain areas of the limbic system establishes a close, essentially nonverbal link with affect, emotions, and distant memories. For example, the smell of freshly polished linoleum can bring back vivid memories of grade school simply because that is how the school used to smell. Often it is difficult to describe an odor in words, and the best we can do is compare the smell to something else or describe it as “flowery,” “fruity,” etc.

The olfactory epithelium can regenerate within 100 days, which is unique for sensory organs. The sense of smell, like other senses, demonstrates the phenomenon of adaptation. The sensitivity of olfaction also depends on hunger. A very hungry individual can perceive several olfactory stimuli better than one who has eaten. This is a useful physiologic regulation mechanism.82

In the isthmic region of the limen nasi, the inspired air is slowed and separated into two streams. The main stream is directed over the nasal floor to the choana. A smaller stream is directed upward and sweeps over the dorsum of the inferior nasal turbinate. At this point, the air is warmed and continues to move upward. On reaching the head of the middle turbinate, the “updraft” splits into a lateral stream that ventilates the paranasal sinuses and another stream that is directed medially upward. The alignment of the middle turbinate is crucial for ventilation of the olfactory groove. It has the shape of an airfoil suspected between three points of attachment. A negative pressure prevails on the medial or “lee” side of the turbinate, causing the inspired air to rise into the olfactory fossa. Gustatory olfaction is subject to the same basic flow patterns following convection of the flow around the body of the turbinate (see Fig. 1.16).

Respiratory hyposmia can result from obstruction or deficient aeration of the olfactory groove caused, for example, by septal deviation, polyps, or tumors. Deformities of the nasal turbinates (e.g., lateralization, atrophy, paradoxical curvature) can also lead to hyposmia (Fig. 1.16).
1.6 Prerequisites for the Concept of Functional-Aesthetic Nasal Surgery

Several prerequisites have been essential in developing a common concept in rhinosurgery that places equal emphasis upon functional and aesthetic demands.

1.6.1 Septal Surgery with Functional and Aesthetic Goals

The nasal septum is the central connecting link between the internal and external nose. It supports the lateral cartilages and provides a secure attachment of the cartilaginous nose to the facial skeleton between the rhinion (keystone area) and the anterior nasal spine, premaxilla, vomer, and perpendicular plate of the ethmoid.

The successful correction of axial deformities of the nose is not possible without fully utilizing the capabilities of the submucous septoplasty.

Aufricht said: “Where the septum goes, there goes the nose.” This is equally true for the reconstruction of saddle nose deformities, where a stable buildup of the septum is the key to a successful outcome.

While the nasal septum may be affected by numerous deformities, three patterns are most commonly encountered (Fig. 1.18):

- The septum is too long in the basal-to-dorsal direction. This situation is common in the overprojected nose and functional tension nose with hyperplasia of the upper lateral cartilage or alar cartilage.
- Phylogenetically, the connection between the vomer and basal septal cartilage is a zone of “tectonic unrest.” Originally, it had the form of an articulation. Even slight growth or forward movement of the vomer, usually during puberty, leads to elevation of the cartilaginous nasal dorsum due to the wedged shape of the underlying vomer or to characteristic vomerine ridges that run obliquely upward.
- The septum is too long in the craniocaudal direction. This situation is often seen in axial deformities and is associated with two sites of nasal airway obstruction. Subluxation is common (Fig. 1.18).
The external shape of the septum can be selectively modified in septal operations. Resections of the anterior septal margin can be helpful in shortening the nose and in establishing a symmetrical nasal tip with an equilateral rhomboid shape. An infratip triangle that is too long can be shortened. Also, the anterior septal margin can be beveled to rotate the tip upward and accentuate the double break in the nasal profile. Septal modification is an essential part of creating a subtle, aesthetically pleasing supratip break in women.\(^5\)

### 1.6.2 Principles of Submucous Septoplasty

Cottle (1948) introduced his cartilage-conserving operation as an alternative to the Killian septal resection (see pp. 6 and 7). The Cottle operation attempts to preserve the supporting function of the septal cartilage and the physiological function of the nasal mucosa. After the anterior margin of the septum has been exposed, the mucoperichondrium is undermined to create a superior tunnel on the left side and an inferior tunnel on both sides. The mucosa remains adherent to the septal cartilage on the right side. This provides good septal mobility. The classic Cottle operation has been continually modified over the years. One modification is the swinging door technique in which the septal cartilage is detached just anterior to the perpendicular plate to increase the mobility of the cartilage during the operation (Fig. 1.19a). The mucoperichondrium is left in place. Also, small strips or wedges can be excised from the cartilage to eliminate redundant material that would create undesired stresses. The cartilage can also be scored or cross-hatched to modify its bending properties.

In our experience, a large percentage of septal deviations can be managed with this technique. For greater, sharp-edged deviations that are combined with axial deformities, the mucosa can be completely elevated from the septal cartilage to form two superior and inferior tunnels in preparation for an extracorporeal septoplasty.\(^6\)

In this technique, the cartilaginous and bony septum is completely removed, straightened, stabilized for instance with spreader grafts and reimplanted and fixed by sutures at the k-stone region and the anterior nasal spine. A compound graft is made by suturing pieces of septal cartilage in a mosaiclike pattern to a sheet of polydioxanone suture material (PDS). This sheet gives the composite implant the necessary mechanical stability until the material is absorbed.\(^25,30\)

A complete tunneling of the nasal septum is useful in deviated noses, because the unwrapping effect might help to analyze and correct deviations.

If the potential of the septoplasty is to be fully realized in terms of improving function and aesthetics, this procedure must take the form of a technically demanding plastic operation. As Adamson put it, "The only easy septum is the one which has no need to be done"\(^34\) (Fig. 1.19a).

### 1.6.3 The Pediatric Nasal Septum

Traditionally, the main argument against septal surgery in childhood has been the belief that the septal cartilage is an essential pillar for the primary growth of the midfacial region.\(^51\)

Today it is known that the septum, maxilla, and premaxilla develop independently of one another.\(^25,3\)\) Strict criteria should be applied in selecting children for septal operations. Nevertheless, even small children can be successfully operated for traumatic deformities or malformations of the septum that cause significant nasal obstruction. Deformities of the anteroinferior septum are the most common problem.\(^24\)

It is important that the surgery preserve the perichondrium, the growth zones (e.g., the caudal septum), the premaxilla, and the sutural junctions with the perpendicular plate and vomer.\(^25\)

The pediatric septum consists mainly of the quadrilateral plate; the vomer and perpendicular plate are relatively small. This calls for an atraumatic, chondroplastic mode of surgery. Pieces of cartilage that are removed should be straightened and reimplanted. Even after surgical trauma, the septal cartilage still has considerable regenerative capacity.\(^23\)

### 1.6.4 The Nasal Valve

As early as 1882, Zuckerkandl described the nasal valve as follows: "The fold of the upper lateral cartilages and the wall of the nasal septum form a space leading into the nasal cavity that is much narrower than the external naris." Mink called this area the nasal valve because of its dynamic function in regulating the cross-sectional area of the nasal airway.\(^20,40\) The resistance to nasal airflow is to a large degree determined by the nasal valve.\(^19\)

Over the years, numerous operations have been described for widening the nasal valve and preventing alar collapse.\(^45,96–100\) A history of obstructed nasal breathing plus visual inspection of the external and internal nose (preferably with an endoscope) will direct attention to the underlying problem and suggest the best technique for widening or stabilizing the nasal valve.

A positive Cottle maneuver indicates a problem with the nasal valve; when the ala is pulled laterally upward, the nasal valve opens and breathing improves (Fig. 1.20).

Some surgical techniques to enlarge or stabilize the internal nasal valve are shown in Fig. 1.21.
1.6.5 Physiological Limits of Nasal Breathing

Our experience in the treatment of speed skaters at the Olympic Center in Berlin has demonstrated an interesting phenomenon. Good nasal breathing is particularly important in this sport, where very cold, dry air is forcibly inspired in short, deep breaths taken through the mouth or through the nose and mouth combined. Twelve top athletes who had septal deviation, turbinate hyperplasia, inflammatory ethmoid changes, or an anatomical variant (concha bullosa, paradoxical curve of the middle turbinate, pneumatized agger nasi) underwent a septoplasty that usually included an endoscopic ethmoidectomy or turbinate reduction. But even patients who showed very good postoperative nasal breathing by rhinomanometry reverted to oronasal breathing during exercise. The reason is a physiological collapse of the nasal valve that occurs with extreme inspiration to protect the lower airways and lungs from unconditioned air that is too cold or too hot. Activation of the sympathoadrenergic system in response to physical exercise leads to a decongestion of the nasal mucosa. This results in increased airflow through the nose and a lowering of nasal resistance, accompanied by an acceleration of mucociliary secretion.19 Nevertheless, the resistance to open mouth breathing is still less than the resistance to nasal breathing. The athletes adopt a combined oronasal mode of breathing that includes a degree of nasal breathing while regulating the airway resistance so that the work of respiration (pressure and volume) does not become too great.101–103 (Fig. 1.22).

1.6.6 Atraumatic, Structure-Conserving Techniques of Septorhinoplasty

The description of new principles of rhinoplasty, especially by Tardy, has changed the fundamental character of this surgery.104–107 The key is a detailed analysis of the presenting anatomical problems, taking into account other fundamental factors such as skin type, connective-tissue type, and the age of the patient.108 Surgical access is gained through adequate approaches that are as minimally invasive as possible. The surgery is structure-conserving and aimed at preserving and reorienting the cartilages. The strategies include circumscribed resections and the use of suture and graft techniques to shape the nasal tip. Any unnecessary tissue trauma is avoided. The following measures are helpful in achieving these goals:

- Selective, local vasoconstriction is added to general anesthesia to minimize bleeding.
- Osteotomies are performed with micro-osteotomes that do not damage the periosteum or the overlying vascular and muscle plane. Traditional transverse osteotomies are avoided.
- Intranasal sutures or splints eliminate the need for laborious packing.
By minimizing tissue trauma, intraoperative bleeding is reduced. A well-defined surgical concept based on an analysis of the specific morphological problem and of preoperative photographs helps to shorten the operating time. Less bleeding and shorter operating times are the prerequisites for expanding the range of indications for rhinosurgical operations that include endoscopic microsurgery.

An understanding of the tip-supporting mechanisms will protect against unnecessary destabilization of the nasal tip and dorsum during the operation. The dynamics of rhinoplasty refers to a system of surgically induced interactions to fine-adjust the position of the nasal tip. Dissection strictly in the favorable surgical planes can minimize unnecessary bleeding, edema, and subsequent scarring. The task of the surgeon is to lay the groundwork for a stable long-term result.

Fig. 1.21 Some surgical measures to enlarge or stabilize the internal nasal valve. (a) Flaring sutures. (b) Alar batten grafts of autologous cartilage, used to treat stenosis of the internal (circled 1, 2) and external nasal valve (circled 3). (c) Butterfly grafts keep the nasal valve patent. They are placed on the dorsal border of the septum and pushed beneath the dorsal alar cartilage. (d) Horizontal mattress bending sutures. (e) The à Wengen titanium breathe implant.

Fig. 1.22 Typical combined oronasal breathing, demonstrated by five-time Olympic ice-skating gold medalist, Claudia Pechstein.
1.7 Functional Aspects of Septorhinoplasty

1.7.1 Olfactory Disturbances

Disturbances of olfaction are the second most common leading symptom of nasal obstruction reported by our patients. Olfactory disturbances may be described as quantitative or qualitative. *Hyposmia* and *hyperosmia* signify a change in the olfactory threshold, while *anosmia* denotes an absence of the smell sensation. This may affect the perception of certain odors or of all smells. *Parosmia* refers to an altered perception of smells under certain physiological conditions, such as pregnancy. *Pseudosmia* refers to the misidentification of perceived smells, as in cacosmia. *Phantosmia* is an olfactory hallucination, or the perception of an odor with no stimulus present. In *anosmia*, olfactory information is perceived but is not recognized. The most important distinction for the rhinosurgeon is between *respiratory* and *sensory hyposmia*.82

The modern classification distinguish two kinds of olfactory disorders: sinonasal olfactory disorders and nonsinonasal olfactory disorders.

Sinonasal Olfactory Disorders

These are the most common disorders encountered in otorhinolaryngology.

- Infectious causes: chronic rhinosinusitis.
- Noninfectious causes: allergies, polyposis, hyperplastic rhinosinusitis, postinflammatory and toxic, postinfectious, rhinitis sicca.
- Noninflammatory causes: anatomic (malignant and benign tumors, stenosis, choanal atresia, adhesions, septum deviations) or nasal congestion, idiopathic rhinitis, side effects of drugs.

Nonsinonasal Olfactory Disorders

Viral infections can lead to primary damage to the olfactory cells. Typically, patients experience a subjective loss of the sense of smell immediately after an infectious disease. Neurologic, congenital, toxic, and psychiatric conditions may involve olfactory disorders, as well as head injuries. Dysosmias may be an initial symptom of Alzheimer’s disease, preceding loss of cognition, and abnormal behavior. In Parkinson’s disease, olfactory disorders often occur before motoric disorders. Noxious substances such as carbon dioxide, formaldehyde, or tobacco smoke can directly damage the olfactory cells. Congenital dysosmias (e.g., Kallmann syndrome) are rare.82

Basic Diagnostic Workup of Olfactory Disturbances and Paranasal Sinus Diseases

Olfactometry

Olfactometry should precede every surgical operation on the nose or paranasal sinuses.

First, a precise case history is taken that includes triggering events, associated symptoms, relevant illnesses, operations, drugs, and noxious influences. This is followed by nasal endoscopy, with exploration of the nasopharynx and olfactory cleft.

Assessment of olfactory function is based on a standardized, validated test. We prefer the Kobal Sniffin’ Sticks.114,115 Sixteen scents on felt-tip pens are presented to the patient, who is asked to identify them. This test is widely used in Europe. It combines threshold, identification, and discrimination of scents. The identification test is suitable for screening.

For more information about clinical olfactory tests, you may refer to the textbook *Ear, Nose, and Throat Diseases*.82

Computerized Rhinomanometry

Active anterior computerized rhinomanometry with a decongestion test can be used to differentiate between fixed stenoses, dynamic stenoses, and pseudostenoses.

In our practice, rhinomanometric measurements are an indispensable tool in selecting patients for septoplasty or septrhinoplasty.2

Computed Tomography

Computed tomography (CT) in the coronal plane or a digital volume tomography provides an excellent overview of the ethmoid region and paranasal sinuses. The marked individual variations in the degree of ethmoid pneumatization can be appreciated on CT scans. CT can also demonstrate pathological mucosal changes, the relative locations, and special features of major structures like the optic nerve, the presence of Onodi cells, the depth of the olfactory fossa, and the distance from the medial infundibular wall to the orbit. Thus, CT can provide both an inventory of pathological changes and a “roadmap” for endoscopic operations.

Endoscopic Examination of the Nose

Nasal endoscopy, with its ability to explore the internal nose, has become an essential tool for modern finding-oriented rhinological diagnosis and treatment. The endoscopist looks for signs of inflammatory mucosal disease such as abnormal mucous tracks, areas of mucosal edema, or mucosal polyps on the lateral nasal wall. Attention is also given to anatomical variants of pathogenic significance such as concha bullosa or paradoxical middle turbinates.

Nasal endoscopy also permits the topographic evaluation of aerodynamic obstructions such as ridges or spurs on the posterior septum or perpendicular plate, nasal valve stenosis, and alar collapse.

Frequent Causes of Respiratory Hyposmia

- Large deviations of the nasal septum.
- Septal deviation with compression or lateralization of the middle turbinate.
- Prominent spurrs and ridges.
- Nasal and sinus polypos.
- Papillomas.
- Morphological variants of the middle turbinate (e.g., concha bullosa, large pneumatized labyrinth-turbinate complex).
- Synechiae.
- Rhinitis sicca.

Surgery in the Olfactory Groove

Surgical manipulations in the olfactory groove should be carried out with extreme care. Olfactory and respiratory epithelia are indistinguishable from each other.
To avoid a cerebrospinal fluid (CSF) leak caused by the avulsion of fila olfactoria, the surgeon should use only sharp, low-profile, 70- to 90-degree angled instruments that cut through the tissue. The middle turbinate should be displaced laterally without breaking the bony lamella during the dissection to afford maximum exposure.

The Storz minishaver has proved especially useful for operations in the olfactory groove. Floating tissue is aspirated into the window of the outer sheath and cut off cleanly with a rotating blade. The sheath protects the opposing mucosa from accidental injury.

1.7.2 Recurrent and Chronic Sinusitis

Wibke Behrböhm

Significant deviation of the nasal septum, like that often found in axial deformities of the nose, is a predisposing factor for recurrent sinusitis.

Fig. 1.23 illustrates the most important cellular structures and their variants that may have causal significance in recurrent sinusitis.

Endoscopic Surgery of the Paranasal Sinuses

Endoscopic surgery of the paranasal sinuses is a minimally invasive microsurgical operating technique. Dissection through a well-exposed field will cause minimal intraoperative bleeding. With some practice and good anatomical orientation, it is our experience that endoscopic microsurgery and septorhinoplasty can be effectively combined.

Algorithm for Simultaneous Septorhinoplasty and Endonasal Microsurgery

The recommended sequence of surgical steps is shown below, based on the example of a long, humped nose:

1. Decongestion of the nasal mucosa with nose drops.
2. Local anesthesia plus vasoconstriction of the external nose and septum.
3. A pledge soaked with tetracaine and epinephrine is placed in each naris for 10 minutes for vasoconstriction.
4. Infiltration of the lateral nasal wall under endoscopic control.
5. Endoscopic microsurgery of the ethmoid and paranasal sinuses, including adjunctive measures. This presumes that a strong septal deviation is not obstructing the middle turbinate. The beginner can determine this by noting whether a 4-mm telescope can be easily positioned at the antrum of the middle meatus. If not, a submucous septoplasty should be performed first.
6. A pledge is inserted into the ethmoid at the end of the ethmoid surgery.
7. Submucous septoplasty is carried out, usually through a hemitransfixion or superior transfixion incision, paying attention to aesthetic aspects such as:
   a) Shortening the entire caudal or dorsocaudal edge to shorten the nose, reducing an infratip triangle that is too long, or tip rotation.
   b) Resecting a narrow basal strip to relax a tight nasal valve.
   c) Removing or shortening the nasal spine if there are signs of vestibular tension or an obtuse nasolabial angle. The soft tissues of the nasolabial angle are augmented as required.
8. The nasal tip and dorsum are accessed through a non-delivery or delivery approach or an open approach. In the splitting approach, the transcartilaginous or intercartilaginous incision is combined with a hemitransfixion or transfixion incision. The intracartilaginous incision may also be combined with these incisions (e.g., for a delivery approach).
9. The nasal tip is corrected, according to the anatomical situation.
10. The cartilaginous hump is removed first, then the bony hump.
11. Medial oblique and lateral curved osteotomy.

Principles of Endonasal Microsurgery

A detailed endoscopic evaluation is an essential prelude to microsurgery of the lateral nasal wall and paranasal sinuses. The endoscopic and imaging findings provide the basis for designing an individualized concept for operative treatment. The value of this endoscopic–microsurgical concept is that it provides the means for detecting and eliminating the often subtle causes of recurrent or chronic inflammatory diseases of the maxillary, frontal, and sphenoid sinuses.

The mucosal pathology begins in the anterior ethmoid and spreads from there in a centrifugal pattern. Foci of mucosal edema in the tight spaces of the lateral nasal wall hamper mucous drainage from the frontal and maxillary sinuses, causing infected secretions to dam back. If the mucosal disease persists, the edematous foci become organized. This leads to disturbances of the mucociliary apparatus such as restricted ciliary beating and
sinuses, we can recommend the following indications:

- Torhinoplasties with endoscopic microsurgery of the paranasal
- Based on our experience in more than 3,000 simultaneous sep-
- Indications

78 entity. The Samter’s triad—should be viewed as a separate disease
- of analgesic intolerance, bronchial asthma, and sinonasal pol-
- inflammation is perpetuated by immune mechanisms, in most
- to toxic to the epithelium and play a central role in the patho-
- The goal of mucosa-conserving surgery is to create the
- ethmoid labyrinth and to the frontal, maxillary, and sphenoid
- soon as possible to halt the spread of inflammation to the entire
- seromucous glands (Fig. 1.24).
- Rheological mucus changes. These are followed by morphologi-
- cal mucosal changes such as an altered ratio of ciliated cells
goblet cells, loss of cilia, and mucous transformation of the
- The metabolic products of eosinophilic granulocytes are
toxic to the epithelium and play a central role in the patho-
- genesis of chronic hyperplastic rhinosinusitis. A mixed-cell
- inflammation is perpetuated by immune mechanisms, in most
- cases by T lymphocyte–activated eosinophilic granulocytes.

Against the backdrop of these immune responses, eosino-
phil-associated “rhinosinusbronchopathy”—especially the triad
of analgesic intolerance, bronchial asthma, and sinonasal pol-
- ys, the Samter’s triad—should be viewed as a separate disease
- entity.9

Surgery in these cases is only one component of a treat-
- ment concept consisting of finding-oriented endoscopic after-
care and topical medical treatment, with systemic therapy
- added in selected cases.

**Indications**

Based on our experience in more than 3,000 simultaneous sep-
- torhinoplasties with endoscopic microsurgery of the paranasal
- sinuses, we can recommend the following indications:

- Recurrent ethmoid and maxillary sinusitis.
- Recurrent ethmoid and frontal sinusitis.
- Chronic hyperplastic sinusitis with circumscribed mucosal
- changes.
- Cysts of the maxillary and sphenoid sinus.
- Postinflammatory or postoperative synechiae.

**Contraindications**

As a general rule, any complications of inflammatory diseases,
tumors, and suppurative inflammations should be excluded prior
to the simultaneous operative treatment of extensive pansinusitis.

Revision procedures (e.g., of the ethmoid or frontal sinus) for mucoceles or obliteratorive scarring of the frontal recess should be performed separately. One should never compromise the functional or aesthetic outcome in order to achieve a one-stage operation.

- Chronic hyperplastic pansinusitis.
- Acute exacerbation of chronic or recurrent sinusitis.
- All types of complication (orbital, central, vascular).
- Tumors.
- Revisions.

**Complications**

The complication of endoscopic endonasal microsurgery can
be classified as orbital, central, or vascular.

**Orbital Complications**

The most frequent orbital complication is injury to the lam-
- ina papyracea, resulting in a hematoma of the upper or lower
- eyelid. If the periorbita is injured, orbital fat will herniate
- into the ethmoid cells. The ocular compression test described
- by Stankiewicz can be used to assess the magnitude of the
- injury.116 It is important for the surgeon to detect any orbital
- injuries at once so that the use of sharp and cutting instruments
can be avoided. If an orbital perforation is suspected, the eye
- should be opened to check for concomitant movement of the
globe. Lesions ≥ 0.4 cm² should be repaired with fascia or peri-
- chondrium, while smaller lesions can be covered with mucosa.

Injury to the anterior ethmoid artery can lead to the formation
of an intrabulbar or retrobulbar hematoma. In severe cases, the
- associated effect on intraorbital pressure can lead to blindness.
The best first aid in these cases is to compress the orbital contents
with external pressure on the closed eyelid. If this does not stop the hemorrhage, the pressure can be relieved by a lat-
- eral canthotomy or endonasal incision of the periorbita.

The bony canal of the optic nerve forms a typical promi-
- nence in the lateral wall of the sphenoid sinus. It may also
- encroach upon the posterior ethmoid, especially in the pres-
- ence of Onodi cells. This is the area in which most optic nerve
- injuries occur. Pupillary response should be checked during
- the operation. Direct or indirect injuries are manifested by a
- reflex mydriasis. Injuries to the orbit always require specific or
- empirical antibiotic therapy as an adjunct.117-119

**Intracranial Complications**

CSF leak is the most common intracranial complication. Partic-
- ular danger sites are located in the cribriform plate and ante-
- rior skull base at the level of the canal of the anterior ethmoid
- artery. The skull base is very thin in that area, and the surgeon
approaches it directly after opening the anterior ethmoid. The
- surgeon should be alert for any leakage of the colorless fluid.

Small defects can be covered with free grafts of nasal or turbi-
- nate mucosa. Lesions of the bony skull base larger than
- 4 mm should be repaired with autologous fascia lata harvested
- from the thigh. Fibrin glue is excellent for attaching the graft.
- The fascia should be supported for 1 week with antibiotic-
- impregnated packing. Coverage with an antibiotic agent that
will enter the subarachnoid space is also required.
Vascular Complications

The most serious vascular complication is injury to the carotid artery in the lateral wall of the sphenoid sinus. The surgeon should take every precaution to avoid this disaster. This includes the use of coronal CT scans and high-performance endoscopes with a wide-angle view that will encompass peripheral surgical landmarks.

Even when opening the sphenoid sinus, the surgeon should proceed very carefully while noting key landmarks such as the attachment of the middle turbinate, the choana, the sphenoid sinus. The surgeon should proceed very carefully while noting key landmarks such as the attachment of the middle turbinate, the choana, the sphenoid sinus. The posterior ethmoid cell may even be larger than the sphenoid sinus itself. The sphenopalatine artery runs level with the floor of the sphenoid sinus and may bleed profusely when injured. This vessel is easy to locate, however, and can be coagulated with a bipolar cautery even through the mucosa.

The anterior and posterior ethmoid arteries may or may not traverse a bony canal in the anterior skull base. The vessels are easily identified and can be coagulated. There is a danger of vessel retraction into the orbit.66,70

Biostatic Endoscopic Surgery

Based on author’s own experience, the following procedures and the principles of biostatic surgery can be recommended in simultaneous procedures.

The ethmoid bone is a “lightweight structure” between the skull base and midface. The ethmoid bone has an interindividual structure. There are three pneumatization types (labyrinth type, pneumatized conchal type, and interlamellar type), yet the number of possible variants is infinite.

1. In order to ensure preservation of its “spacer” function, the individual construction plan must be analyzed.
2. Ethmoid surgery should aim to respect the biostatics of the structure as far as possible.
3. Only a sustainably wide ethmoid equates to surgical success. If control over the positioning of the middle turbinate is lost, it results in a loss of control over the success of surgery (Fig. 1.25).
4. There are both “supporting” and compartmentalizing walls in the ethmoidal bone: the bulla lamellar and basal lamella are important support structures.
5. Turbinate trimming is only possible with anchorage to three points.

Surgery of the Anterior Ethmoid

Infundibulotomy

The goal of this procedure is to join the ethmoid infundibulum with the nasal cavity. The first step is to cut around and remove the uncinate process, which basically forms the medial wall of the infundibulum. After removing the medial wall, the surgeon can inspect the ostium of the maxillary sinus, which opens anteroinferiorly. The intraoperative endoscopic findings will determine whether it is necessary to remove additional cells during the infundibulotomy—especially the ethmoid bulla, which bounds the infundibulum dorsally. The bulla lamella should be preserved to avoid shrinking of the anterior ethmoid (Fig. 1.26a–c). In all cases, at least an exploratory opening should be made in the anterior wall so that the endoscope can be passed into the bulla.

This procedure is indicated for recurrent maxilloethmoid sinusitis with circumscribed changes in the ethmoid epithelium.

Anterior Ethmoidectomy

Removal of the anterior ethmoid cells creates a uniform cavity through which the frontal and maxillary sinuses communicate with the nose. Care is taken to obtain a clean, complete excavation of the cells. Not infrequently, walled-off residual cells create a nidus for recurrent inflammation.124

The resection cavity is bounded dorsally by the basal lamina of the middle turbinate with its hyperbolic line of insertion on the lamina papyracea (Fig. 1.27).

Trepanation not resection of the ground lamella is essential to avoid ethmoidal atelectasis.

Fenestrations of the Maxillary Sinus

Supraturbinate fenestration of the maxillary sinus is done to improve mucus drainage and ventilation in patients with diffuse hyperplastic maxillary sinusitis. It also affords access for intracavitary maxillary surgery.
After infundibulotomy is completed, the maxillary ostium can be located by viewing laterally with the 45-degree oblique scope. The ostium is extended anteriorly with back-biting forceps, taking care to preserve the epithelium of the dorsal circumference to avoid a circular wound with a strong tendency to restenose.

Diffuse hyperplastic (“cobblestone”) mucosa is left to heal by reparative processes. Cysts and polyps can be removed through a 9- to 12-mm window under vision using the 70-degree scope.

To avoid blind optical angles in the alveolar and prelacrimal recess alternatively or additionally an infraturbinal and prelacrimal approach to the maxillary sinus is useful. There are new indications for the fossa canina approach before and during sinus lifts in dental implantology.

Endoscopic Frontal Sinus Surgery in the Context of Functional–Aesthetic Nasal Surgery

Recurrent bouts of sinusitis are an indication for enlarging the frontal recess. A useful landmark for locating the frontal recess is the bony canal of the anterior ethmoid artery, which runs just dorsal to the recess. The frontal recess is bounded anteriorly by the agger nasi, which may be pneumatized. It should be noted that the frontal recess runs obliquely downward and backward at about a 120-degree angle to the infraorbitomeatal line. A 45-degree scope should be used to locate the region anterior to the bony canal of the ethmoid artery at the anterior skull base. The recess can be enlarged in the dorsoventral direction into a Draf I–III level. This dissection technique is also recommended when agger nasi cells (K1–K4) or infundibular cells obstruct the frontal recess. Freeing the recess of these cells has been described as “uncapping the egg.”

It is essential to preserve the posterior circumference of the mucosa, for otherwise the recess is bound to become occluded by adhesions. If this is not possible, specially designed silicone stents (Rains drains) can be placed to provide temporary drainage and promote stable epithelialization. The drains are left in place for 4 to 6 weeks. They are very soft, are well tolerated by the patient, and are easy to remove.

Over this, the removal of intracavitary cells (K4 cells, bullae frontalis) across endonasal approaches is important because these cells are often the reason for residual or recurrent frontal sinus infections after previous FESS (Fig. 1.26).

The techniques and special instruments for icmic (intracavitary minimally invasive surgery) are described in a surgical manual (see Fig. 1.28).
1.7.3 Adjunctive Intranasal Measures

Adjunctive measures are endoscopic endonasal procedures in the nasal cavity and nasopharynx that are intended to:
- Improve nasal breathing.
- Correct rhinogenic ventilation problems in the maxillary, frontal, and sphenoid sinuses.
- Decompress the middle meatus.

**Adjunctive Septoplasty**

Circumscribed ridges or spurs can be removed by a minimally invasive endoscopic technique. The selective removal of spurs or ridges from the septal cartilage or perpendicular plate is performed through dorsally based “trapdoor flaps.”

The mucoperichondrium is undermined by selective subperichondrial injection. The flap is outlined with a No. 15 blade and raised with a Freer elevator. The cartilage ventral to the deformity is divided with the Freer elevator, separated from the contralateral mucoperichondrium, and excised with nasal scissors.
1.7 Functional Aspects of Septorhinoplasty

Fig. 1.30 (a) Young woman with a broad, asymmetrical tip and supratip area. She had severe nasal obstruction and a history of postorbital headaches. (b) The profile view shows a bony and cartilaginous hump and an overprojected nose. (c) The basic view shows a moderately widened tip, an obstruction of the nasal airway in the right vestibule by a septal subluxation. (d) Coronal CT scan of the paranasal sinuses shows polypous mucosal swelling in the ethmoid cells, maxillary sinuses, and nasal cavity on both sides. (e) View in the left middle meatus with the 0-degree endoscope (4 mm, Karl Storz, Tuttingen, Germany) demonstrates severe obstruction by a mucosal polyp. (f–h) Appearance 15 years later in frontal, profile, and basic view after open structure rhinoplasty with asymmetrical reduction of the alar cartilages, removal of the cartilaginous and bony hump in two pieces, curved lateral high-to-low osteotomies, transdomal and interdomal sutures (see p. 42), and shortening of the lower lateral cartilages in interrupted strip technique. The nasal septum was straightened by reduction of the cartilage basically, shortening in a craniocaudal direction of 3 mm, swinging door technique for removal, straightening, and repositioning of deviated posterior parts of the medial nasal wall, incomplete cartilage incision on the right side, and fixation in the midline with anterior nasal spine fixation suture. (continued)
The removed fragment can be straightened with cartilage-crushing forceps and reimplanted. The replaced mucosal flap is secured with several drops of fibrin glue (Fig. 1.31).

The procedure had to be done very carefully because there is a high risk of posterior septal perforations if the opposite mucosal layer is damaged. Suturing in this region is possible but difficult.

**Treatment of the Middle Turbinate**

The middle turbinate is the principal landmark for endoscopic microsurgery of the paranasal sinuses. The medial lamina separates the cribiform plate from the ethmoid roof, which is formed by the frontal bone. The middle turbinate should be preserved whenever possible because it bears olfactory epithelium and has an aerodynamic function in ventilating the frontal and maxillary sinuses and the olfactory groove.

**Most Common Procedures on the Middle Turbinate**

**Splitting a Pneumatized Middle Turbinate**

The middle turbinate is part of the ethmoid bone, and all portions of the turbinate (head, neck) may be pneumatized. The pneumatized middle turbinate behaves like a separate paranasal sinus. It is susceptible to concha bullosa sinusitis and can cause complications, usually headaches. A concha bullosa, or heavily pneumatized head of the middle turbinate, can obstruct the middle meatus of the nose. It is cleanly and completely split from before backward, continuing the split till 2 mm before the insertion of the pterygoid process, and removed.

Any bleeding from the sphenopalatine artery during this procedure can be quickly brought under control by submucous bipolar coagulation of the vessel.

**Swinging Flap**

If the middle turbinate is unstable and hypermobile due to pressure atrophy, it should be shortened. The mucosa is dissected from the bone, the bone is shortened with the nasal scissors, and the mucosa is turned over the bone in a medial to lateral direction.\(^7\)

**“Trimming”**

**Trimming** is a nautical term for opening a sail to a smooth, unfurled position by adjusting the tension on various lines.

The middle turbinate is an aerodynamic body, and its treatment requires attention to aerodynamic principles. It should always be “trimmed” in a tension-free position within the nasal airstream (see p. 13).

Even atraumatic ethmoid operations have the risk of scarring and atrophy of the ethmoid bone with lateralization of the middle turbinate.

Every postoperative patient should receive a follow-up endoscopic examination, and the middle turbinate should be trimmed as required. If the turbinate has a tendency to deviate laterally, the following options exist:

- The turbinate attachment is fractured and the turbinate splinted with a Kennedy-type Merocel pack.
- The middle turbinate has three zones of attachment that keep it stable and properly aligned within the nose:
  - Anterior skull base—frontal bone.
  - Lamina papyracea—ethmoid bone.
  - Pterygoid process—sphenoid bone.
The lateral attachment on the lamina papyracea can be weakened to medialize the turbinate and counteract the tendency toward lateral retraction due to scarring. For additional mobilization, the posterior part can be incised with curved shank scissors.

Initial medialization of the turbinate can be accomplished by making a corresponding small incision in the septal mucosa and medial turbinate mucosa to produce a synechia, which is later divided after wound healing is complete.68

### Treatment of the Inferior Turbinate

Deviation of the septum and hyperplasia of the inferior turbinate are closely interrelated conditions. Deviations that narrow one side and broaden the opposite side lead to a compensatory hyperplasia of the inferior turbinate on the broader side.

The inferior turbinate was long considered off-limits in rhinosurgery. Surgical manipulations of the inferior turbinate were performed only with great caution, if at all. Today that philosophy has been reversed, and the inferior turbinate is the target of various resections and laser procedures. This is not without its hazards, because the inferior turbinate functions as the thermostat of the nose. Once destroyed, its function cannot truly be replaced.

The results are irreparable functional deficits due to inadequate warming and humidification of the inspired air, olfactory disturbances, and mucosal atrophy combined with a feeling of nasal stuffiness in a broad nose.

It is our experience that inferior turbinate hyperplasia is often caused by a mucosal inflammation that spreads centrifugally from the ethmoid. After this region has been cleared of disease, the turbinate hyperplasia tends to resolve in the majority of patients.

There should be little hesitation in removing the hyperplastic ends of the inferior turbinate. They can significantly compromise nasal breathing and eustachian tube function, especially when they extend through the choana into the nasopharynx.

The following procedures can be recommended from our experience:

- **Radiofrequency surgery**: Reduction of the inferior turbinate with radiofrequency is a common procedure. We use bipolar electrodes. The procedure is possible in local and general anesthesia. After a decongestion with a nasal tamponade with tetracaine/adenaline, the electrode will be pushed forward in the lower part of the turbinate. Energy of radiofrequency about 30 kW is effective. A modification is the Coblation technique. The advantage of this technique is no bleeding, little postoperative swelling, and no mucosal reactions like hypersecretion and fibrin covering.

- **Submucosal subperioseal turbinectomy**: In a subperioseal turbinectomy, shrinkage of the submucous tissue is achieved by partial resection of the turbinate bone.129 The approach to the turbinate bone is a little incision in front of the head of the turbinate.

- **Lateralization**: The inferior turbinate can be moved to a more lateral position by fracturing its muscular attachment.130,131 The procedure is sure after uncinectomy because there is a risk to luxate the uncinate process into the ethmoidal infundibulum.

- **Strip excision**: A turbinate strip excision should be done sparingly, removing excess tissue at the lower margin of the inferior turbinate with one sharp cut. The bone should be left covered, as there is a danger that vessels may retract into the bone and cause serious bleeding.

- **Photocoagulation**: Photocoagulation of the inferior turbinate should be mentioned as a special form of laser treatment. In the last years, radiofrequency completely replaced lasers in the nose in our practice.

Different types of laser differ in their wavelength, absorption properties, penetration depth, and mode of operation. This accounts for their different effects in surgical procedures. Noncontact laser use does not ablate epithelial tissue but causes oblitative scarring of the erectile muscle tissue by inducing a vasculitis in the submucous venous plexus. The scarring leads to shrinkage of the affected turbinate. The advantages are that this is a noncontact, largely painless treatment option that causes minimal damage to the mucosa. The laser surgeon must watch for the desired tissue effect, which is recognized by the whitish discoloration (“spotting”) of the mucosal surface.

We can offer the following general recommendations for laser treatment parameters based on our experience in more than 1,000 cases: Nd:YAG laser, 10 to 15 W, 0.2 to 0.3 seconds, distance of 2 to 4 mm from distal fiber end to tissue surface with a 600-μ fiber132 (Fig. 1.32).

### 1.7.4 Tympanic Ventilation Problems

“The rhinologist must share in the responsibility for the ear.”134

Abnormalities of eustachian tube ventilation have considerable importance in the pathogenesis of chronic middle ear diseases. The middle ear spaces are ventilated through the eustachian tube. The tube, which is lined with respiratory epithelium, contributes to the ventilation, clearance, and protection of the middle ear.

Eustachian tube function is an important criterion in selecting patients for ablative and tympanoplastic operations and in making a prognosis.130

Pathophysiologically, the middle ear behaves like a paranasal sinus that is independent of the nose. The following questions should be considered:

- Is it feasible to correct nasal and septal deviations and turbinate hyperplasia as part of a septorhinoplasty in patients with middle ear ventilation problems?

- Should the nasal operation be done prior to tympanoplasty or middle ear surgery?

- By what interval should the nasal surgery precede otopsurgery?

Koch found that rhinoplastic procedures could improve and normalize negative middle ear pressures in patients who had coexisting nasal obstruction.133 Deron showed that the surgical correction of septal deformities on both the deviated and nondeviated sides helps to normalize eustachian tube function.134

![Fig. 1.32 Photocoagulation of the facial skin with an Nd:YAG laser in nontouch technique.](image-url)
Numerous authors have affirmed the value of septoplasty in patients with eustachian tube dysfunction.\textsuperscript{135–138} This contrasts with the view that while bilateral nasal obstruction affects middle ear pressure, a unilateral obstruction does not.\textsuperscript{135,139} While Holmquist\textsuperscript{140} stated that every septal deviation should be corrected prior to tympanoplasty, Maier et al.\textsuperscript{141} could not confirm this rule. Eustachian tube dysfunction is not demonstrable in every patient with chronic middle ear disease. Koch found that one-third of patients with adhesive processes had no eustachian tube dysfunction.\textsuperscript{132,142} The location of the septal deviation also affects tubal function. Gray distinguished between anterior, posterior, and combined septal deviations. He felt that only the combined forms were important in the pathogenesis of eustachian tube dysfunction.\textsuperscript{136}

We can offer the following recommendation based on personal experience: Besides otomicroscopy, all patients with signs of inflammatory ear disease or impaired tympanic ventilation should undergo pure-tone audiometry and also tympanometry, with the assessment of passive opening in the cases with dry perforations.

The endoscopic examination starts with the nasal vestibule and proceeds across the limen nasi to the nasal cavity and the inferior and middle turbinates, using the 0-degree wide-angle endoscope. The 45-degree scope is then used to examine the sphenoethmoid recess, the choanae, and the epipharynx with the pharyngeal orifice of the eustachian tube. The opening mechanism of the eustachian tube can be evaluated during the act of swallowing.

Particular attention is given to any hyperplasia of the posterior tips of the inferior turbinates. The inferior turbinates have the same sagittal orientation as the pharyngeal orifice of the eustachian tube, and hyperplastic tips can obstruct the tubal orifice. Viscous mucus from the posterior ethmoid often flows over the pharyngeal orifice of the tube. A relative negative pressure in the middle ear can aspirate the mucus into the eustachian tube, leading to an acute exacerbation of chronic otitis media.

Deformities of the nasal septum are assessed endoscopically. If vomerine ridges are present, the endoscope must be advanced strictly over the nasal floor to reach the epipharynx. In children and adolescents, the endoscopist should watch for adenoids or their remnants and for scars. If signs of inflammatory paranasal sinus disease are present, coronal CT should be performed. The aerodynamic relevance of axial deformities of the septum and nose or of nasal valve stenosis in a tension nose can be interpreted by comparing the results of computerized rhinometry before and after a decongestion test with the tympanogram, taking into account the findings of nasal inspection and nasal endoscopy.

If rhinomanometry shows deficient nasal breathing parameters in conjunction with impaired eustachian tube function, surgical correction of the septum should be performed in patients with a deviated nose, saddle nose, or functional tension.\textsuperscript{144} The sparing reduction of hyperplastic inferior turbinates should be added in selected cases. If signs of inflammatory ethmoid and paranasal sinus disease are observed, an anterior ethmoidectomy may be indicated, depending on the findings.

Cellular structures such as pneumatized middle turbinates and large ethmoid bullae in contact with the middle turbinate are also treated (Fig. 1.33). Rhinosurgical operations and tympanoplasties should not be carried out in one sitting. Postoperative mucosal swelling, intranasal packs or splints, and retained secretions in the nose or paranasal sinuses can lead to significant impairment of eustachian tube function following the surgery.\textsuperscript{130,133,141}

The nasal operation should precede the ear operation. It is prudent to wait until wound healing is complete and postoperative swelling has subsided. An interval of 4 to 6 days to several weeks is recommended between the operations.\textsuperscript{82}

In the last years, the balloon dilatation of the Eustachian tube became a successful tool in the treatment of disturbed tympanic ventilation. Nevertheless, a straight nasal septum is also a precondition for this maneuver.\textsuperscript{82}

### 1.7.5 Rhinogenic Headache

The differential diagnosis of unexplained headache is a frequent task for the rhinosurgeon, because rhinological patients often present with this complaint. A detailed endoscopic examination and imaging workup will often reveal findings in the nasal septum, and lateral nasal wall that could account for potentially severe rhinogenic headaches.

The principal causes of rhinogenic headache are vasomotor processes, organic vascular lesions, vertebral pathology, psychosomatic states, and toxic agents. Other potential causes are intracranial masses or inflammations, impaired CSF circulation, ophthalmological processes, and dental diseases.

Sinogenic and rhinogenic headaches are usually caused by direct irritation of the mucosa. This may occur between closely adjacent epithelial surfaces, for example. Mechanical irritation of the receptors in the nasal mucosa is transmitted via afferent nerve fibers to the cerebral cortex as pain. Also, neuropeptides such as substance P can induce vasodilation, secretion, and plasma extravasation. Mucosal edema develops via an axonal reflex, triggering a sensation of pain.\textsuperscript{145,146}

The trigger point for this type of pain may be a sharp spur on a vomerine ridge that extends dorsally upward and comes into contact with the inferior turbinate or lateral nasal wall.
Sinogenic pain is caused by abnormalities of sinus ventilation and drainage that induce mucosal inflammation. Normally, there is a constant equalization of pressures between the nose and paranasal sinuses. Valve mechanisms and incomplete pressure equalization can lead to barosinusitis. Local inflammatory processes lead to edema and the secretion of inflammatory mediators, causing a localized irritation of nerve endings in the mucosa. In this way, local mucosal inflammation can generate pain.

Essentially all pneumatized cells in the facial skeleton can incite this kind of pain. Previously operated paranasal sinuses that contain isolated residual cells can be a refractory source of misdiagnosed pain.

The quality of a rhinogenic headache depends on the underlying cause. Sinus inflammation is characterized by a dull, nagging, position-dependent headache that is associated with a feeling of pressure over the affected sinus.

The pain of acute sinusitis is more intense and is projected to adjacent regions (maxillary sinusitis to the forehead, sphenoid sinusitis to the parietal or occipital region). Typically, the pain is aggravated by bending the head forward, coughing, straining, and blowing the nose.

Headache is a late symptom of tumors of the nose and paranasal sinuses. Usually the dominant features are unilateral nasal obstruction, bloody discharge, and impaired ventilation of the middle ear or peripheral sinuses. Adenoid cystic carcinoma grows along nerve fibers and is associated with pain. A neoplasm that reaches the dura mater will produce intense, unremitting pain.

Mucoceles, which almost always occur in surgical or post-traumatic cavities, lead to pressure erosion of the adjacent bone. Typically, the pain subsides when the mucocele can expand by eroding through the lamina papyracea or orbital roof toward the globe.

Facial Neuralgias

Trigeminal Nerve

It is difficult to evaluate facial neuralgias because they are seldom associated with objective organic findings. Idiopathic trigeminal neuralgia is marked by paroxysms of stabbing pain on one side of the face (tic douloureux). The attacks may involve one or more branches of the trigeminal nerve and may be accompanied by hypoesthesia, facial redness, or lacrimation. Clonic spasms of the masticatory muscles may also occur during attacks.

Constant pain of varying intensity in the area supplied by the trigeminal nerve, sometimes with deficit symptoms and often combined with sensitivity to weather changes, should raise suspicion of symptomatic trigeminal neuralgia. It may be precipitated by inflammatory or neoplastic diseases of the paranasal sinuses, dental diseases, or infectious diseases (usually viral, such as herpes zoster).145

Nasociliary Nerve

Severe, unilateral, paroxysmal pain that is maximal at the medial canthus of the eye, epiphora with marked conjunctival injection, and edematous swelling of the ipsilateral nasal mucosa are features of nasociliary neuralgia (Charlin’s neuralgia). The pain typically radiates into the orbit, and many patients initially consult an ophthalmologist.

Pterygopalatine Ganglion

Unilateral, aching nocturnal pain centered in the lower half of the face (“lower half headache”) combined with variable rhinorrhea and sneezing attacks may be symptomatic of pterygopalatine ganglion neuralgia (Sluder’s neuralgia). It is caused by tumors and inflammations of the nose, sinuses, orbit, or pterygopalatine fossa.

Post-Caldwell-Luc Syndrome

Inflammatory exacerbations of a previously operated maxillary sinus, scar traction on the infraorbital nerve, severe maxillary deformity, or scar-related infiltrates and abscesses can cause an aching or stabbing pain of variable and sometimes agonizing intensity. Anesthetic blockades can furnish clues to the nasal or sinogenic origin of the headache and facial pain. If the pain is relieved by local mucosal anesthesia or conduction anesthesia of a trigeminal nerve branch and recurs after the anesthesia subsides, this confirms the origin of the pain.

1.7.6 Nasal Surgery and Sleep-Disordered Breathing

Wolfgang Pirig

Hippocrates (460–377 BC) clearly described 2,400 years ago that nasal polyps cause snoring and also described surgical methods to remove the polyps (De morbis, Liber II, volume V, 29): “When the polyp comes from the nose, hanging down from the middle cartilages like a worm, softly expanding with expiration outside the nose, retracting with inspiration, it causes a croaky voice and snoring during sleep.”

“Neither the site of obstruction during apnea nor the site of generation of snoring is in the nose.” This statement by Hofstein et al.146 may give comfort to those who, despite successful nasal surgery in their patients with sleep-disordered breathing (SDB), have seen little or no reduction of snoring and apneic events, or perhaps rarely even an exacerbation of these symptoms, in the sleep laboratory. A complete or incomplete obstruction of the nasal airways during sleep generally lessens the quality of sleep due to an increased amount of waking during the night and subsequent daytime sleepiness. However, the importance of obstructed nasal breathing in the pathogenesis of SDB, especially in primary snoring and obstructive sleep apnea (OSA), is still poorly understood.

The dominant factor is increased nasal resistance, which leads to a greater reduction of luminescent pressure during inspiration in the unstable pharyngeal segment and in the lower airways. If the inspiratory pressure falls below the critical closing pressure of the pharynx, the results are collapse of the pharyngeal airway and obstructive apnea according to Bernoulli’s phenomenon. Up to 50% of the total airway resistance in normal respiration during wakefulness is furnished by the anterior nose. One-third of this resistance is built up in the nasal vestibule and two-thirds are produced in the nasal valve area, which also works according to Bernoulli’s phenomenon because of its collapsibility.

The nasal resistance is highest in infancy and declines in the first two decades to values of adults.146 This large nasal resistor is needed for the expansion of the lungs during growth. Nasal resistance is influenced by numerous factors such as climate, physical activity, and position. It is lower in the upright than supine position, and it is lower in healthy persons than in patients with OSA. Nasal resistance is approximately equal during sleep and waking. It is increased by nasal allergies and intranasal packing, leading to a greater risk of OSA. Some congenital midfacial diseases with nasal malformations such as cleft nasal atresia, Crouzon syndrome, Apert syndrome, or Treacher-Collins syndrome significantly contribute to OSA due to obstructed nasal breathing. Another influence on nasal resistance was discovered by Kawano et al.140 and Welinder et al.149 They found a significant decrease of nasal
Results of Nasal Surgery

Outcome for Simple Snoring

According to the international classification of sleep disorders, primary snoring is included in the subgroup of parasomnia and not in the subgroup of SDB like OSA. The techniques used to treat nasal obstruction in snoring subjects are identical to those generally used to treat nasal obstruction. In the case of nasal obstruction, nasal surgery can improve snoring, although the individual effects and the durability of the results cannot be predicted. Up to now, no long-term results exist concerning the outcome of nasal surgery as well for snoring as for OSA. Data are mostly based on uncontrolled and nonrandomized studies, and do maximally fulfill a grade B of recommendation according to the criteria of evidence-based medicine (EBM). The inhomogeneous data had usually been evaluated using questionnaires filled out by the bed partner and visual analogue scales with a lack of polygraphic or polysomnographic investigation. The success rate (i.e., cessation of snoring to a socially acceptable level) is estimated to be about 40%.154,158

Outcome of Nasal Surgery for Obstructive Sleep Apnea

No long-term results exist concerning the outcome of nasal surgery for OSA based on the success criteria described by Sher et al,160 which require at least a 50% decrease in AHI or AI and a reduction to values less than 20 or 10. There are only a few case reports in which OSA was cured by nasal surgery alone.155–158 However, several patients even showed an increase of nasal resistance in the waking state was an independent risk factor for OSA and added 21.3% to the AHI variance. Besides increased nasal resistance, the transition from nasal breathing to unstable mouth breathing during sleep and the nasal reflexes also appear to have a role in SDB. While the nasal resistance is greater than the oropharyngeal resistance during waking, this relationship is reversed during sleep.152 These few remarks on the connections between nasal resistance, nasal breathing, and SDB show that their interrelationship is very complex and still not completely understood.

Summarizing the role of the nose in the pathophysiology of SDB, it can be concluded that nasal obstruction may have a negative impact on sleep quality; however, it can be only considered as a cofactor in the pathophysiology of SDB.154 This conclusion is supported by other recent instructive reviews.155–158

Impact of Nasal Surgery on Nasal Continuous Positive Airway Pressure Therapy treatment

Only a few studies report on the pressure-lowering effect of rhinosurgical procedures in OSA patients on nCPAP therapy. In a prospective study of 50 adults with OSA, Friedman et al172 compared 35 men with severe OSA who had nasal surgery with 35 men suffering from severe OSA who had been successfully treated by a septoturbinoplasty before their nCPAP therapy. After 3 years, the mean necessary nCPAP mask pressure was significantly lower (by 1.5 mbar) than in the nonoperated control group, while the average daily use was 0.8 hours longer. In older patients with moderate or severe OSA who require temporary intranasal packing because of nasal surgery or epistaxis, the AHI may increase to a potentially life-threatening level. This led Dorn et al173 to investigate the benefit of oral CPAP therapy in five nCPAP-dependent OSA patients who were wearing intranasal packs following nasal surgery. This therapy prevented the otherwise frequent packing-related abnormal respiratory events during sleep and achieved a permanent reduction of the average nCPAP pressure of 3.2 mbar. In the updated guideline,170 8 studies with 117 patients on isolated nasal surgery for OSA delivered data on preoperative and postoperative CPAP (mbar) values. A mean pressure reduction from 11.9 to 9 mbar was found, in five studies with statistically significant p-values (EBM recommendation C).

Two prospective studies174,175 investigated the influence of an increased nasal resistance on initial acceptance of nCPAP treatment for OSA. Sugira et al173 found that 56 out of 77 patients accepted the nCPAP therapy. BMI, AHI, and ODI were significantly higher (p < 0.01) and nasal resistance was lower (p = 0.003) in patients who accepted nCPAP than in those who did not. Logistic regression analysis of the mentioned parameters showed that nasal resistance and AHI were significant factors for CPAP nonacceptance. Nakata et al performed nasal surgery in 12 males who were refractory to nCPAP therapy. Forty-one OSA patients with nCPAP were used as control. Nasal surgery in 12 males who were refractory to nCPAP therapy.

From this material, the success rate of isolated nasal surgery for OSA is estimated at approximately 10%. Contrary to this poor outcome, the preoperative scores of ESS were significantly reduced from 10.7 to 6.6 postoperatively (342 patients in 13 studies). This mirrors the subjective success by nasal surgery for OSA as to improvement of sleep quality and daytime symptoms. Hence, we can conclude that a successful nasal operation alone cannot cure OSA in any given case based on the criteria of Sher et al,160 but is able to improve sleep quality and daytime symptoms. Furthermore, surgery improving the nasal airway can enhance the success of nasal continuous positive airway pressure (nCPAP).
triggers symptoms like dryness and a crusted nose, nasal congestion or stuffiness, rhinorrhea and sneezing, and rarely recurrent epistaxis or sinusitis.

A well-recognized complication of nCPAP, namely nasal injury, has recently been published by Li et al. in neonates who needed nCPAP to provide respiratory support because of very low weight (< 1,500 g). This sequela is quoted as high as 13.2 to 50%. The authors did a retrospective audit over 33 years in their institution. Eleven patients were identified who sustained nCPAP injury and were subsequently evaluated later in adolescent or adult age. The most common injuries involved the soft triangle and columella. All patients required corrective nasal surgery. Most patients had tissue loss and necrosis and required staged repair with grafts.

**Practical Recommendations**

A clearly defined connection between nasal breathing, nasal resistance, and SDB does not exist, and their interrelationship is a very complex one. There is evidence that two groups exist with regard to the effect of nasal surgery on SDB. In the long term, nasal surgery can achieve a marked improvement of OSA symptoms in only a small percentage of patients. Furthermore, in the majority of cases, surgery to reduce nasal airway resistance will relieve obstructed nasal breathing and improve the quality of sleep and life, but it will not eliminate the symptoms of OSA and may even aggravate them in some cases. Patients must be informed about this possibility and that success cannot be predicted in an individual case because of a lack of predictors. Nasal surgery can achieve success in up to 40% of primary snorers, but only about in 10% of OSA patients. Nasal appliances may help to identify appropriate patients for nasal surgery. Furthermore, nasal surgery can optimize a necessary nCPAP treatment by reducing the nCPAP pressure and thus resulting in higher compliance for ventilation therapy. Therefore, nasal surgery should be included in a comprehensive treatment concept of OSA.

### 1.7 Functional Aspects of Septorhinoplasty

**Wolfram Seiderer**

Judging the nasal component of the sound of the voice during diagnostic and therapeutic measures in the area of the nose and paranasal sinuses is not a conventional procedure. In functional diagnostics, only aerodynamic measurements have become routine. Spectral analyses, especially sonograms, or measurements of vibration are less frequently measured. It is most important to perceive and document peculiarities in the sound of the voice, as these may be decisive in determining whether surgery is indicated.

The term nasality is mostly used to indicate a normal phenomenon, i.e., a nasal component of the voice sound, which is aesthetically satisfying and which contributes to the carrying range of the voice. The latter is often a deliberate aim of artistic voice training. The extent of nasality in speaking, however, also depends on factors such as dialectal influences, models, and speech habits.

The term nasализation, on the other hand, describes changes in the sound of the voice that are characterized by a too prominent or too faint nasal component, changes which often even sound unesthetic and which suggest a pathological organic or functional condition. There are two main varieties: an open form (sounding exaggeratedly open) and a closed form (sounding blocked). The open variety sounds flat, shifted backward, sometimes sharp, “irritating,” and thus aesthetically unsatisfactory. The closed variety sounds dull and also shifted backward; the inherent nasality of the phonemes [n], [m], and [ŋ] is missing. “Nancy needs new nighties,” and thus becomes “Daddy deeds dew dighties,” with a shift in the zone of articulation. It seems strange that there appears to be no discrimination between the two varieties in everyday usage. A combined variety can also occur.

If the changes mainly relate to the sound of the voice, the term rhinophonia with the subvarieties hyperrhinophonia (rhinophonia aperta), hyporhinophonia (rhinophonia clausa), or rhinophonia mixta is used. Sometimes pathological conditions, such as hypernasality and hyponasality, are distinguished from the normal condition of nasality. If, on the other hand, the changes mainly relate to impairment of articulation or changes in the pronunciation of phonemes, including consonants, they are designated by the term rhinolalia with the subgroups rhinolalia clausa, rhinolalia aperta, or rhinolalia mixta.

The diagnosis is mainly based on the perceptual assessment of spontaneous speech, the enouncing of certain sequences of words, or reading of a text. In hyperrhinophonia or hyporhinophonia, the RBH scale (roughness, breathiness, hoarseness), often used for the assessment of hoarseness, can be used. The scale has the following degrees: 0 = nil; 1 = mild; 2 = moderate; 3 = severe. Voice recordings are a reliable method to document abnormalities and are absolutely necessary for precise follow-up checks on the course of therapy, and also, and above all, for apparative sound analyses. Descriptions of specific samples of nasализation will not be given here since these are mostly used for judging the function of the velum.

It is always necessary to identify the underlying causes of rhinophonia and rhinolalia. The open varieties may be due to functional or organic disorders, mostly malformation or paralysis, or may result from surgery. In the framework of this publication, it is more important to focus on the closed forms, which may also be due to functional disorders, though this occurs extremely rarely. In most cases, they are caused by organic changes of various kinds, which also impair breathing through the nose and thus affect the normal nasal component of the voice. Hyponasophilia, even if barely perceptible, that persists for a longer period of time always calls for a thorough inspection of the nasopharynx and main nasal cavities.

In therapeutic measures, especially surgical ones, which may entail the risk of hyperrhinophonia, it should be noted that open nasализation is more conspicuous and sounds more unpleasant than the closed variety. As demands on oral communication abilities are higher than ever today, this aesthetic sound component should not be underrated.

Objectification of nasality and its pathological varieties is made possible by means of a so-called nasometer, in which two microphones, separated by a plate, measure the oral and nasal sound energies. The acoustic passage of the nose is then described in terms of nasalance, i.e., the amount of nasal sound energy as a percentage of the total sound energy (see also Fig. 1.34).

Singers in the occidental tradition of artistic singing always aim at an optimum of sound quality of the voice and their term for this is “focus.” This relates not only to an acoustic category, which also comprises nasality, but also to a physical one, as, while using his/her voice, the singer senses vibrations in the areas of nose, forehead, cheeks, and palate and uses this phenomenon for deliberate control of the voice (“singing into the mask”).

According to our own experience, endoscopic surgery on the nose and the paranasal sinuses of patients in voice-intensive professions can have major consequences for their voices. Apart from the improvement in voice quality and clearer vibrational sensations in the areas of forehead and cheek, a decrease in voice fatigue, a reduction of the compulsion to clear one’s
The Dual Character of Nasal Surgery

The results should not be taken to suggest that specialists should be generous in providing indications for surgery on the area of the nose, as the hope to reach major improvements in the sound of the voice by plastic septum surgery in students of singing or professional singers, which was widespread some decades ago, did not materialize. This does not mean, however, that the judgment of the voice sound and its potential alteration by therapeutic measures are unimportant. It should always be recognized that clearer vibrational sensations can be very useful, especially for professional singers.

In summary, we can say that the quality of the voice sound should always be considered in all diagnostic and therapeutic measures in the area of the nose, as the hope to reach major improvements in the sound of the voice by plastic septum surgery in students of singing or professional singers, which was widespread some decades ago, did not materialize. This does not mean, however, that the judgment of the voice sound and its potential alteration by therapeutic measures are unimportant. It should always be recognized that clearer vibrational sensations can be very useful, especially for professional singers.

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1.8 Aesthetic Aspects of Septorhinoplasty

The nose is, quite literally, a prominent facial feature. It critically determines the facial appearance. Its symmetry, proportionality, and contours determine whether the facial features are perceived as harmonious. An impression of disharmony arises when the nose is perceived as too broad, too long, or too large. Patients tend to consult a rhinoplastic surgeon when they become aware of this disharmony and desire a change. Generally, the physician will have developed a feel for these matters but will still try to apply objective criteria by measuring angles, proportions, or projections. It is less important in facial plastic surgery to form a single aesthetically pleasing feature than to match the various features to one another in a harmonious, aesthetically pleasing way. Moreover, there is an acknowledged hierarchy of facial features, starting with the eyes. The eyes can speak, and the nose should be subordinated to them with a certain understatement. For this purpose, a gently curved imaginary line is drawn from the medial point of the eyebrow to the pronasale (greatest anterior projection of the nasal tip).

Rhinoplastic surgeons should be careful and patient listeners as well as keen observers and anatomical analysts. They should understand what is troubling the rhinoplasty candidate about his or her own face or nose.

The face is the most important means of communication, even without words. It is considered a mirror of the human psyche and it conveys much about the personality.

Lavater correlated the shape of the nose with several basic human temperaments, relating a large, convex nose to a choleric or sanguine temperament (Fig. 1.35).

When combined with a prominent chin, this feature is generally associated with an active, aggressive type of personality. Without belaboring this point, we may observe that the effect of physiognomy on human beings does follow certain principles. The nose is a personality trait and, as such, has been an object of studies in anthropology and constitutional research. Ziegelmayer could find no specific modes of inheritance for morphological variants and individual features of the human nose (Fig. 1.36a, b).

The French caricaturist Honoré Daumier (1808–1879) used his brilliant talent to stereotype character traits by exaggerating certain physiognomic features.
Whenever the physiognomy of a human being is altered, a reasonable aesthetic indication should exist. Physicians should act responsibly and dissuade patients from changing their face in a desire to mimic current trends or idols. Surgeons should also be wary about altering ethnic characteristics. As a general rule, the individual features of a human being should be respected and preserved. We have found that the great majority of our own patients have the same desire. As a general goal, we would recommend a somewhat large nose with a high dorsum and aesthetic proportions. Type-altering operations or the desire for a "perfect nose" also have their justification if the current appearance of the nose is distressful to the patient. But physicians are obliged in these cases to use their "sixth sense" in distinguishing the reasonable desire for a morphological change from a psychopathological condition such as body dysmorphic disorder (see below).

"While knowledge of the anatomy, physiology, and surgery of the nose is a sine qua non, the artistic creative power is the most important factor in the success of the operation."87

1.9 Selecting an Approach for Septorhinoplasty

Various approaches are used to gain access to the nasal tip and dorsum in functional–aesthetic surgery. The selection of a particular approach is based on a clinical analysis of the specific problem.185 Taking into consideration the patient’s age and his or her skin type and connective-tissue type, the surgeon mentally composes a plan for the operative procedure.

Moderately thick nasal skin is favorable for rhinoplasty. Thick skin is more prone to scarring and postoperative problems such as pollybeak deformity. When dealing with thick skin, the surgeon should avoid removing too much cartilage in an effort to form a delicate tip. Thick skin and thin cartilage are a particularly unfavorable combination.

On the other hand, thicker skin will cover small irregularities in the nasal dorsum and allows for all techniques of nasal tip surgery, i.e., incision, graft, and suture techniques.

Thin skin is less susceptible to postoperative problems but requires a high degree of precision, since all contour imperfections and irregularities can be seen. Superficial contour-defining grafts cannot be used in the tip area. As a general rule, the tip should always be left slightly broader than is ideal, as it will tend to become narrower as the patient ages and the overlying skin–subcutaneous tissue complex shrinks (Figs. 1.37a–d and 1.38a–d).

1.9.1 Open versus Closed—An Old Controversy

In the last hundred years, there has been much controversy on the best approach in rhinoplasty. Currently, the majority of rhinoplasty operations are performed using the “open access” approach. This approach has helped many surgeons get started in functional aesthetic surgery. Good visual overview has become more important than minimal invasive-ness. However, the disadvantages of the open technique, such as destabilization of structures, longer operation times, and prolonged wound healing and the risk of postoperative rigidity of the nose allowed a comeback of the closed technique. Therefore, a new “old” closed technique is now experiencing a renaissance. The benefits gained from the development of open access techniques as several grafts and suture techniques can also be applied endonasally with refined surgical techniques.20,186

"Preserve functionality of the natural structure of the nose. You can rebuild form with a lot of grafts, but not the natural functional elasticity of the nose."187

1.9.2 Endonasal Approaches

Endonasal approaches offer the advantage of an exacting and less invasive operation. By dissecting in the surgical plane, the operator can avoid injuring vessels of the superficial musculoaponeurotic system. Undermining is done only over the cartilaginous and bony nasal dorsum and is used to develop precise pockets for deep or superficial graft placement. Suture fixation at the nasal dorsum is unnecessary in most cases.

There is minimal tissue trauma in these approaches, and scar formation is limited to circumscribed areas. As a result, postoperative healing is rapid and uncomplicated. External scars and postoperative asymmetries due to scar contraction are avoided.
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Fig. 1.38 (a) Middle-aged woman with thin skin and thick cartilage tissue. A prominent, overprojected tip is combined with a saddle depression in the supratip area. The nose requires reduction and augmentation with septal cartilage. (b) Appearance 3 years after surgery (endonasal approach, double-suture technique).

Fig. 1.37 (a,c) Note the broad, elliptical nares. Nasal breathing is obstructed by ballooning with inferior turbinate hyperplasia. (b,d) Appearance after correction of vestibular stenosis.
1.9 Selecting an Approach for Septorhinoplasty

Nevertheless, it is not easy to achieve perfect results with these techniques.

**Cartilage-Splitting Approach**

The cartilage-splitting approach is very well suited for reducing the volume of the upper alar cartilages to correct a bulbous nasal tip. The approach is suitable for correcting tip asymmetries only in exceptional cases. It is best for cases with a symmetrical, non-bifid tip that does not have a broad, obtuse dome (angle).

While the cartilage-splitting approach provides good access to the upper alar cartilages, the shape of the lower alar cartilages cannot be altered through this approach. The incision typically runs cranial to the *tip-defining point*, which should be marked beforehand.

Narrowing of the supratip area and cranial rotation of the tip can be supported by beveling the anterosuperior septal margin. Cranial tip rotation is produced by scar contraction occurring between the caudal margin of the upper lateral cartilage and the intact alar cartilage. It depends on the extent of volume reduction of the upper alar cartilage.

The tip projection is unchanged when the tip-defining points are preserved. Owing to the low invasiveness of the cartilage-splitting approach and the minimal bleeding, endonasal operative steps can be performed concurrently with this approach.

The case report presented in Fig. 1.39a–j shows a 23-year-old woman with broad nasal pyramid, a rest hump after septorhinoplasty 2 years ago. Over this, a cystic formation filled the left alveolar recess, which was the reason for nasal mucosa swelling and nasal obstruction. The patient wanted a narrowing of the nasal pyramid, a refinement of the nasal tip, a straightening of the nasal dorsum, all together a more delicate appearance of the nose.

**Delivery Approach**

The delivery approach is an elegant endonasal technique that gives experienced surgeons a variety of options for correcting the nasal tip.

It basically involves creating a chondrocutaneous flap from the alar cartilage and the skin of the nasal vestibule. Two incisions are required. First, an intercartilaginous incision is placed in the fold between the upper lateral cartilage and alar cartilage. Then the skin is incised along the caudal margin of the alar cartilage. From this marginal incision, the surgeon carefully undermines the alar skin as far as the intercartilaginous incision, dissecting strictly along the contour of the cartilage.

Now the alar cartilages are delivered into view, where they can be modified under direct vision with the benefit of side-to-side comparison. Wedges or strips can be resected from the cartilages for volume reduction, cartilage tension can be modified by scoring or cross-hatching, the cartilages can be augmented with autologous graft material, and intradomal or interdomal suture techniques can be applied.

This approach is suitable for asymmetrical and bifid tips. The tip projection can be assessed and modified. Cranial tip rotation can also be induced.

The *dome suture technique* is particularly suitable for patients with a broad or bifid nasal tip, thin skin, and scant subcutaneous fat and connective tissue. The alar cartilages themselves should be stable and resilient.

Interdomal sutures are used to narrow the domes. Transdomal sutures are effective for approximating the tip-defining points, usually after removal of the interdomal fat or connective tissue.

Based on personal experience, we can recommend 5–0 PDS for these tip-suturing techniques. Following suture absorption, the tip shape remains permanently stable as a result of shrinkage and submucous scarring. The knots should always be placed on the inside between the domes and should not be subcutaneous on the cartilage surface.

The intercartilaginous incision can be combined with a transfixion, hemitransfixion, or high transfixion incision, or with an oral vestibular incision for midfacial degloving through a transfixion approach (Fig. 1.40).

The next case illustrates the possibilities of the delivery approach (Fig. 1.41a–p). A 34-year-old woman had undergone rhinoplasty for hump removal 9 years ago. As a fashion model, she felt that her wide nasal tip was unphotogenic and her nose had an unsightly appearance in photographs of her face.

In the previous operation, the nasal tip had been untouched, so all revision options were available to the surgeon. The suture technique was an obvious choice for narrowing the tip-defining points closer together (see p. 43). The nasal bones were of moderate length, suggesting that reosteotomies could be successfully used to narrow the bony pyramid and the brow-tip aesthetic lines. If the nasal bones had been short, the use of spreader grafts would have been considered.
The Dual Character of Nasal Surgery

Fig. 1.39  (a) A young woman with broad nasal pyramid, lateral dislocated fragment after osteotomy. (b) Rest hump after rhinoplasty after incomplete hump removal. (c) The basic view of the nose. During forced inspiration, a collapse phenomenon of the alar cartilages was evident. (d) The patient 4 years later. The refinement of the nasal contour lines, a narrowing of the nasal pyramid, and a delicate shape of the nasal tip are visible. (e) A straightening of the nasal profile and better tip definition by cranial volume reduction of the lower alar cartilages are evident. (f) The basal base. The support of the alar vestibulum was achieved with rim grafts. (g) Principle of the cartilage-splitting approach. (continued)
1.9 Selecting an Approach for Septorhinoplasty

In this case, the tip refinement was achieved with tip refinement graft in a trapeze shape from thin septal cartilage, softly squeezed. The technique of hump removal with preserving of the underlapping upper lateral cartilage parts is useful in small humps. Rim grafts are a good tool to support soft alar cartilages. The principle of the endonasal removal of a cystic formation in a deep alveolar recess on the left side across a deep infraturbinal fenestration.
Fig. 1.41  (a,b) Images of the patient from earlier photo shoots. The face is overexposed to conceal the nasal tip. (c,e,g) The patient before rhinoplasty. (d,f,h) The appearance 2 years after rhinoplasty in a closed technique. (continued)
Fig. 1.41  (continued) (i–p) Intraoperative images with sequence of transdomal and interdomal suture placement for narrowing the nasal tip through a delivery approach. (continued)
1.9.3 Endoscopic Approach

In order not to lose the advantage of a better overview in the open technique, some steps of septorhinoplasty may be performed under endoscopic control. For this purpose, new instruments and an optical Aufricht were developed. Visual inspection of individual steps of the operation, as well as specialized miniaturized instruments, allow operations to be performed using minimally invasive technology, leading to good results and fulfilling the desire of many patients especially in revision surgery.\(^{189,190}\) (Figs. 1.42 and 1.43).

Indications

Endoscopic Surgery of the Media Nasal Wall

Endoscopic septal dissection using a hemitransfixion cut offers several advantages such as exact analysis of pathogenesis and morphology of the deviation, optical-aided preparation at each stage of the operation, and better overview of the back mucosal tunnel (Figs. 1.44 and 1.45). In deviated noses, the unwrapping effect of a complete tunneling of the nasal septum is helpful and an ideal precondition for the endoscopic surgery. Easy spoken the “tension point” of the medial nasal wall might be identified and sective broken.

Furthermore, surgical trauma may be minimized via an optical control at constant magnification and depth-of-field effect.

Endoscopic Surgery of the Nasal Vault

The combination of endoscopic and miniaturized instruments offers the possibility of circumscribed, minimally invasive surgical procedures of the nasal vault with minimal downtime and reduced surgical trauma (Fig. 1.46a, b). Besides the optical Aufricht, a range of new instruments has been developed for this purpose, such as the “mini-joseph” in different sizes, small sharp curettes, mini-diamond rasps and mini-rasps, pulling swords (backward cutting), as well as chisels (forward-tapping).

Controlled individual surgical steps visually create a major benefit even for revision rhinoplasty, in contrast to previous blind or noise-supported procedures. In conjunction with certain instruments, this facilitates, for example, the neat elevation of periosteum from below and above.

1.9.4 Open Approach

The open approach for rhinoplasty provides maximum exposure of the alar cartilages with their medial and lateral crura, the domes, and the nasal dorsum.

The skin incision is stepped or zigzagged at the midcolumellar level. The incision is carried around the contour of the medial crura, runs on the lateral columella about 2 mm behind the anterior side of the columella, and joins with marginal alar incisions. Then the skin of the midcolumella is undermined with small, sharp scissors above the medial crura of the alar cartilages. Now the columnellar flap is progressively developed. When the medial crura of the alar cartilages have been exposed, their medial surfaces provide a guide for dissecting in the cephalad direction. In this way, the surgeon reaches the top of the domes and, after dividing the interdomal connective tissue, the lateral crura.

Later in the operation, the upper lateral cartilages and nasal valve can be exposed. They can be traced to the rhinion, or key-

stone area. The nasal bones and frontomaxillary process can
1.9 Selecting an Approach for Septorhinoplasty

Fig. 1.42 Anatomical structure of the medial nasal wall. Blue/light blue: cartilago quadrangularis; yellow: vomer; purple: lamina perpendicularis. The arrows show the vectors of the most common "tectonic shifts."

Fig. 1.43 The endoscopic Aufricht.

Fig. 1.44 (a) An upper endoscopic dissection tunnel. (b) Incision and removal of a vomer crest.

Fig. 1.45 Selection of instruments for endoscopic rhinoplasty.

also be directly visualized. While the dissection is supraperichondrial initially, it should be continued in the subperiosteal plane at the level of the rhinion. This is done by carefully elevating the peristeme laterally from the midline with a sharp Freer or Joseph elevator (this produces a scratching sound).

The advantages of the open approach are the binocular, three-dimensional view of the operative site and the ability to dissect the structures bimanually and under vision with controlled hemostasis.

Larger grafts can be placed and secured with great precision (Figs. 1.47 and 1.48).

The open approach is a revelation for understanding the anatomy of the nose. It is common to discover fine curvatures and asymmetries (e.g., of the alar cartilages) that could not be appreciated preoperatively. The open approach does not help us to understand the dynamics of rhinoplasty, however, and the question must be asked whether this degree of exposure is necessary in any given case. The art of rhinoplasty includes the ability to choose an approach that is as invasive as necessary
but as noninvasive as possible. In this regard, the open technique abandons the principle of conservatism in favor of a more aggressive approach. Large submucous wound areas lead to relatively extensive scarring. The results might be prolonged wound healing, edema, and possible sensory disturbances in the tip area. Strict criteria should be applied, therefore, in selecting patients for this approach.

**Indications**

- Marked asymmetries of the nasal tip.
- Revisions (usually after multiple previous operations).
- Septal perforations larger than 6 mm.
- Severe axial deformities.
- Cleft nasal deformities.
- Pronounced saddle noses.
- Reduction rhinoplasty of large overprojected noses.

The case presented here shows a 17-year-old girl who had undergone previous operations for the repair of a cleft lip palate. She sought now to optimize the aesthetic appearance of her nose (Fig. 1.48a-f).

The findings show in the frontal view a broad nose at the level of the nasal pyramid, middle vault and tip, a washed-out appearance of the bridge, and a slanted nasal base with a flat sharp nasolabial angle. In the basic view, we see an asymmetry of the nasal base and nostrils.
1.9 Selecting an Approach for Septorhinoplasty

Fig. 1.48  (a–c) Appearance before rhinoplasty. (d–f) Appearance 2 years after open structure rhinoplasty. (g–v) The surgical procedure. (g) The skin is incised for harvesting of the rib cartilage. (h) The perichondrium is elevated from the rib. (continued)
Rib cartilage is harvested from the perichondrial sac. (j) The graft is carved. (k) Only a “balanced” graft taken from the central portion of the rib cartilage will retain a permanent, stable shape. (l) Graft size is precisely determined with a Behrbohm surgical caliper (Karl Storz, Tuttlingen, Germany). (m) Supraperichondrial dissection of the nasal tip and dorsum is performed. (n) A columellar pocket is developed to receive the supporting columellar strut. (o,p) The columella strut is sutured into place. (continued)
1.9 Selecting an Approach for Septorhinoplasty

The open approach with the use of rib cartilage is usually the method of first choice for the correction of cleft nasal deformities (see Fig. 1.48g–v).

**Essential Grafts Types**

Autologous grafts should be used whenever possible. More detailed information on grafts and implants is presented in the following chapters. In the meantime, the choice of grafts and sutures techniques is infinite.

The grafts discussed next are not exhaustive but are based on author’s preferred and proved techniques (see Fig. 1.49a–c).

Autologous grafts can be obtained from pieces of septal or alar cartilage (first choice), or auricular cartilage may be harvested from the conchal cavity or tragus (second choice). A distinction is made between deep grafts for replacing lost substance and superficial grafts for contouring the nose. Grafts can always be placed on one or both sides.

Surgical templates are available for harvesting the grafts and cutting them to size. “Carving” of the grafts is done on a small bench on the operating table.

**Tip Grafts**

Sheen pioneered the use of multilayer tip grafts in closed techniques. He started this technique for restoring the tip shape in overly resected noses. He extended its use to primary surgery with broad tips, alar malposition, and thick skin191,192 (see Fig. 1.50).
The Dual Character of Nasal Surgery

Fig 1.49  (a) Septal and alar cartilages are first-choice material for all grafts in the nose. The best harvesting zone is the lower posterior septum. (b) Ear cartilage has the advantage that it can be used in all parts of the nose, for instance, the nasal vault, nasal valve, or the alar region. Because of its natural elasticity and stability, it is the second choice. (c) Rib cartilage is useful for the rebuilding of nasal structures with structural and stable implants. A disadvantage is the difference in flexibility compared with nasal cartilages.

Later, Johnson combined the open approach with Sheen’s tip grafts and Anderson’s columellar struts. Tip grafts can be placed on the domes as trapezoid-shaped grafts to contour the tip or improve its projection.

**Tip Refinement Grafts**

Tip refinement grafts are small parts of excised alar cartilage in different shapes added to sutured tips. These grafts are a little surgical step but a great tool of finesse in tip refinement.

**Camouflage**

Peaked domes can be camouflaged by covering them with autologous tissue. This softens the tip contours and creates a harmonious junction with the facets. Tragal perichondrium and temporalis fascia have proved effective for this purpose (Fig. 1.47).

**Shield Grafts**

Shield grafts can be placed to lengthen the nose, form a fine double-break contour, or create a harmonious columella–lobule–tip junction (Fig. 1.51). They can be combined with a columella strut to support the tip and dome contours.

**Onlay Grafts**

Onlay grafts are used on the nasal dorsum or lateral alar cartilages as *alar onlay grafts* to correct for loss of substance or contour the nose.
1.9 Selecting an Approach for Septorhinoplasty

Columella Strut
This graft is placed into a pocket between the basal medial crura of the alar cartilages over the anterior nasal spine and fixed between the medial crura with through-and-through sutures (Fig. 1.52). It is used to control tip projection and provide tip support. It can correct for disparities in the height of the domes. Tip symmetry can be created by working upward from the base. The strut can be set up on the anterior septal spine or end free as a “flying strut” without bony contact.

A modification is the extended columellar strut tip-graft. It is a structural unit first used in endonasal rhinoplasty that combines the advantages of the columella strut and the tip graft used to provide projection and contour to the nasal tip.

Spreader Grafts
Sheen first described spreader grafts for an endonasal placement in primary rhinoplasty in patients with thin skin and weak upper lateral cartilages and in those with short nasal bones and a narrow middle vault. Spreaders are placed in the extramucous plane between the dorsal septal margin and the upper lateral cartilages (Fig. 1.53).

The external approach extended the indications of spreader grafts use. They are equally useful for both functional and aesthetic goals. They may be placed after the removal of large humps, on a depressed nasal dorsum in a functional tension nose, or in a large nose with short nasal bones. They are equally useful for the correction of deviated noses. Spreader grafts prevent the development of nasal valve stenosis and can create a harmonious eyebrow-tip line. The grafts have an active and a passive part depending on cranial septal border tension and direction.

Spreader Flaps
In principle, spreader flaps are inside-rotated medial ends of the upper lateral cartilages with suturing on the cranial septal border (Fig. 1.54). The upper lateral cartilages had to be dissected from the septal cartilage and the mucosa under the upper lateral cartilages had to be detached. It is an elegant technique to create a harmonic middle vault contour and prevent functional stenosis of the middle vault and nasal valve. It is a viable option in patients with large humps.

Rim Grafts
Rim graft can be inserted by an incision along the alar rim anteriorly (Fig. 1.55). With small scissors, a narrow pocket along the rim is created. The grafts are pieces of cartilage from the septum, ear cartilage, or rib. The length depends on the concrete indication. Normally the transplants are 12 to 15 mm long and 2 to 3 mm wide.

The indications are functional and aesthetic: vestibular aspiration, external valve collapse, short nostrils, cleft noses, alar retraction, vestibular skin show.

The use of rim grafts is possible by closed or open approaches. The insertion is variable from medial to lateral or from lateral to medial.
Alar Battens
Alar battens are cartilage grafts that are placed into precise pockets at the point of lateral wall collapse or pinching of the supra-alar region. The indications are internal and external nasal valve collapse. More information can be found on page 12. The transplants can be harvested from the nasal septum, the ear, or the rib. Over this, alar batten implants might be used to correct concave lower lateral cartilages. Alar batten struts can support the elasticity and reduce alar collapsibility by a placement under the lower lateral cartilages (Fig 1.21).

Essential Sutures Types
Every surgeon will develop predilections regarding his repertoire of grafts and sutures. Fig. 1.56 shows sutures that are essential in the author’s opinion.

Transdomal Suture
The suture goes from the medial side of one dome, passes across the dome without violating the lining to the lateral portion of the dome, and then turns back across the dome and is tied in the medial side of the dome. The effect depends on the precise placement. The main aim of positioning the transdomal suture centrally is to reduce the domal width without a rotation of the ala. This creates an increased protection and definition (Figs. 1.56a and 1.57).

Interdomal Suture
The suture apprehends the dome on one side, passes the interdomal space across the opposite dome, and returns to the interdomal angle (Fig. 1.56b).

Domal Creation Suture
This suture is essential for the tip definition by creating the ideal domal anatomy. Before suturing, the domal notch has to be determined by a squeeze with Addison-Brown forceps to form the desired tip-defining point (Figs. 1.56c and 1.58).

Domal Equalization Suture
The domal equalization suture is placed through the cephalic domal segments and moves them closer together. The aim is to ensure tip symmetry and to lower the cephalic portion of the rim below the tip-defining points (Fig. 1.56e, upper part of the drawing).

Spanning Suture
An effective technique to control the lateral convexity of the alar cartilages—the so-called flaring—is spanning sutures. The sutures are placed through the lateral crura. In combination with a posterior sling, a controlled cranial rotation of the lower lateral cartilages is possible (Fig. 1.56d, g).

Medial Crural Footplate Suture
The suture is a stitch between both footplates through a skin incision in the membranous septum. The effect is an approximation of the footplates, an improvement of the nostrils shape, and narrowing of the columella bas for functional and aesthetic reasons (Fig. 1.56f).

Lateral Crural Mattress Sutures
Convexities and bulbousities of alar cartilages can be corrected with the horizontal mattress suture technique developed by Gruber. The vestibular skin on the undersurface of the cartilage deformity is undermined. Convexities might be corrected by mattress sutures placed on the undersurface of the lateral crus as visualized in Fig 1.56f.
1.9 Selecting an Approach for Septorhinoplasty

Fig. 1.56 (a–h) Essential sutures in functional aesthetic rhinoplasty.

Fig. 1.57 Placement of transdomal sutures.

Fig. 1.58 Dome creating suture.
1.10 Special Techniques

J. Eichhorn-Sens

1.10.1 Treatment of the Concavity of the Lower Lateral Cartilages

Concavity of the lower lateral cartilages may be aesthetically disturbing. In particular, if only one side is affected. If there is a very strong degree of concavity, it may also cause functional problems by pushing the convex undersurface into the vestibule.

There are several techniques available to correct the concavity, some of which are discussed in the following sections.

Lateral Crural Overlay Technique

When the cartilage texture is softer, the lateral crural overlay technique can be a good option to correct concave deformities. Only the cephalic edge of the lateral crus is separated from the vestibular skin and is incised but not excised. This portion is then folded over the remaining part of the lateral crus (Fig. 1.59a, b) and fixed at the edges with fine absorbable sutures.

Lateral Crural Underlay Technique

The concavely deformed lower lateral cartilage is separated from the vestibular skin (Fig. 1.60a, b).

The cephalic portion is incised but left attached to the inferior perichondrium (Fig. 1.60c). Then the cartilage is folded under the remaining lateral crus and secured at the edges with fine absorbable sutures (Fig. 1.60d).201

Lateral Crural Reversal Technique/Upside-Down Technique

This technique is recommended if there is a very strong deformity of the lower lateral cartilages (Fig. 1.61a). First, the underlying vestibular skin is elevated from the cartilage. The deformed portion is removed (Fig. 1.61b) and turned 180 degrees (Fig. 1.61c). Then, the cartilaginous ends are sutured together back into place (Fig. 1.61d). The lateral crus can be fixed easily while leaving a thin cartilaginous strip at the edge of the crus, as recommended by Eichhorn-Sens and Gubisch.201

1.10.2 Conservative Cephalic Trim

In a bulbous tip, a sparing cephalic trim can narrow the supratip area and allow the tip lobule to blend in better with the upper nose while also producing some cephalic tip rotation. Suture techniques, such as domal equalization suture and transdomal sutures, are used additionally to stabilize and control the tip.

The cephalic trim maneuver must be done extremely conservatively (Fig. 1.62a, b). Otherwise, the “dead space” in the supratip area created due to overaggressive cephalic trim may lead to continued contracture and retraction of the alar rim with columellar show. The cartilage should be left at least 8 to 10 mm wide to preserve the necessary functional stability. Trimming too much cartilage at the lateral third of the lower lateral cartilages may lead also to a pinching and a collapse of the lower lateral cartilage with subsequent nasal airway constriction and may even become accentuated over time.

1.10.3 Sliding Technique

The complete understanding of the tripod principle, introduced by Anderson in the 1960s202 is fundamental for nasal tip correction with sliding techniques: shortening the anterior leg (= the conjoined medial crura and columella) results in decreasing tip projection and down rotation and shortening the posterior legs (= the lateral crus) results in increasing cephalic rotation and decreasing projection. With the sliding techniques, the projection of the tip can be accurately reduced and the rotation of the tip can be changed. Unequal dome heights can be adjusted by a unilateral sliding maneuver.201

Medial Sliding Technique

Medial sliding will lead to an accurate deprojected tip with caudal rotation. Minor malformations at the junction of the medial and intermediate crura can be corrected simultaneously (3 = 14). Changing the axis of the overlapping cartilages cranially and not placing them parallel to each other can avoid the caudal rotation effect.

First, the vestibular skin is separated from the medial lower cartilages. After marking the domes, a second mark 5 to 6 mm caudally from the first is drawn. This is the site where the cartilage will be cut. A third mark defines the amount of required sliding (Fig. 1.63a, b). The cartilage edges are overlapped and fixed with an absorbable 6–0 suture (Fig. 1.63c, d). The vestibular skin is reattached to the cartilages to avoid dead space.

Lateral Sliding Technique

Lateral sliding will lead to a deprojection of the nasal tip combined with increasing cephalic rotation (Fig. 1.64a, c). By turning the axis of the slide rather than keeping the edges parallel, cephalic rotation can be prevented.203

The vestibular skin must be separated from the lower lateral cartilages. The dome is marked, and a second mark is drawn 10 mm from the first. Laterally, the third mark defines the distance of sliding. An incision is made at the second mark and the cartilage is overlapped until the third mark (Fig. 1.64b). The edges are fixed together with 6–0 absorbable sutures and the lower lateral cartilage is sutured again to the vestibular skin. A columellar strut can be added to support the anterior leg of the tripod.203,204

If there is a concave deformity of the lateral crus in addition to an overprojection, both can be corrected simultaneously by lateral sliding technique alone because of the stabilization effect by the overlap.

1.10.4 Lateral Crural Steal Technique

If the tip is underprojected because the domes are too low, the tip projection and the rotation can be improved simultaneously with a lateral crural steal technique (Fig. 1.65a, b). When the tip is underprojected because the domes are too low, with a lateral crural steal technique the tip projection and the rotation can be improved. It can also improve the contour of a flattened nasal base and change the shape of the nostrils from a more horizontal to a more natural-looking vertical orientation.205,206
1.10 Special Techniques

Fig. 1.59 Lateral crural overlay. (a) Concavity of both lower lateral cartilages. (b) The cephalic portion of the lower lateral cartilages was incised only on the underside of the cartilage and folded over the remaining part of the lateral crus and fixed in that position.

Fig. 1.60 Lateral crural underlay. (a) Both lower lateral cartilages show a concave deformity. (b) The underlying vestibular skin is separated from the cartilage and the cephalic portion is incised. (c) Still based on the inferior perichondrium, the cephalic portion is passed beneath the lateral crus. (d) Absorbable fine sutures fix the position.
The Dual Character of Nasal Surgery

Fig. 1.61 Lateral crural reversal technique/upside-down technique. (a) The left lower lateral cartilage has a strong concave deformity. (b) The deformed concave portion is separated from the vestibular skin and removed, (c) turned 180 degrees, and (d) fixed to the remaining parts of the lower lateral cartilage.

Fig. 1.62 Conservative cephalic trim. (a) A bulbous tip with asymmetric convex lower lateral cartilages. (b) The cephalic trim maneuver is done conservatively. A domal equalization suture and transdomal sutures will stabilize and control the tip.
1.10 Special Techniques

The vestibular skin has to be carefully separated from the undersurface of the dome area. The new, more cephalad, position of the dome is temporally determinated by a thin cannula and fixed by an intradomal suture. The technique preserves the continuity of the cartilaginous structures. The lower lateral cartilages are shortened, causing cephalic rotation of the nasal tip. To prevent cephalic rotation, Kridel et al recommend separating the entire lateral crus from the piriform aperture and the vestibular skin to bring the crus more anteriorly, resulting in an increased projection. For supporting the tip in these cases, a columella strut is recommended. This technique is less advantageous in patients with thin nasal skin because the transposed cartilage edges may be visible through the skin.

1.10.5 Tongue-in-Groove Technique

The tongue-in-groove technique can shorten the nasal length, prevent reliably postoperative loss of tip projection, and can control tip projection (push-down or push-up technique). A prerequisite is that the septum has a sufficient length, so that the anterior border of the septum can be positioned between the medial crura and both structures can be fixed to each other with fine absorbable sutures (Fig. 1.66). With the tongue-in-groove technique, the tip rotation can be modified: changing the axis at which the medial crura are fixed to the septum more cephalically, a slightly increase of tip rotation will occur. Patients who have a hanging columella due to a long caudal septum will benefit from this technique. Fixing the medial crura to the caudal septum will usually produce slight extension of the upper lip. This is beneficial in patients with a very short upper lip. Some patients consider a stiff feeling of the nasal tip to be a disadvantage. The shortening of the nose can be supported by an internal nose lift if there is excess skin that cannot shrink.

1.10.6 Push-Down Technique

If only moderate deprojection is needed and the septum is of adequate length, the medial crura are held down at the anterior border of the septum and are fixed in the desired position to the

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**Fig. 1.63** Medial sliding technique. (a) The dome is marked, and a second mark caudal from the first defines the site where the cartilage will be cut. The third mark is drawn at a distance depending on the required amount of sliding. (b) The medial crus is cut at the second mark. (c) The cartilage is brought down to the third mark. (d) The right crus is already deprojected, while the left crus is still overprojected before medial sliding.
Fig. 1.64  Lateral sliding technique. (a) Overprojected tip. (b) The dome is marked. At the second mark, the incision of the cartilage is made. (c) The cartilage is brought to the third mark and the edges are fixed together. The overprojection is corrected.

Fig. 1.65  Lateral crural steal technique. (a) The original domes are in a low position. (b) The lateral steal technique reconstitutes the domes above the original position. This results in increased tip projection and cephalic rotation.
1.10 Special Techniques

By changing the position of the medial crura, the tip rotation can also be achieved (Fig. 1.67a, b).

1.10.7 Dome Division

This technique is recommended only in very thick seborrheic skin and only if an increased projection is desired. In patients with thin skin, the sharp edges of the narrowed tip will be visible and produce an “operated look.” The narrowed tip in these cases may be accompanied with potential collapse of the alar sidewalls.

The dome division affects the projection as well as the configuration of the nasal tip. The dome is divided by a vertical incision (Fig. 1.68). The cartilage edges are approximated with sutures, thereby increasing the tip projection.

1.10.8 Bending Technique

In revision cases, when the patient has a thick and heavy skin, we often see an over-resection or complete resection of the caudal cartilaginous framework, probably done with the intention of reducing and refining the nasal tip. The problem is that the thick and heavy skin cannot shrink enough, so the nasal tip may become ptotic over the years due to a lack of cartilaginous support and the weight of the soft-tissue envelope. This may lead to a pollybeak deformity with an underprojected nasal tip. Within thin skin, the over-resection can cause a conspicuous asymmetry with visible and palpable cartilage ends and a pinching or retraction of the nostrils, and functional problems in the external nasal valve complex can also occur.

If both the lateral and the intermediate crura were resected or are unstable, the cartilaginous framework could be anatomically reconstructed by the bending technique (Fig. 1.69a–c).

The technique can also be used in the cases in which tip projection needs to be increased but the caudal framework has insufficient length.

Two long cartilage strips from septal, conchal, or rib cartilage are sutured medially to the stumps of the medial crura and laterally to the vestibular mucosa. In septal and rib cartilage, the strips are shaped with a burr to create the desired arch in the new dome area (Fig. 1.69d, e). Fixing the reconstructed framework to a columella strut increases the support.

Too much stiffness in the new dome area may complicate the creation of the arch. This can be corrected by dome division and cartilage reapproximation. Suture techniques, using intradomal and transdomal techniques, as well as a spanning suture, will define the new tip (Fig. 1.69f, g). An additional tip suspension suture fixes the nasal tip to the dorsal septal margin to prevent subsequent drooping of the tip.
Fig. 1.69  Bending technique. (a, b) Intraoperative views show massive scar tissue after two previous operations elsewhere. (c) A destroyed and over-resected right lower lateral cartilage and dome area are seen after removal of the scar tissue. The left cartilage is already reconstructed with a modified sliding with the remaining cartilages. (d) A stripe of septal cartilage is designed to rebuild the cartilaginous framework. (e) The stripe is fixed medially between a sepal extension graft and the stump of the medial crus. (f, g) The dome area and the new lower lateral cartilage are rebuilt.
Chapter 2
Contemporary Rhinoplasty: Personal Principles and Philosophy

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2 Contemporary Rhinoplasty: Personal Principles and Philosophy

M. Eugene Tardy, Jr.

2.1 Introduction and Personal Philosophy

Although the history of modern rhinoplasty surgery extends back only one century, typical, traditional reduction rhinoplasty is now commonly associated with a nasal reconstructive procedure characterized by tissue preservation, reconstruction, augmentation, and reorientation. The most significant advances in rhinoplasty in the past two decades have been characterized by a stronger emphasis on exacting anatomical analysis. Although techniques have certainly been refined and improved, the final result of any rhinoplastic procedure develops as the consequence of the patient’s unique anatomy coupled with the surgeon’s skill in accurately diagnosing the exact anatomy and variants of anatomical components. Fundamental knowledge of the universal principles and canons of rhinoplasty, coupled with an understanding of the dynamics of the operation itself and the healing changes that inevitably evolve over time, equips the contemporary surgeon best to achieve uniformly excellent results. The surgeon must initially judge, by inspection and palpation, the character and texture of the skin and subcutaneous tissues as they vary from nasal region to region, the influences of facial mimetic musculature, the relative strength and support of the cartilaginous and bony framework and substructure, and the limitations imposed by the interrelationship of all these structures on the ultimate favorable result. Concomitant creation or preservation of normal airway function is essential. All this must be balanced with the individual surgeon’s aesthetic judgment, factoring in the surrounding facial features and overall stature of the patient. No single surgical technique will suffice to refine every nose to an ideal state. Thus, a wide repertoire of surgical skills must be employed to manage the plethora of abnormalities encountered.

Most importantly, the wishes of the patient create a critical factor in fashioning the ultimate surgical outcome. Rhinoplasty continues to be increasingly characterized by a global, multicultural desire for improvement in appearance and nasal function. Thus, the racial variations in nasal form and function assume more importance, and patients increasingly request nasal modifications that improve appearance but preserve cultural and racial characteristics.

The objective of aesthetic nasal plastic surgery is to create a nose that draws no attention to itself but enhances the beauty of the eyes, allows for comfortable nasal function, and is in harmony with the other features of the face. This simple statement belies a complex problem. The universal concept of what is “beautiful” or “ideal” remains an age-old question, and the solution involves a multiplicity of emotional reactions and prejudices. In addition, values and assessments of beauty vary within different age groups and social structures. To evaluate what is beautiful entails a study of physical and cultural anthropology, ethnology, psychology, and aesthetics.

Beauty of the human face is neither abstract nor absolute; it varies among different ethnic groups and is subject to interpretation by each individual. This attitude is based on a multiplicity of factors varying according to the body image and cultural values of individual conditioning, particularly during the formative years, when it often becomes part of the unconscious mind.

Contemporary rhinoplasty fortunately is characterized by the strong, appropriate concern for conservative and subtle anatomical changes (Fig. 2.1). Rather than excisional sacrifice of large segments of cartilage or bone, a philosophy of preservation and reorientation of tissues has developed that largely eliminates the creation of unnecessary tissue voids that too often contract and scar unpredictably. Conservation surgery thereby further extends the surgeon’s control over the healing surgical result, as an appropriate equilibrium between the corrected nasal skeleton and investing soft-tissue covering is more reliably achieved. Effective methods of autogenous tissue grafting extend the surgeon’s control over the final outcome and its long-term stability. Finally, thoughtful nasal surgeons, through accurate anatomical diagnosis, discern which portions of the nasal anatomy are pleasing and satisfactory, striving to avoid disturbing these structures and areas when correcting (or gaining access to) anatomical components in need of correction.

Fig. 2.1 (a–h) Favorable surgical outcome in patient shown 3 years after conservative and balanced septorhinoplasty surgery. (continued)
2.2 Indications

Rhinoplasty is traditionally undertaken as the result of a patient's request to surgically correct perceived anatomical nasal abnormalities. A didactic list of surgical indications might include the following:

- Nasal aesthetic deformity.
- Nasal functional deformity with airway blockade.
- Nasal traumatic deformities, both acute and preexisting.
- Abnormalities from previous nasal operations (revision rhinoplasty).

An artistic anatomical concept must be developed by the rhinoplastic surgeon when approaching the study of nasal anatomy (Fig. 2.2). The surgeon visualizes the nasal structure not only as static bone and cartilage, but also as muscle and cartilage tension, skin texture, interconnected relationships with surrounding structures, and the effect of related and interrelated structures on the shape of the nose. He or she must develop a personal sense of the “ideal normal,” altering abnormal nasal anatomical components based on this artistic concept, coupled with the patient's clearly defined expectations.

Fig. 2.1 (a–h) Favorable surgical outcome in patient shown 3 years after conservative and balanced septorhinoplasty surgery.
2.3 Contraindications

Absolute as well as relative contraindications to rhinoplasty exist.

**Absolute Contraindications**
- Bleeding and coagulation disorders which are uncorrectable.
- Pregnancy.
- Any systemic illness that might be worsened by rhinoplasty surgery.
- Significant psychiatric disorder.

**Relative Contraindications**
- Temporary or correctable coagulopathies.
- Severe nasal acne.
- Psychological and psychiatric disorders that cannot be corrected or stabilized.
- Active relapsing polychondritis and similar autoimmune illnesses.

2.4 Alternative Techniques

Although closed reduction of nasal fractures is not uncommon in acute and subacute nasal fractures, no other true alternatives to elective rhinoplasty presently exist.

2.5 Preoperative Considerations

Whether septorhinoplasty is to be performed as a hospital inpatient or an office (or hospital) outpatient procedure depends on several factors. Although traditionally this operation involved overnight hospitalization, increasingly rhinoplasties deemed to be straightforward may be accomplished safely as outpatient or office procedures, provided that no additional compromise to patient safety and well-being is involved. Regardless of the surgical setting, the preoperative evaluation and preparation remain the same, and must be exacting.

Education of the patient by the surgeon and his staff is preeminent. It is essential to guide patients and the family gently through a form of self-analysis and awareness of the interdependent structures of the nose and face, an exercise that catalyzes the patient’s understanding of the scope of the deformity and operation, and the limitations imposed on the procedures by the imperfect existent anatomy. Using a three-way mirror supplemented by accurate preoperative photographs aids in the patient and surgeon arriving at a joint understanding about the nature and goals of the operation. It is absolutely essential that the patient be able to characterize exactly what outcome is desired. Even a result judged by the surgeon to be superb may fall short of the patient’s expectations without this knowledge.

If, in the surgeon’s judgment, realistic motivation and understanding is present, plans are made to schedule the desired operation. If any doubt exists, it is propitious to allow a period of reflection and contemplation on the part of the patient, scheduling a second interview and consultation before any firm decision for surgery.

The following is a necessarily incomplete list of characteristics of potential problem patients:
- Unrealistic expectations.
- Obsessive-compulsiveness, perfectionism.
- Sudden whims.
- Indecisiveness.
- Rudeness.
- Unkemptness.
- Uncooperativeness.
- Depression.

Questionable candidates may also be:
- Overly flattering.
- Overly familiar.
- Possessed of a minimal or imagined deformity.
- A careless or poor historian.
- Obsessed with being a “very important person.”
- Overly talkative.
- A “surgeon shopper.”
- A “plasti-surgiholic.”
- A price haggler.
- Involved in litigation.
- Disliked by the surgeon or his staff.

Surgeons should be alert to the above characteristics and evaluate such patients more carefully before accepting them for appearance-changing surgery. The wise admonition “the surgeon makes his living from the patients he operates, but secures his reputation from those he refuses to operate” should be heeded.
2.6 Special Surgical Requirements

Standard classical rhinoplasty instrument sets are ubiquitous in operating theaters throughout the world. In addition, a personal preference is strongly held for the following:

1. The Dunning semisharp septal perichondrial elevator.
2. Long nasal speculum.
3. Rubin guarded osteotomes.
4. Osteotomes: 2 and 3 mm.
5. Sharpening stone (hone).
6. Tardy microsurgical RHINOBUR (Medtronic, Jacksonville, Florida, United States).

2.7 Preoperative Analysis

An exacting preoperative analysis and diagnosis of the unique nasal deformity presenting in each patient is arguably more important than surgical skill. Skillful surgeons who fail to accurately understand (and thus correct) the many nasal variants encountered in a rhinoplasty practice stand little opportunity of achieving an excellent long-term outcome. Detailed anatomical descriptions of the nasal anatomy exist in several excellent anatomy textbooks. The following description, unlike traditional anatomy discussions, will review the specific features of nasal anatomy that directly influence the rhinoplasty operation, with emphasis on the philosophy of surgical conservatism and reorientation of the interrelated nasal anatomical components. The commonly accepted anatomical terms in rhinoplasty are illustrated in Figs. 2.2–2.5 and will prevail throughout this chapter.

The nose itself represents an aesthetic unit located centrally within the other aesthetic regional units of the face. On the nasal surface, one can identify several distinct anatomical topographical subunits (Fig. 2.3).\(^1\) Individual inherited characteristics render these subunits prominent or unobtrusive. In the reconstruction of external nasal defects, it is often preferable to resect and replace an entire topographical subunit with skin of like color, character, and texture rather than simply fill the existing primary defect with a skin graft or pedicle flap. In similar fashion, during rhinoplasty the surgeon must avoid a sharp, unnatural overemphasis of any one subunit in comparison to a surrounding subunit; each should ideally blend into the other with a gracefulness that draws no attention to the nasal repair. Nasal subunits consist of the nasal dorsum, the nasal sidewalls, the nasal tip (including the infratip lobule and columella), the alar lobules, and the depressions of the supraalar facets (Fig. 2.3).

The quality and thickness of the skin and supportive subcutaneous tissues investing the nose exert a major influence on the surgical dissection in rhinoplasty and the ultimate natural appearance of the final healed result. By inspection and palpation, one can judge the character, thickness, elasticity, and overall quality of the skin to accurately estimate how much and what form of surgical correction is possible. Surgeons often prefer patients with thin, delicate skin, as they invariably develop less postoperative edema and heal more quickly. Markedly thin skin with sparse subcutaneous tissue, however, poorly camouflages even minor irregularities in the nasal supporting structures, potentially unveiling bony or cartilaginous highlights, asymmetries, offsets, or irregularities during the early postoperative healing period. Conversely, thick skin, which heals and contracts less quickly, tends toward greater postoperative edema, healing and contracting less quickly. Since subcutaneous scar formation generally is more abundant, the unwary surgeon is exposed to the possibility of one form of postoperative pollybeak deformity: this is particularly true when excessive nasal skeleton is needlessly sacrificed. Smooth draping of skin is less easily accomplished when thick skin exists; therefore, efforts aimed at surgical creation of accentuated definition, particularly at the nasal tip, are largely limited. Excision of excessive subcutaneous tissue in the nasal tip, commonly necessary in thick skin, is usually contraindicated in thin skin, since the maintenance of a pleasing, natural contour demands preservation of interposed soft tissue between skeletal structures and delicate overlying skin. Nasal skin is considerably thinner, more mobile, and more easily repositioned in the cephalic three-fifths of the nose, where it is relatively devoid of subcutaneous tissue and sebaceous glands. Progressing caudally toward the nasal tip, the skin assumes a thicker, more glandular sebaceous quality (Fig. 2.2).

An ideal skin type does in fact exist for favorable results in rhinoplasty. Neither too thick nor too thin, this ideal epithelium possesses a minimum of sebaceous glands and wide pores and redrapes well after conservative undermining and elevation. Sufficient subcutaneous tissue is present to cushion the epithelium from underlying osseocartilaginous structures, but a minimum of fat is present. Gentle palpation and rolling of the nasal skin during the physical examination identify this favorable skin condition for the surgeon.

The varying thickness of the skin-subcutaneous tissue sleeve plays a vital role in profile planning in rhinoplasty. The skin covering is usually thin at the rhinion and thick at the nasion and supratip area (Fig. 2.4); a slight skeletal hump at the rhinion exists even when the external epithelial profile line is relatively straight and devoid of an external humped appearance. Straight-line removal of the nasal hump (consisting of cartilage and bone) will generally result in an unacceptable profile line. The more abundant and subcutaneous tissue covering the cartilaginous dorsum creates a need for a quantitatively differential profile alignment (as opposed to bony dorsum alignment) to achieve desirable profile contouring. Whereas excessive soft tissue may require reduction in thick-skinned patients, ordinarily every effort must be made to preserve the subcutaneous soft tissues to ensure the most favorable long-term result.

There are definitive tissue dissection planes in the nose and these should be exploited during primary rhinoplasty; in revisional rhinoplasty, favorable dissection planes are commonly obliterated by scar tissue. By sharp knife and scissor...
dissection in the immediate supraperichondrial plane over the upper and lower lateral cartilages and subperiosteal elevation over the bony dorsum, ideal soft-tissue preservation for potential cushioning and camouflage of possible slight irregularities that may develop postoperatively along the nasal profile is maintained (Fig. 2.5). Elevation of the soft tissues in this favorable plane not only creates less eventual scarring but also facilitates access to the supportive skeletal substructures of the nose and avoids the vascular and neural structures lying more superficially.

Too much emphasis cannot be placed on this all-important concept of proper nasal dissection planes. Ideally, anesthetic infiltration should be placed precisely in this supraperichondrial (superficial musculoaponeurotic system) plane in the lower half of the nose to aid in avascular dissection.

The ideal base view and the terminology applied to the anatomical components are depicted in Fig. 2.6.

### 2.8 Surgical Techniques

As a bilateral and often difficult operation, rhinoplasty remains the most challenging of all aesthetic facial operations because no two procedures are ever identical. Equally importantly, total control of the healing process by the surgeon is not possible. Each patient’s nasal configuration and structure require individual and unique operative planning and surgical reconstruction. Therefore, no single technique, even when mastered, will prepare the surgeon for the varied anatomical patterns encountered. It is essential to regard rhinoplasty as an operation planned to reconstitute and shape the anatomical features of the nose into a new, more pleasing relationship with one another and the surrounding facial features. Rhinoplasty should be approached as an anatomical dissection and exposure of the nasal structures requiring alteration, conservatively shaping, repositioning, and often augmenting these anatomical elements. Excision should be kept to a minimum, and cartilage grafting should be employed when indicated. Many more problems and complications arise from overcorrection of nasal abnormalities than from conservative correction. An inappropriate technique applied persistently without regard for existing anatomy creates frequent complications. One truism, namely that “it is not what is removed in rhinoplasty that is important but what is left behind,” remains valid. Furthermore, one must comprehend clearly the dynamic aspects of operative rhinoplasty because all surgical steps are interrelated and interdependent, most maneuvers leading to a temporary deformity to be corrected progressively by the steps that follow (the “dynamics” of rhinoplasty).
Sculpture of the nasal tip is regarded, and properly so, as the most exacting aspect of nasal plastic surgery. The surgeon is challenged by the bilateral, animate, and mobile nasal anatomical components. Because no single surgical technique may be used successfully in correction of the endless anatomical tip variations encountered, the surgeon must analyze each anatomical situation and make a reasoned judgment about which approaches and tip modifications are indicated and which techniques will result in a predictably natural appearance. Factored into this decision must be consideration of, among other things, the following:

1. The strength, thickness, and attitude of the alar cartilages.
2. The degree of tip projection.
3. The texture and quality of tip skin and subcutaneous thickness.
4. The columellar length.
5. The width of the tip.
6. The interdomal distance and domal angles.
7. The tip–lip complex angulation.
8. The size, shape, and resiliency of the medial and lateral crura.
9. The wraparound attachment of the medial crural footplates to the caudal end of the quadrangular cartilage.
10. The membranous septum.

One fundamental principle of tip surgery is that normal or ideal anatomical features of the tip should be preserved and, if possible, remain undisturbed by surgical dissection, and abnormal features must be analyzed, exposed, reanalyzed, and corrected by reduction, augmentation, or reorientation and shape modification. Surgeons have gradually come to understand that radical excision and extensive sacrifice of alar cartilage and other tip support mechanisms all too frequently result in eventual unnatural or “surgical” tips. What appears pleasant and natural in the early postoperative period may heal poorly because of overaggressive attempts to modify the anatomy more extensively than the tissues allow. Cross-cutting or morselization of the lateral crus may provide an excellent early appearance, but commonly results in asymmetry, bossae, and distortion or loss of tip support as the soft tissues “shrink-wrap” around the weakened cartilages over time. Rhinoplasty is, after all, a compromise operation, in which tissue sacrifices and reorientation are made to achieve a more favorable appearance. It is thus judicious to develop a reasoned, planned approach to the nasal tip based entirely on the anatomy encountered coupled with the final result intended. A philosophy of a systematic incremental anatomical approach to tip surgery is highly useful in achieving a consistently natural result.

Conservative reduction of the volume of the cephalic margin of the lateral crus, preserving a substantially complete, undissected strip of residual alar cartilage, is a preferred operation in individuals in whom nasal tip changes are intended to be modest. As the tip deformity or asymmetry encountered becomes more profound, more aggressive techniques are required, from weakened and complete strip techniques to significant vertical interruption of the residual complete strip with profound alteration in the alar cartilage size, attitude, and anatomy. Cartilage structural grafts (tip shield grafts, columellar struts, onlay grafts, alar batten grafts, and alar sidewall grafts) to influence the size, shape, projection, and support of the tip are often invaluable.

Tip sculpture cannot be successfully undertaken, let alone mastered, until the major and minor tip support mechanisms are appreciated, respected, and preserved or, when indicated, reconstructed (Table 2.1). Loss of tip support and projection in the postoperative healing period is one of the most common surgical errors in rhinoplasty. This tip “ptosis” is usually the inevitable result of sacrificing nasal tip support mechanisms.

In the majority of patients, the major tip support mechanisms consist of the following:

- The size, shape, and resiliency of the medial and lateral crura.
- The wraparound attachment of the medial crural footplates to the caudal end of the quadrangular cartilage.
- The soft-tissue attachment of the caudal margin of the upper lateral cartilage to the cephalic margin of the alar cartilage.

Compensatory reestablishment of major tip support by suture repair, columellar struts, application of tip grafts, etc., should be considered if, during the operation, any or all of these major tip support mechanisms are compromised in any fashion. The minor tip mechanisms that, in certain anatomical configurations, may assume major support importance include the following:

- The dorsal cartilaginous septum.
- The interdomal ligament.
- The membranous septum.
- The nasal spine.
- The surrounding skin and soft tissues.
- The alar sidewalls.

Tip projection in every rhinoplasty operation is inevitably enhanced, reduced, or preserved in its original state (Fig. 2.8). Anatomical situations in which each of these outcomes is
Contemporary Rhinoplasty: Personal Principles and Philosophy

The desirable surgical goal in every operation is preservation of the projection already existent, if, as is true in the majority of rhinoplasty patients, preoperative projection of the tip is satisfactory. Other patients require an increase in the projection of the tip relative to the intended new profile line. A predictable variety of reliable operative methods exist for creating or augmenting tip projection, which are discussed later in the chapter. Finally, in a limited but clearly definable group of patients with overprojecting tips, a calculated, intentional reduction of excessive tip projection is desirable to effect intentional retroprojection. Successfully achieving these diverse surgical results requires an understanding of and a healthy respect for the major and minor tip support mechanisms, seasoned by the recognition of the intraoperative surgical tip dynamic principles that interact in every tip operation. It clearly follows that the appropriate tip incisions and

Table 2.1 Major and minor supports of the nasal tip

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<td>1. Size, shape, thickness, and resilience of the alar cartilages</td>
<td>2. Upper lateral cartilage attachment to the cephalic margin of the alar cartilages</td>
<td>3. Wraparound attachment of the medial crural footplates to the caudal septum</td>
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<th>Minor supports:</th>
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<td>1. Anterior septal angle</td>
<td>2. Skin of nasal tip</td>
<td>3. Membranous septum</td>
</tr>
<tr>
<td>7. Sesamoid cartilage complex extending the support of the lateral crura to the pyriform margin</td>
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</tbody>
</table>

*Under certain anatomical variant conditions, minor tip supports can contribute major support to the tip.

Fig. 2.7 Algorithm depicting the graduated anatomical systematic approach to nasal tip surgery: As the tip deformity which presents to the surgeon becomes more severe, more invasive and aggressive tip operations are considered than if the tip deformity were modest.

Fig. 2.8 (a,b) Ideal tip projection improvement in patient who requires columnar strut associated with an infratip sutured-in-place cartilage tip graft.
approaches should be planned to preserve as many tip supports as possible. Alar cartilage sculpturing should similarly respect this principle by conserving the volume and integrity of the lateral crus and avoiding, in all but the most extreme anatomical situations, radical excision and sacrifice of tip cartilage.

The surgeon should differentiate clearly between incisions, approaches, and techniques. Incisions are simply methods of gaining access to the underlying supportive structures of the nose and in themselves have little importance. Approaches to the nasal tip provide important exposure to the skeletal structures and consist of procedures either to deliver the tip cartilages or to avoid complete delivery or operating on the alar cartilages without removing them from their anatomical beds. Sculpturing techniques are defined as surgical modifications: excision, reconstruction, or orientation of the alar cartilages calculated to cause significant changes in the definition, size, orientation, and projection of the nasal tip. Because of the amazing complexity of anatomical configurations encountered in nasal tip surgery, further modifications are frequently used to ensure stable refinements. In planning tip remodeling, the surgeon must determine whether or not the tip requires the following:

- A reduction in the volume of the alar cartilages.
- A change in the attitude and orientation of the alar cartilages.
- A change in the projection of the tip.
- A cephalic rotation with a subsequent increase in the columellar inclination (nasolabial angle).
- A bilateral narrowing of the angle of the domes.
- Reduction of the interdomal distance.

Ideally, conservative reduction of the volume of the cephalic margin of the lateral crus, preserving the majority of the crus while maintaining a complete (uninterrupted) strip of alar cartilage, is preferred. This procedure is satisfactory and appropriately safe when minimal conservational tip refinement and rotation are required. As the tip deformity increases in size and complexity, more aggressive techniques are required. A philosophy of a graduated incremental anatomical approach to nasal tip surgery has proved useful. This implies that no routine tip procedure is ever used; instead, the appropriate incisions, approaches, and tip sculpturing techniques are selected based entirely on an analysis of the varying anatomy encountered. Whenever possible, a complete strip operation is used, reserving more complicated and risky interrupted strip techniques for anatomical situations in which more profound refinement changes and significant rotation are desirable. As a general rule, when an alar complete strip is surgically interrupted, suture repair or cartilage grafting is employed to stabilize the alar remnant.

**Surgical Approaches to the Tip**

**Nondelivery Approaches**

In anatomical situations in which the nasal tip anatomy is favorable, only conservative refinements are necessary, and nondelivery approaches are of great value. Less dissection and less disturbance of the tip anatomy are necessary, and this reduces the chance for asymmetry, error, and unfavorable healing. Properly executed (when indicated), nondelivery approaches therefore allow the surgeon to control the healing process more accurately than when more radical approaches and techniques are chosen. The transcartilaginous approach is preferred—when the presenting anatomy will allow—because of its simplicity, ease of use, and predictable healing. The same tip refinements, however, may be accomplished through the retrograde approach. This approach is chosen in patients whose tip anatomy is fundamentally satisfactory and the domal angles and interdomal distance are normal, requiring only cephalic volume reduction of the lateral crus to accomplish a thinning sculpture reduction (Fig. 2.10). Nondelivery approaches with transcortilaginous incisions require that the following anatomical situations exist: normal domal angles, normal interdomal distance, and reasonable symmetry. When tip projection is to be enhanced by the use of cartilage tip grafts, nondelivery approaches are useful because precise recipient pockets may be more accurately created in the infratip lobule undisturbed by the minimal dissection inherent in nondelivery approaches. Properly positioned, tip grafts may be sutured in place without the open approach. If complex sutured-in-place tip grafts are planned, a delivery or open approach is preferred.

**Delivery Approaches**

Delivering the alar cartilages as individual bipedicle chondrocutaneous flaps through intercartilaginous and marginal incisions is the preferred approach when the nasal tip anatomy is more abnormal (broad, asymmetrical, etc.) or when more dramatic tip refinements are necessary. Significant modifications in the alar cartilage shape, attitude, and orientation are more predictably attained when the cartilages are delivered (Fig. 2.11). The base photograph is usually helpful in determining which patients may best be approached in this manner. If the trianularity of the tip from below is satisfactory and only modest volume reduction of the lateral crus appears necessary, the nondelivery approach serves well. If, however, on base and frontal view the alar cartilages flare unpleasantly, tip triangularity is unsatisfactory, or the tip appears too amorphous and bulbous, the domal angles are too wide, and the interdomal distance must be narrowed, a delivery approach is chosen to correct these aesthetic deficiencies more thoroughly. Transdomal suture narrowing of broad domes (Fig. 2.12), an effective and preferred technique, is easily effected by means of the delivery approach. In similar fashion, interrupted strip techniques (rarely necessary) for more radical tip refinement and cephalic rotation are more efficiently accomplished when the cartilages are delivered. The increased surgical exposure provides the surgeon with an improved binocular view of the tip anatomy and affords the added ease of bimanual surgical modifications.

**Open (External) Approach**

The external or open approach to the nasal tip is in reality a more aggressive form of the delivery approach and is chosen with discretion in specific nasal tip deformities (Fig. 2.13).

When the nasal tip is highly asymmetrical, markedly overprojected, severely underprojected, or anatomically confusing in its form (as in certain secondary revision cases), the open approach is considered. The transcolumellar scar is of negligible importance in this decision because it routinely heals inconspicuously when meticulously repaired. The anatomical view is unparalleled through this approach, affording the surgeon diagnostic information unavailable through traditional closed approaches. These technical virtues must be balanced with the potential disadvantages of an enlarged scar bed, slightly delayed healing with some prolongation of tip edema, and increased operating time. Indications for choosing the open approach might include the following:

- Asymmetrical tip cartilages.
- Severe tip underprojection or overprojection.
- Severely deviated nose.
- Middle vault deformities requiring grafting.
- Nasal tumors.
- Cleft lip/nose deformities.
- Difficult revision rhinoplasty.
- Infantile (tiny) nostrils.
- Teaching.

Clearly, when subtle and conservative tip surgery is indicated by the patient’s existent anatomy, the open approach is unnecessary and even counterproductive.

**Alar Cartilage Sculpturing Techniques**

The choice of the technique used to modify the alar cartilages and the relationship of the nasal tip with the remaining nasal structures should be based entirely on the anatomy encountered and the predicted result desired, as defined from the known dynamics of long-term healing. The astounding diversity of anatomical tip variations encountered demands the mastery of a broad diversification of surgical planning and execution.

Three broad categories of nasal tip sculpturing procedures may be identified. Although additional subtle technical variations exist, the three primary categories are as follows:

1. **Volume reduction of the cephalic lateral crus margin with residual complete strip.**
2. **Volume reduction with suture reorientation of the residual complete strip** (dome-narrowing sutures, interdomal sutures, transdomal sutures).
3. **Volume reduction with interrupted strip.**

Preserving intact the major portion of the residual complete strip of the alar cartilage is always preferred when the anatomy of the alar cartilages and their surrounding soft-tissue investments allows. This preservative approach retains...
the supportive advantage of the intact cartilage strip (thus “mimicking” nature), discourages cephalic rotation when it is undesirable, eliminates many of the potential hazards of more radical techniques, and tends to produce a more natural final result.

Techniques involving a weakened (or suture-reoriented) residual complete strip possess all the foregoing positive virtues and in addition allow the surgeon to effect reorientation of the breadth of the domal angle and interdomal projection modification, and narrowing refinement so desirable in the ideal postoperative appearance. The control of favorable healing is enhanced with these techniques, with the risk of complication diminished considerably.

Despite a laudable desire to preserve the integrity of the residual complete strip whenever possible, anatomical situations are occasionally encountered in which the shape, breadth, and orientation of the alar cartilages must be changed more radically by interrupting the complete strip in a vertical
Fig. 2.10 (continued) (a–h) Favorable long-term outcome (10 years) in patient requiring conservative surgery, in whom a transcartilaginous nondenial approach to the nasal tip was ideal.

(continued)

fashion somewhere along its extent to refine severe anatomical deficits (Fig. 2.14). When significant cephalic rotation is indicated, interrupted strip techniques are considered. The risks of asymmetrical healing are higher when the alar cartilages are divided, however, and initial loss of tip support occurs immediately. The latter problem must be recognized and countermeasures taken during surgery to ensure that sufficient tip support is reconstituted. Shoring struts in the columella, infratip lobule cartilage grafts, and transdomal suturing are the most commonly used tip support adjuncts. Almost without exception, interrupted strips should be avoided in patients displaying thin skin with sparse subcutaneous tissue.

Cephalic Trim Preserving Complete Strip Intact

When only modest reduction of the alar cartilages is indicated by the presenting anatomy, symmetrical resection of a conservative amount of the cephalic margin of the lateral crura while preserving a complete intact residual cartilage provides a predictable healing outcome.

Fig. 2.11 Delivery approach to the nasal tip, effected through bilateral intercartilaginous and marginal incisions, delivering the alar cartilages as bipedicle chondrocutaneous flaps. (a) Intercartilaginous incision. (b) Marginal incision. (c) Freeing and delivery of alar cartilage as a bipedicle chondrocutaneous flap. (d) Resection of calculated portion of cephalic margin of lateral crus.
Transdomal Suture Repair

In patients who demonstrate a broad, boxy tip characterized by bifidity, broad domal angles, and excessively large alar cartilages, predictable narrowing refinement may be achieved by transdomal suturing of the reduced, residual complete strips with one or more horizontal mattress sutures of 5–0 polydioxanone suture (PDS) (Fig. 2.15). Narrowing refinement results, vital tip supports are preserved, and symmetrical healing is facilitated (Fig. 2.16). Because a complete strip is preserved intact and only its shape is modified, the surgical outcome is highly predictable. Transdomal sutures strengthen tip support and can be used to enhance tip projection slightly. We rely strongly on this narrowing technique when the proper anatomy is encountered. When indicated to further narrow an excessively broad domal angle, individual dome narrowing sutures are positioned in each dome.
In addition to the creation of narrowing refinement and symmetry of the nasal tip, most evident in the frontal view, appropriate projection must be preserved or newly created to result in the most natural appearance possible. Clearly, the most attractive and elegant noses are those in which anterior projection is sufficient to set the tip subtly but distinctly apart from the nasal supratip areas. Ptotic or poorly projected tips produce a snubbed and indistinct appearance.10

**Tip Projection and Cartilage Tip Grafts**

In addition to the creation of narrowing refinement and symmetry of the nasal tip, most evident in the frontal view, appropriate projection must be preserved or newly created to result in the most natural appearance possible. Clearly, the most attractive and elegant noses are those in which anterior projection is sufficient to set the tip subtly but distinctly apart from the nasal supratip areas. Ptotic or poorly projected tips produce a snubbed and indistinct appearance.10

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Fig. 2.12 (continued) (a–g) Transdomal suture narrowing of the broad nasal tip, characterized by a wide interdomal distance and domal angles. Outcome shown at 11 years following surgery.

Fig. 2.13 Open approach to nasal tip cartilages. (a) Transcolumellar incision connected to paracolumellar and marginal incisions. (b) View of exposed nasal tip cartilages utilizing open approach. (c) Illustration of one method of repairing the concave lateral crus seen in (b): removal, reversal, and replanting of crus with its convex surface outward.
2.8 Surgical Techniques

Interrupted strip procedure, utilized only when more conservative procedures are not indicated or sufficient to gain significant tip projection and tip narrowing. (b) Lateral interrupted strip technique, resecting a triangle base upward to effect significant upward tip rotation, (c,d) created when the cut edges of the lateral crus are reconstituted by fine suture.

Fig. 2.14 (a) Narrowing refinement of broad boxy tip characterized by wide domal angles and excessive interdomal distance, created by a horizontal mattress suture passed through both domes and tied without undue tension between the domes, (b) Single-dome sutures utilized to narrow the over-wide domal angle found in some patients with over-wide tips, (c) Interdomal suture placed in conjunction with transdomal or single-dome sutures to bring tip-defining points closer together. Care should be taken not to overnarrow tip, resulting in an abnormal “unitip” appearance.

Fig. 2.15 (a) Narrowing refinement of broad boxy tip characterized by wide domal angles and excessive interdomal distance, created by a horizontal mattress suture passed through both domes and tied without undue tension between the domes, (b) Single-dome sutures utilized to narrow the over-wide domal angle found in some patients with over-wide tips, (c) Interdomal suture placed in conjunction with transdomal or single-dome sutures to bring tip-defining points closer together. Care should be taken not to overnarrow tip, resulting in an abnormal “unitip” appearance.

Ideally on profile view, the nasal tip should be slightly elevated above the cartilaginous dorsum by 1 to 2 mm, blending gently rather than abruptly into the supratip. If the preoperative projection of the tip is normal and adequate, lowering the cartilaginous dorsum into proper alignment will achieve a satisfactory aesthetic appearance, provided no loss of tip support occurs during the operative or postoperative periods. Preserving the major and minor tip support structures increases likelihood of this, whereas their sacrifice without compensatory reestablishment of support inevitably leads to eventual tip ptosis. If preoperative tip projection is inadequate, attempts to overreduce the supratip cartilaginous dorsum to produce pseudoprojection of the tip are inadvisable and lead to apparent flattening or widening of the middle third of the nose.

If tip projection is inadequate, several reliable methods may be used singly or in tandem to establish permanent improvement. All involve reorientation of the alar cartilages or addition of autogenous cartilage grafts to strengthen or sculpture the projection and/or altitude of the tip and infratip lobule. Because the long-term viability and stability of
sutured-in-place cartilage tip grafts are well established, they are regularly and successfully used if the surgical modification of existing alar cartilage configuration is not adequate to produce the desired degree of projection (Fig. 2.17a, b). In revision rhinoplasty in particular, tip cartilage grafts are irreplaceable in skeletal reconstruction beneath scarred skin and asymmetrical topography. Such grafts are routinely used to camouflage and provide more symmetry to nasal tips whose alar cartilages have been badly damaged. Two distinct varieties of tip grafts are preferred: those that directly overlie the dome profile of the alar cartilage and those that redefine and contour the skeletal anatomy of the infratip lobule. Because these grafts (single or laminated) lie in intimate subcutaneous pockets, exacting sculpture of their size and shape is mandatory. Harvested from septal or auricular cartilage, they are ideally inserted with or without suture fixation into small pockets dissected to accommodate exactly the dimensions of the graft(s). Bilateral marginal incisions beneath the anatomical dome area facilitate precise graft positioning.

Onlay and Stiffening Supportive Tip Grafts

Onlay Grafts
Patients who present with asymmetrical tip anatomy, unilateral or bilateral lateral crural concavity, or even unequal development of the alar cartilages are commonly encountered. If the asymmetry or deformity is not overly profound, onlay cartilage grafts may be fashioned from resected segments of the lateral crus, septal cartilage fragments, or curved contoured cartilage grafts from the auricle (preferred). One or two layers of grafts may be sculpted and sutured together and in place to camouflage irregularities, provide needed projection, and reconstruct tip defects (Fig. 2.18).

Lateral Crural Strut Grafts
Patients are encountered with nasal tip variants that are characterized by thin, frail, and delicate alar cartilages that support the nasal tip poorly, leading to asymmetry, tip irregularities, and even inspiratory alar sidewall collapse. Such frail lateral crura may be strengthened by lateral crural strut grafts, fashioned to stiffen, straighten, and support weak lateral crura. By dissecting a pocket between the undersurface of the lateral crus and the underlying vestibular skin, thin supportive grafts may be sutured to the crus, offering stiffening and straightening characteristics (Fig. 2.19).

Tip Rotation
In many patients undergoing rhinoplasty, cephalic rotation of the nasal tip complex (alar cartilages, columella, and nasal base) assumes major importance in the surgical event, whereas in other individuals, the prevention of upward rotation is vital. Certain well-defined and reliable principles may be invoked by the nasal surgeon essentially to calibrate the degree of tip rotation (or prevention thereof). The dynamics of healing play...
a critical role in tip rotation principles; the control of these postoperative healing changes distinguishes rhinoplasty from less elegant procedures. In the past, overrotation of the nasal tip created an unhealthy stigma regarding the rhinoplasty procedure. Most individuals recognize and prefer the aesthetic advantages of a stronger nose possessed of sufficient length to impart character and suitable proportions to the face.

The planned degree of tip rotation depends on a variety of factors, which often include the following:
- The length of the nose.
- The length of the face.
- The length of the upper lip.
- Facial balance and proportions.

Fig. 2.17  (a) Various sized and shapes of cartilage tip grafts used for improving nasal tip projection in patients with inadequate projection (grafts are generally best avoided in patients with extremely thin skin). (b) Sutured-in-place tip graft placed through an open approach to the nose.

Fig. 2.18  Contoured auricular projection graft placed directly over the nasal domes to camouflage irregularities and effect increased tip projection.

Fig. 2.19  Lateral crural cartilage strut grafts may be effectively utilized to stiffen and favorably reshape irregular, concave, or excessively convex lateral crura. Grafts are sutured between the undersurface of the lateral crus and the vestibular skin.
• The patient’s aesthetic desires.
• The surgeon’s aesthetic judgment.

An important distinction must be drawn between tip rotation and tip projection. Although certain tip rotation techniques may result in desirable increases in tip projection, the converse is not true. Tip rotation and projection, in fact, complement each other, and their proper achievement in individual patients is constantly interrelated. A classic example of this interdependent relationship is illustrated by the almost inevitable loss of tip projection when interrupted strip techniques are chosen to enhance cephalic rotation; steps must be planned to restore adequate long-term tip projection by one of the several methods recommended.

Finally, a distinction must be drawn between true tip rotation and the illusion of tip rotation achieved by contouring cartilage grafts placed in the infratip lobule, columella, and nasolabial angle. Favorable modifications in the tip-lip complex profile areas with autogenous implants may obviate the need for any actual tip rotation, thus preserving a long, and at times more desirable, nasal appearance. Reduction of the nasal profile, particularly the supratip cartilaginous pyramid, may also impart the illusion of rotation and a shortened nose, although occasionally at the expense of a strong and narrow dorsum.

Nasal tip rotation results fundamentally from planned surgical modifications of the alar cartilages, but increments of rotation may also be realized from additional adjunctive procedures on nasal structures adjacent to the alar cartilages, which exert a favorable influence on calibrated tip rotation methods used to enhance the effects of a planned degree of tip rotation. Shortening of the caudal septum, excision of overlong caudal upper lateral cartilages, and septal shortening with a high transfixion incision are regularly used to enhance the effects of a planned degree of tip rotation.

Because tip rotation is only one of the many objectives of rhinoplasty, decisions regarding rotation and planning for tip volume reduction, alar cartilage thinning reduction, and modifications in the attitude and angulation of the alar cartilages must be interrelated.

The techniques and healing dynamics described are not absolute, but are reasonably predictable. Most tip rotation techniques may be incorporated into an organizational scheme that involves three procedures to preserve a complete, intact strip of alar cartilage (Fig. 2.20) and three additional procedures involving interrupted strip techniques (Fig. 2.21). Unique anatomical situations are regularly encountered that require modifications of this scheme to achieve a more refined result, but the fundamental principles elaborated remain constant. In addition, the thickness and strength of the alar cartilages, along with the character of their enveloping soft tissue and skin, dictate, to a degree, which techniques may safely and predictably be used in each anatomical situation.

**Complete strip techniques** are always preferable tip procedures when the nasal anatomy permits, and the goals of the surgical procedure may be met without resorting to the less predictable interrupted strip procedures. Preserving a complete, uninterrupted segment of alar cartilage remnant

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**Fig. 2.20** Principles applicable to tip rotation when a complete strip procedure is utilized. Within limits, as slightly more cephalic margin of the lateral is removed, slightly more cephalic rotation occurs.

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**Fig. 2.21** General principles applicable to tip rotation when an interrupted strip procedure is utilized. The degree and amount of cephalic rotation are affected by other maneuvers as well, such as caudal septal resection, resection of the caudal aspect of the upper lateral cartilages, and even moderate resection of excessive vestibular skin.
contributes to a more stable and better supported nasal tip that tends to resist cephalic rotation during healing.\textsuperscript{13}

Interrupted strip techniques combined with volume reduction of excessive alar cartilage tend to result in a more substantial degree of cephalic rotation of the tip complex. Once the complete strip of residual alar cartilage is divided (interrupted), the result is relative instability of the nasal tip, on which the forces of upward scar contraction create a variable degree of cephalic rotation, underscoring the principle that during scar contracture tissues are generally moved from areas of instability (in this case, the unstable nasal tip cartilages) toward areas of stability (the bony–cartilaginous nasal pyramid). Generally, suture reconstitution of the divided lateral crus after removal of a base-up triangle achieves predictable and reliable rotation from repositioning of the attitude of the alar cartilages (Fig. 2.22). Caution must be exercised constantly in the use of interrupted strips in patients with thin skin and/or more delicate cartilages.

Fig. 2.22 (a–h) Favorable outcome 3 years following tip-narrowing rhinoplasty with dome interruption procedure, borrowing from the lateral crural to increase tip projection. (continued)
because the absence of good tip supporting structures sets the stage for loss of projection, alar collapse, notching, pinching, and asymmetry.

**Correcting the Overprojecting Tip**

Profound facial and nasal disharmony may result from the anatomical facial feature variant termed “the overprojecting nose.” Because the entire nose, and especially the normal nasal tip, is composed of distinct, interrelated anatomical components, any one or a combination of several of these components may be responsible for a tip that projects too far forward of the anterior plane of the face. The guidelines for determining appropriate and inappropriate tip projection are now well accepted. When numerous patients with overprojecting tips are analyzed, it becomes apparent that no single anatomical component of the nose is consistently responsible for overprojection; therefore, no single surgical technique is uniformly useful in correcting all the problems responsible for the various overprojection deformities. Accurate anatomical diagnosis allows preoperative development of a logical individualized strategy for correction and tip repositioning. In almost every instance, weakening or reduction of normal tip support mechanisms is required to achieve normality, supplemented by reduction of the overdeveloped components. The following anatomical variants are commonly responsible individually or collectively for overprojection of the nasal tip (Fig. 2.23a, b).

- **Overdevelopment of the alar cartilages**, commonly associated with thin skin and large nostrils, is frequently encountered in the overprojecting nose. The junction between the medial and lateral crura may form an overlarge dome of significant convexity, or the anatomical dome area may be sharply angulated, twisted, or even buckled, frequently demonstrating significant asymmetry of the entire tip and its tip-defining points. The hypertrophied cartilages must be delivered, their abnormalities visually diagnosed, and overall volume reduction of both the lateral and medial crura accomplished. Portions of the medial crus may require resection to retroposition the nasal tip satisfactorily.

Overprojection and obliteration of a definitive nasolabial angle may be the result of overdevelopment of the caudal quadrangular cartilage. The nasal spine may in fact be of normal size, but if it is even slightly overlarge, it compounds the problem of overprojection. In effecting repair, the caudal septal margin abutting the nasal spine should always be inspected and shave reduced to normal proportion before sacrificing any of the nasal spine.
A high anterior septal angle caused by an overdeveloped quadrangular cartilage component may spuriously elevate the tip to an abnormally forward-projecting position, even when associated with otherwise perfectly normal tip anatomy. This condition tends to “tent” the tip away from the face and “tether” the upper lip, producing an indefinite nasolabial angle and, on occasion, creating abnormal exposure of the maxillary gingiva, particularly on smiling. Correction demands a departure from the normal operative sequence of correcting the tip first. The initial surgical steps are planned to lower the cartilaginous profile first, releasing the tip from an abnormal overprojected influence. Further tip refinement measures can then be carried out as desired and indicated by the alar cartilage anatomy.

A less common cause of excess nasal tip projection is an overly long columella associated with excessively elongated lateral crus, which may appear short, tethered, and tense, often exposing excessive gingiva in facial repose as well as animation. Rongeur or osteotome reduction of the overlarge spine and associated caudal quadrangular cartilage and soft tissue is a surgical prerequisite to tip retrodisplacement.

Tip overprojection may occur as a result of an overlarge nasal bony spine, which seemingly imparts an upward thrust of the tip components (which may otherwise be of normal dimensions). Compounding this abnormal appearance is often a coexistent blunting of the nasolabial angle, which may appear full, webbed, and excessively obtuse, with no obvious demarcation between the tip and columella. The upper lip may appear short, tethered, and tense, often exposing excessive gingiva in facial repose as well as animation. Rongeur or osteotome reduction of the overlarge spine and associated caudal quadrangular cartilage and soft tissue is a surgical prerequisite to tip retrodisplacement.

Table 2.2 Anatomical causes of tip overprojection

<table>
<thead>
<tr>
<th>Anatomical Cause</th>
<th>Description</th>
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<tbody>
<tr>
<td>1. Hypertrophy of alar cartilages</td>
<td>Enlarged alar cartilages</td>
</tr>
<tr>
<td>2. Hypertrophy of dorsal septum (anterior septal angle)</td>
<td>Elongated medial crus</td>
</tr>
<tr>
<td>3. Hypertrophy of caudal septum (midseptal and caudal septal angles)</td>
<td>Enlarged alar cartilages</td>
</tr>
<tr>
<td>4. Hypertrophy of nasal spine</td>
<td>Elongated medial crus</td>
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</table>
| 5. Combined components (combinations of above) | Various combinations of the foregoing hypertrophic anatomical problems may contribute to the overprojecting tip problem. In preoperative analysis, each nasal component must be identified and analyzed; only then can a definitive plan for natural correction be conceived. Generally, a combination of weakening of the major tip support mechanisms associated with reduction of the components responsible for the tip overprojection is carried out incrementally and as conservatively as possible to achieve the desired normal final result in a progressive fashion. The various components capable of creating or contributing to overprojection of the nose are shown in Table 2.2.

Iatrogenic overprojection may occur when surgeons intent on profoundly increasing tip projection produce an unnaturally sharp and projected tip configuration (often with associated overrotation of the tip). These misadventures commonly result from overaggressive tip surgery in which portions of the lateral crus are borrowed and rotated medially to increase medial crus projection.

2.8.2 Profile Alignment

Three anatomical nasal components are responsible for the preoperative profile appearance: the nasal bones, the cartilaginous septum, and the alar cartilages. Generally, all three must undergo modification to create a pleasing and natural profile alignment. If the nose is overlarge with a convex profile, reduction of the three segments is required. Less commonly (except in revision rhinoplasty), profile augmentation with autograft materials must be accomplished.

The surgeon visualizes the ultimately intended profile, extending from the nasofrontal angle to the tip-defining point, and then on around the infratip lobule and columella to the nasolabial angle. The extent of reduction of bone, cartilage, and soft tissue always depends on and should be guided by stable tip projection; therefore, positioning the projection of the tip at the outset of the operative procedure is beneficial. The thickness of the investing soft tissues and skin varies at different areas of the profile and from patient to patient, dissimilar portions of cartilage and bone must be removed to ultimately create a straight or slightly concave profile. Strong, high profiles generally suit the patient best in the long term, contributing to a more elegant nose on profile and oblique views and also a more narrow nasal appearance on frontal view (Fig. 2.24). Overreduced profiles result in a washed-out, indefinite, and widened appearance from the front, inadequately separating the eyes and poorly reflecting light.

In planning profile alignment, the two stable reference points are the existing (or planned) nasofrontal angle and the
operative tip projection. Esthetics are generally best served when profile reduction results in a high, straight-line profile in men and with the leading edge of the tip just slightly higher in women. A gentle slope of no more than 2 to 3 mm should exist between the caudal part of the cartilaginous dorsum and the most anteriorly projecting aspect of the nasal tip. Reversal of the usual preoperative tip–supratip relationship is required to achieve this aesthetic ideal. The degree and angulation of the "hump removal" depends on various factors, the most important of which are the size of the various anatomical components involved and the surgeon's confidence in the stability of postoperative tip projection. These must be balanced with the patient's personal preference for profile appearance combined with the surgeon's value judgment of facial aesthetics.

Surgical access to the nasal dorsum is gained through the transcartilaginous, intercartilaginous, or transcolumellar incision, depending on which approach was used during tip refinement. In endonasal approaches, a complete transfixion incision for exposure is unnecessary and may compromise tip support by sacrificing the attachment of the medial crural footplates to the osteocartilaginous junction and plunged through this area, then advanced caudally to and around the anterior septal angle of the caudal septum (Fig. 2.25). In large cartilaginous reductions, a portion of the upper lateral cartilage attachment to the quadrangular cartilage must be removed with the dorsal septum, but leaving these two cartilaginous components attached by the intact underlying mucous perichondrial bridge.

A Rubin osteotome, honed to razor sharpness for each procedure and seated in the opening made by the knife at the osteocartilaginous junction, is advanced cephalically to remove the desired degree of bony hump in continuity with the cartilaginous hump (Fig. 2.26).

Either of two methods of profile alignment is preferred: incremental or en bloc. In the first method, the cartilaginous dorsum is reduced by incrementally shaving away the cartilaginous dorsum until an ideal tip–supratip relationship is achieved followed by sharp osteotome removal of the residual bony hump. If only minimal hump removal is contemplated, the knife is positioned at the ossecartilaginous junction and plunged through this area, then advanced caudally to and around the anterior septal angle of the caudal septum (Fig. 2.25). In large cartilaginous reductions, a portion of the upper lateral cartilage attachment to the quadrangular cartilage must be removed with the dorsal septum, but leaving these two cartilaginous components attached by the intact underlying mucous perichondrial bridge.

Any remaining irregularities are corrected under direct vision with a knife and sharp tungsten carbide rasp. Palpating the skin of the dorsum with the examining finger moistened with hydrogen peroxide often provides clues to unseen irregularities, as does intranasal palpation of the profile with the noncutting edge of the No. 15 blade. Except in large or severely twisted noses, it is unnecessary and potentially harmful to separate the upper lateral cartilages from the septum by cutting through the mucoperichondrial bridge of tissue connecting them at the nasal valve. Redundant soft tissue around the anterior septal angles may be trimmed away to achieve improved tip–supratip definition. The caudal septum, assessed by stretching the partial transfixion incision posteriorly, lies exposed for geometric shortening or repositioning.

In patients in whom the nasofrontal angle is poorly defined or in need of retropositioning, weakening of the bone in the desired area is accomplished before bony hump removal. At the exact site in the midline where nasofrontal angle is desired, a 2-mm osteotome is plunged transcutaneously into the midline of the nasal bone (Fig. 2.27). By angulating this small osteotome laterally on either side, the exact cephalic extent of bony hump removal may be controlled by scoring the bone in a horizontal line at the nasofrontal angle. During the bony hump removal phase of profile alignment, the nasal bones fracture cephalically where this weakening maneuver has established a bony dehiscence, allowing the surgeon some additional control over the ultimate site of...
the nasofrontal angle. Creating a more caudally placed angle provides the illusion of a shorter nose without actually shortening, whereas establishing a more cephalically placed angle creates the appearance of a longer nose.

In patients in whom the nasofrontal angle is overly deep, augmentation with a radix graft composed of residual septal cartilage or remnants of the excised alar cartilages provides a beneficial aesthetic refinement (Fig. 2.28).

Further profile enhancements may be favorably developed with contouring cartilage grafts positioned along the dorsum, supratip area, infratip lobule, columella, and nasolabial angle. In the last site, plumping cartilage grafts are commonly used to open an otherwise acute or unsatisfactory nasolabial angle and thereby contribute to improved profile appearance. The illusion of tip rotation and nasal shortening results from this maneuver, reducing the degree of actual shortening required and preserving a longer and often more elegant nose.

2.8.3 Bony Pyramid Narrowing and Alignment

Significant advances have been made over the past two decades in the reduction of osteotomy trauma in rhinoplasty surgery. Osteotomies, the most traumatic of all nasal surgical maneuvers, are best delayed until the final step in the planned surgical sequence, when vasoconstriction exerts its maximal influence and the nasal splint may be promptly positioned. Profile alignment in typical reduction rhinoplasty inevitably results in an excessive plateau-like width of the nasal dorsum, requiring narrowing of the bony and cartilaginous pyramid to restore a natural and more narrow frontal appearance to the nose. The lateral bony sidewalls (consisting of the nasal bones and maxillary ascending processes) must be completely mobilized by non-greenstick fractures and moved medially (exceptions may exist in older patients with more fragile bones in whom greenstick fractures may be acceptable or even preferable). The upper lateral cartilages are also moved medially because of their stable attachment cephalically to the undersurface of the nasal bones.

To facilitate atraumatic low lateral osteotomy execution, medial–oblique osteotomies angled 15 to 20 degrees laterally from the vertical midline are preferred (Fig. 2.29). By creating an osteotomy dehiscence at the intended cephalic apex of the lateral osteotome, the surgeon exerts added control of the exact site of back fracture in the lateral bony sidewall. A 2- to 3-mm sharp micro-osteotome is positioned intranasally at the cephalic extent of the removal of the bony hump (if no hump removal has been necessary, the site of positioning is at the caudal extent of the nasal bones in the midline). The osteotome is advanced cephalo-obliquely to its intended apex at an angle of 10 to 15 degrees, depending on the shape of the nasal bony sidewall. Little trauma results from medial–oblique osteotomies, which prevent the ever-present possibility of eccentric or asymmetrical surgical fractures from developing when lateral osteotomies alone are performed. In addition, bony narrowing to accomplish desired in-fracture as a consequence of lateral osteotomies combined with medial–oblique osteotomies occurs without strong manual pressure exerted on the nasal bones, a traditional but unnecessary traumatic maneuver.

Trauma may be significantly reduced in lateral osteotomies if 2- or 3-mm micro-osteotomies are used to accomplish a controlled fracture of the bony sidewalls. There is no need for elevation of the peristeme along the pathway of the lateral fractures because the small osteotomies require little space for their cephalic progression. Appropriately, the intact

Fig. 2.27 Transcutaneous osteotomy at the nasion to deepen the nasofrontal angle.

Fig. 2.28 (a,b) Improved profile 6 years following retropositioning of an overprojected tip, enhanced by an onlay radix graft to the overdeep nasofrontal region.
periosteum stabilizes and internally splints the complete fractures, facilitating stable and precise healing. The low curved lateral osteotomy is initiated by pressing the sharp osteotome through the vestibular skin to encounter the margin of the pyriform aperture at or just above the inferior turbinate. This preserves the bony sidewall along the floor of the nose, where narrowing would achieve no favorable aesthetic improvement but might compromise the inferior nasal airway without purpose. The pathway of the osteotome then progresses toward the base of the maxilla, curving next up along the nasal maxillary junction to encounter the previously created small medial–oblique osteotomy (Fig. 2.30). A complete, controlled, and atraumatic fracture of the bony sidewall is thus created, allowing in-fracture without excessive traumatic pressure. Immediate finger pressure is applied bilaterally over the lateral osteotome sites to forestall further extravasation of blood into the soft tissues. In reality, little or no bleeding occurs during micro-osteotomies because the soft tissues embracing the bony sidewalls remain essentially undamaged.

In most rhinoplasty procedures, controlled nasal fractures as the result of osteotomy should cause slight but definite mobility of the bony sidewalls stabilized by the internal and external periosteum, which bridges the nasal fragments on either side of the osteotome pathway. Large, guarded osteotomies destroy this vital periosteal sling, potentially rendering the bony fragments unstable and susceptible to eccentric or asymmetrical healing. In addition, trauma from large osteotomes may produce increased bleeding, edema, and unnecessary ecchymosis. In the elderly, however, greenstick fractures are preferred because of the tendency for the brittle nasal bones to become unstable.

2.8.4 Alar Base Reduction
Appropriate retroprojection of the projecting nose typically requires diminishing the various major and minor tip support mechanisms to retroposition the tip closer to the face. A concomitant reduction of the alar component length and lateral flare (occasioned by tip retropositioning) is usually required to improve nasal balance and harmony. Alar wedge excisions of various geometric designs and dimensions are necessary to balance alar length and position (see Chapter 9). The exact geometry of these excisions is determined by the present and intended shape of the nostril aperture, the degree and attitude of the lateral alar flare, the width and shape of the nostril sill, and the thickness of the alae. It is axiomatic that the surgeon creating alar reduction by excision of alar or nostril floor tissue should always err on the side of conservatism and strive for symmetrical repair, since overaggressive and asymmetrical tissue resection leads to an almost irreversible situation of disharmony and even nostril stenosis.

2.8.5 Dressings and Bandages
Nasal dressings are now applied. No intranasal dressing or packing is necessary in routine rhinoplasty. If septoplasty has been an integral part of the operation, a folded strip of Telfa is placed into each nostril along the floor of the nose to absorb drainage. If septoplasty has been incorporated into the operation, the previously placed transseptal quilting mattress suture (Fig. 2.31) acts as a sole internal nasal splint for the septum, completely obliterating the submucoperichondrial dead spaces and fixing the septal elements in place during healing. The external splint consists of a layer of compressed Gelfoam placed along the dorsum and stabilized in place with flesh-colored micropore tape, extending over and laterally beyond the lateral osteotome sites. A small aluminum and Velcro splint applied firmly over the nasal dorsum completes the operation.

2.9 Key Technical Points
1. Exacting preoperative analysis.
2. Profound hemostasis (anesthesia injected into favorable tissue planes).
3. Dissection in favorable tissue planes.
5. Streamlined, efficient surgical technique.
7. Avoidance of overreduction of nasal skeletal structures.
8. Disciplined, accurate suture repair of all incisions.
2.10 Postoperative Care

Care of the postrhinoplasty patient is directed toward patient comfort, reduction of swelling and edema, patency of the nasal airway, and compression with stabilization of the nose.

Whether the patient is discharged on the afternoon of or the morning after surgery, all intranasal dressings are removed from the nose before the patient leaves. A detailed list of instructions is supplied for the patient or accompanying family member; the important aspects of these dos and don’ts are emphasized. Prevention of trauma to the nose is clearly the most important consideration. Oral decongestant therapy is helpful, but the value of corticosteroids and antibiotics in routine rhinoplasty is conjectural.

The external splint is removed 5 to 7 days after surgery. An important consideration should be gentle removal of the tape and splint by bluntly dissecting the nasal skin from the overlying splint with a dull instrument without disturbing or tenting up the healing skin. Failure to follow this policy may lead to disturbance of the newly forming subcutaneous fibroblastic layer over the nasal dorsum, with additional unwanted scarring and even abrupt hematoma.

2.11 Complications

Early complications following well-performed rhinoplasty by experienced surgeons are uncommon; any of the well-recognized complications of surgery (and anesthesia) are certainly possible. Since most patients undergoing this surgery are ordinarily youthful and healthy, serious complications are rare. The most important (and still all too common) complication is **patient dissatisfaction**. Complications may be categorized as follows.

**Early Postoperative Complications**
- Epistaxis.
- Hematoma.
- Airway obstruction.
- Patient trauma and injury to nose.
- Infection (nasal, sinus, skin).
- Excess swelling.

**Late Postoperative Complications**
- Patient dissatisfaction.
- Recurrence of deformity.
- Development of new deformity or asymmetry.
- Tip support loss with ptosis.
- Airway blockade.
- Contour abnormalities.

2.12 Summary

Contemporary rhinoplasty is characterized by increased preservation of the presenting anatomy, and reorienting and reshaping the abnormal anatomical components. An intimate knowledge of the variant anatomy encountered in patients, supplemented by accurate detailed analytical and diagnostic skills, sets the stage for superior surgical outcomes generated through tried and tested surgical techniques designed to produce superior long-term outcomes.

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### Chapter 3

**Facial Proportions and Aesthetic Ideals in Rhinoplasty**

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3 Facial Proportions and Aesthetic Ideals in Rhinoplasty

Randolph B. Capone and Ira D. Papel

“The qualities of measure and proportion invariably constitute beauty and excellence.”
Plato (427–347 BC)

3.1 Introduction

Beauty is a characteristic with an elusive definition, but its presence is generally unmistakable. When used to describe the human form, it can be thought of as the aggregate of facial or body features that produces a strong sense of pleasure in the beholder. It is a motivator for a great number of human behaviors, including social, reproductive, architectural, and artistic endeavors. Among the earliest historic records are the Gravettian Venuses (Fig. 3.1a–c), Paleolithic stone carvings believed to represent the standard of human beauty at the time of their creation. Art from successive civilizations indicates a continual desire to portray beauty, and also illustrates a dynamic aspect to our perception of it (Figs. 3.2 and 3.3). Over nearly 30,000 years, the human form depicted in art serves as a historical record for the changing standards of beauty.

The observation that beauty ideals are dynamic illustrates a fundamental anthropologic principle: features deemed attractive change with time, but the social, reproductive, and evolutionary advantages they convey do not. With plastic surgery, the human form has become a medium with which to create or enhance beauty, enabling the procurement of these advantages beauty conveys. Of the plastic surgical repertoire, rhinoplasty has assumed a prominent role. This chapter will examine facial proportions, aesthetic ideals, and analysis of nasal deformity in the contemporary era of rhinoplasty.

3.2 Facial Proportions

The initial awareness of beauty as a quality to be appreciated, enhanced, or created cannot be located within the historical record. Self-ornamentation with jewelry has been dated to the genus *Homo neanderthalensis* in the Upper Pleistocene Epoch (c. 32,000 BC), even before the Gravettian Venuses, but it remains unknown whether this adornment was for personal embellishment, superstitious protection, or both. It is an important distinction, as the former implies concern for appearance and acknowledgment that beauty can be enhanced. While possible that our early forebears had developed such awareness, it is documented with certainty that the academic study of beauty and the first principles of facial analysis arose millennia later in Ancient Greece. The word aesthetic derives from Greek *aisthesis*:
3.2 Facial Proportions

Greek philosophers felt that beauty was an essential part of the ideal universe and attempted to define it with the same mathematical principles and geometric relations that were thought to define the laws of nature. Chief among them were Plato and his student Aristotle, whose pursuits concentrated largely on harmony, beauty, and mathematical proportions. Their teachings were manifest in the work of Greek sculptors including Phidias, Polykleitos, and Praxiteles, whose own works embodied the beauty ideal that subsequently influenced the perceptions of subsequent generations.

3.2.1 Standard of Reference

Despite much endeavor, there is no universal algorithm for beauty. It is a spectral characteristic, achieved to varying degrees when an individual’s features combine to produce a visually pleasing result. A set of geometric conditions has been described which, when satisfied, tend to yield an attractive visage. These conditions are the rules of facial proportion. The universal standard of reference for these rules is defined by a plane oriented parallel to the floor connecting the superior aspect of the external auditory canal to the infraorbital rim. This horizontal reference is the Frankfurt plane (Fig. 3.4), so designated at the 1884 World Congress of Anthropology in Frankfurt, Germany. It defines the patient position in which all-facial analysis and photography should occur. Since the landmarks defining the Frankfurt plane are bony landmarks that would technically require radiographic determination, corresponding surface anatomy is used. The tragiom marks the supratragal notch and approximates the superior aspect of the porus acusticus. The point of transition between the skin of the inferior eyelid and the skin of the superior cheek approximates the infraorbital rim. Recognized topographical facial landmarks are illustrated in Fig. 3.5.

3.2.2 Golden Ratio

An interesting rule of historical significance is the Golden Ratio. Utilized most notably by the Greeks, this mathematical phenomenon was probably first recognized by Ancient Egyptians. It is found in ancient art and architecture and yields proportions appealing to the human eye. The Golden Ratio is defined as the ratio of two unequal segments of a line, where the ratio of the longer segment $a$ to the shorter segment $b$ is equal to the ratio of the whole line $a + b$ to the longer segment $a$. Represented by the Greek letter $\phi$, after the Greek sculptor Phidias (500–432 BC), the Golden Ratio is an irrational
number whose numerical value is approximately 1.618. If certain proportions in a human face are Golden, it has been noted that the face is more likely to be beautiful (Fig. 3.6). The ratio of the width of the mouth to the width of the nose, the ratio of the distance between the lateral canthi to the width of the mouth, and the ratio of nasal length to nasal projection are all notable examples. However alluring, it has been shown that the Golden Ratio is not the fundamental relation that governs facial beauty.

### 3.2.3 Facial Angles

The face is a complex set of surfaces with tremendous variability. One goal of facial analysis is to provide a straightforward framework to compare preoperative and postoperative results. The facial angles describe such a framework and are especially important in evaluation of the rhinoplasty patient. The lines connecting the nasion to the glabella and the nasion to the tip-defining point form the nasofrontal angle (NFR). Ideally, this angle is 115 to 130 degrees (Fig. 3.7). The facial plane (FP) is a two-dimensional section including the glabella and the pogonion. The nasofacial angle (NFA) is formed by the angle between the FP and the line tangent to the nasal dorsum (Fig. 3.8). The ideal NFA is 36 to 38 degrees. The nasomental angle is formed by the same nasal dorsum tangent and the line connecting the tip-defining point to the pogonion (Fig. 3.9). Its aesthetic range is 120 to 132 degrees. The nasolabial angle (NLA) is defined by the line from the subnasale to the superior vermillion border and the columellar tangent from the subnasale (Fig. 3.10). It generally is thought to lie between 90 and 100 degrees in males and 100 and 110 degrees in females. More recently, the columellar facial angle (CFA) has been proposed as a better metric to quantitate tip rotation because of its independence from the maxilla and upper lip position. The CFA is the angle between the line connecting the anterior columella to the subnasale and a perpendicular dropped from the Frankfurt horizontal. Its typical value is slightly greater than the typical NLA, but it still falls generally within the same aesthetic range. The FP and the line connecting the cervical point to the menton define the mentocervical angle. It ideally lies between 80 and 95 degrees (Fig. 3.11).

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*Fig. 3.6* Nasal analysis before and after rhinoplasty. If the nasal length (nasion to tip) is $\phi$ times nasal projection, the nasofacial angle falls within the aesthetic ideal 36 to 38 degrees.

*Fig. 3.7* Nasofrontal angle.

*Fig. 3.8* Nasofacial angle.

*Fig. 3.9* Nasomental angle.
Use of the five facial angles collectively was outlined by Powell and Humphries and it is known as the Aesthetic Triangle. Incorporation of the individual facial geometric relations into this single construct allows for simultaneous evaluation of facial proportions and emphasizes the interdependence of the facial elements (Fig. 3.12).

### 3.2.4 The Face

The Ancient Greeks taught that the ideal human head is one-eighth the height of the body and twice the length of the neck, as measured from the sternal notch to the chin and from the chin to the vertex. The face can be divided into equal horizontal thirds and vertical fifths (Fig. 3.13) on frontal inspection. The superior third is the forehead from the trichion to the glabella. The middle third, or midface, extends from the glabella to the subnasale, and the inferior third, or lower face, is the region from the subnasale to the menton. These divisions are less applicable if the trichion is high, as in male pattern baldness, or unusually low. In such instances, division of the lower two-thirds of the face liberates facial analysis from the inconsistencies of the hairline (Fig. 3.14). The superior landmark becomes the nasion, the middle point the subnasale, and the lowest the menton. Using this method, the upper division (n-sn) is ideally three-fourths the height of the lower division (sn-me).

Inspection of the face divided vertically reveals the width of one eye should equal the intercanthal distance, and this width should equal one-fifth the facial width. Lines dropped from the outer canthi should approximate the width of the neck. The lateral fifths of the face extend from the lateral canthi to the furthest lateral points of the pinnae (Fig. 3.13).

### Forehead

Division of the face into its constituent anatomical features yields the aesthetic units. The forehead is the prominent region of the face located superior to the brows and inferior to the hairline. It ideally comprises the upper third of the face and has a gentle sloping convexity. The glabella is the most anterior point of the forehead and is located at the nose–forehead transition, just superior to where the paired nasal bones about the frontal bone. As with nearly all facial units, the forehead and nose maintain an aesthetic interdependence. Differing contours of the forehead influence nasal appearance by either accentuating the nasal profile, as in the case of a retrusive forehead, or diminishing it with a protrusive forehead.

### Brow

Part of the frontal bone, the brow is the supraorbital bony prominence that separates the upper and middle thirds of the face and serves as the face’s prime horizontal buttress. Just anterior to the frontal sinuses, the brow serves to protect the orbits and cranial vault from the forces of blunt trauma. It is accentuated by the presence of eyebrows, two parame- dian strips of hair-bearing skin. The eyebrows ideally begin 1 cm above the medial canthus, directly superior to the lateral aspect of the ala nasi. In females, the eyebrows should have an arched shape peaking above the supraorbital rim at the level of the lateral limbus. Males should have less of an arched shape with the eyebrows located at the level of the supraorbital rim. The eyebrow terminus should occur laterally at an oblique line that passes from the lateral aspect of the ala nasi through the lateral canthus.

### Eyes

With variegated color and size, the eyes are perhaps the most individualized part of the human face. They are frequently described as the seat of human expression; however, the intrinsic muscles of the pupil and iris are under involuntary autonomic control, incapable of commanding outward affect. A survey of facial expressions quickly reveals that the muscles surrounding the eyes, in fact, convey emotion. Aging is also conveyed by the appearance of the skin and soft tissues surrounding the eyes. Blepharochalasis and blepharoptosis project a worn look, often incongruous with the actual state of the patient’s physical or mental health.

The distance from the medial to lateral canthus is the width of the eye. In the well-proportioned face, this distance equals one-fifth the facial width as well as the intercanthal distance. This distance should equal one-half the interpupillary distance,
which ideally is the distance from the nasion to the vermilion border of the upper lip.

The structure of the ideal orbit has the supraorbital rim projecting anterior to the infraorbital rim with the head in the Frankfurt plane. The lateral canthus is located slightly superior to the medial canthus, and its attachment is posterior to the medial canthal attachment. Eyelids cover the eyes, and their edges of opposition are lined by a row of protective eyelashes. The distance from the lash line to the supratarsal crease in the upper eyelid varies from 7 to 15 mm, depending mostly on skin thickness and ethnicity. The upper eyelid normally covers a portion of the iris (but not the pupil), whereas the lower eyelid ideally abuts the inferior iris. The presence of canthal dystopia or ectropion has significant effects on the perception of beauty.

Cheeks
The cheeks are rounded soft-tissue regions lateral to the nose and inferolateral to the eyes. Their projection toward the FP is caused by the malar eminence and its overlying musculature, fat, and skin. The degree of projection is an important characteristic as it is increasingly valued in our appreciation of both youth and beauty. Aging causes a loss of malar projection from bony and fat atrophy, as well as muscle and skin atrophy, frequently resulting in a sunken midfacial appearance. Concomitant migration of the remaining cheek soft tissue toward the mandible and the appearance of jowling occur as supportive architecture is lost. Malnutrition also can cause a hollowed appearance of the cheeks. Maxillary hypoplasia or trauma can cause flattened, retrusive cheeks whose projection is located posterior to the FP.

Ears
The ears are a pair of ovoid cartilaginous appendages on the sides of the face with a complex yet highly consistent geometry. Part of the hearing organ, the auricles collect and localize sound with resonance in the vicinity of 4,500 Hz. To do this effectively, the ear prescribes an auriculocephalic angle of roughly 15 to 20 degrees with respect to the scalp. Ear length should equal the distance between the orbital rim and the root of the helix. Ear width is roughly 55% of its length. The dome of the ear should be located at the level of the lateral eyebrow margin. The long axis of the ear should parallel the nasal dorsum, or 20 to 25 degrees off vertical. Significant deviations from any of these auricular parameters can quickly be viewed as deformity.

Lips
The lips are the only vertically paired aesthetic unit of the face. Fullness of the lips with a pronounced vermilion border and strong philtrum define a provocative and youthful appearance. Thin lips and overly plump lips tend to be viewed as less attractive. Ideal lip width occurs when the oral commissures are located at a vertical dropped from the medial limbus. Upper lip length is normally 19 to 22 mm from subnasale to the inferior margin of the visible vermilion, and typically both the interlabial gap and amount of incisor show range from 1 to 5 mm in relaxed position. A long upper lip reduces the interlabial gap and eliminates incisor show, and is associated with advancing age. The position of the nasal tip influences our perception of upper lip length, as a ptotic tip will convey a short upper lip, and a rotated tip can make the upper lip look longer. Lip posture can be referred to as procumbent or recumbent and is largely dependent on the underlying dentition. In profile, lip posture can be analyzed by drawing a line from the subnasale to the pogonion. The distance along a perpendicular from this line to the most anterior point of each lip defines its position. The upper lip should rest 3.5 mm anterior to this line and the lower lip 2.2 mm. Another characteristic unique to lips is their color. Vermilion is a naturally occurring brilliant red pigment made of mercury sulfide. Lips marked by pallor or cyanosis are decidedly less attractive.
**Chin**

The chin is an often-overlooked facial aesthetic unit, and failure to properly evaluate the nasal–chin relationship is a common error in assessment of the rhinoplasty patient. Chin deformities occur in multiple varieties, including chin asymmetry or any combination of horizontal microgenia or macrogenia and vertical microgenia or macrogenia. The ideal chin is proportionate in both the vertical and horizontal dimensions and should fit harmoniously with the remaining units of the face. A properly positioned pogonion with a labiomialental sulcus of 3 to 4 mm in depth is important for maintaining proper balance of the lower facial third with the remainder of the face. Several methods of chin analysis have been devised, but none is universally accepted. Most of these address horizontal chin projection but disregard the vertical dimension. The importance of distinguishing between horizontal and vertical microgenia is important since treatments, including mentoplasty or genioplasty, can differ. Retrogнатhia and prognathia are terms that describe the position of the mandible, not the mentum. In these instances, orthognathic surgery, not mentoplasty, may be required depending on the patient’s occlusion.

**Dentition**

Although not traditionally considered an aesthetic unit, dentition is of significant aesthetic importance. Oral health as manifested by the appearance of one’s teeth and gums is an outward sign of overall health and influences our perception of beauty. Dentition therefore should be examined as any other facial aesthetic unit. Dental deformities include various eruption asymmetries and imperfections, increased gingival show, and occlusal disturbances originally described by Angle. Any of these will hinder the appearance of the rhinoplasty patient.

**Nose**

Of all the facial aesthetic units, the nose plays perhaps the most critical role in proportion and facial harmony. A single, unpaired anatomical unit occupying the central face, it serves to balance the facial thirds and fifths as well as those structures surrounding it. Seemingly small changes to the nose can affect dramatic changes in facial appearance and the other aesthetic units. The nose has been divided into subunits, which helps with surgical planning and description of both cosmetic and reconstructive procedures. These units include the dorsum, sidewalls, tip, alae, columella, and soft-tissue triangles. The subunits’ borders define natural demarcations and shadows that allow for the placement of incisions or scars, less easily seen on inspection. The nose projects anteriorly from the face, and its forward thrust is ideally orthogonal to the FP and parallel to the midsagittal plane. Quantifying nasal projection is a critical component of rhinoplastic evaluation and several methods have evolved. The simplest method, described by Simons, defines projection as the distance from the subnasale to the tip-defining point and postulates that it should equal the length of the upper lip. Baum described a method based upon a line connecting the vertices of the nasolabial and NFRs, and a second perpendicular line to the nasal tip. He suggests ideal projection occurs when the former line has a 2:1 ratio to the latter. Powell modified the Baum method and using the same parameters suggested the ideal ratio of nasal height to projection was 2.8:1. Alternatively, Goode’s method measures the distance from the alar crease to the tip-defining point as projection, and relates this to nasal length. Using this method, ideal projection is between 0.55 and 0.6 of the nasal length (Fig. 3.15). He found that when the ratio of projection to height to length was 3:4:5, the NFA is an ideal 36 degrees. Crumley found the most consistent method of determining tip projection compared the lengths of a line from the nasion to the vermilion border to a perpendicular line to the nasal tip. Ideal projection occurs when projection is 0.283 of the midfacial height.

On frontal view, the nasal dorsum should follow a gentle curve from the medial brow to the ipsilateral tip-defining point. Any irregularities in this contour will quickly be noted as different from the contralateral side, thereby contributing to asymmetry and an unsightly appearance. Nasal width varies along its length, and is widest at the base and narrowest at the nasion. Perpendicular lines dropped from the medial canthi describe the ideal nasal base width, and the width at the nasion is approximately the height of the palpebral fissure. In addition, frontal view should reveal the paired tip-defining points and a subtle gull-wing appearance of the alae blending with the columella. On lateral view, the dorsum should be straight and lie at or slightly posterior to a line connecting the nasion to the tip. The nasal ala-to-tip lobule ratio should be nearly equal. The ideal tip has a double break where the infratip lobule descends into the columella, and there should be 2 to 3mm of columellar show (Fig. 3.17).

The view from the nasal base should resemble an isosceles triangle with the infratip lobule comprising the top one-third and the columella/nostrils the bottom two-thirds of this triangle. The nostrils should be symmetric, pear-shaped, and with a long-axis orientation at 45 degrees with respect to the columella. Each nostril should approximate the width of the columella. The columella is narrowest at its midportion.
3.3 Analysis of Patients with Nasal Deformity

“A great nose indicates a great man—genial, courteous, intellectual, virile, courageous.”

Edmond Rostand (1868–1918)

As the keystone feature of the human visage, slight changes in the nose can produce dramatic improvements in facial harmony and the perception of the surrounding aesthetic units. Critical to the success of any rhinoplasty, therefore, is a thorough preoperative examination with facial analysis, performed by a surgeon with precise understanding of nasal anatomy and a clear vision of the desired outcome.

3.3.1 General Considerations

Like all medical encounters, the initial assessment begins with the history. The plastic surgeon should elicit the chief concern and motives that bring the patient to the office, as well as expectations for the visit. Past medical history should identify high-risk patients with disorders that could confound anesthesia (e.g., family history of malignant hyperthermia) or nasal surgery (e.g., coagulopathy). Medications, allergies, and abusive social habits should also be elicited. By the conclusion of the interview, the surgeon should also be able to comment on the patient’s personality traits (e.g., narcissistic) and if they harbor pathologically unrealistic expectations (e.g., body dysmorphic disorder).

While the patient–doctor relationship is being established, initial assessment of the facial skin, subcutaneous tissue, and underlying facial skeleton should occur. Rhinoplasty has been described as the redraping of skin and soft tissue over a modified bony–cartilaginous framework, and making note of these features is critical. Skin thickness, Fitzpatrick’s sun-reactive skin type, the presence of nevi, rhytids, scars, or other lesions should be noted. Facial fat distribution, particularly regions of excess or atrophy, should also be noted. The surgeon should assess facial musculature for atrophy (e.g., temporal wasting in anorexia nervosa) or other abnormalities (e.g., depressor septi nasi, type I). Additionally, the surgeon should document bone structure and the presence of any craniofacial deformities or asymmetries (e.g., hemifacial microsomia). All of these features can be determined during the interview simply by observation of the patient’s static and dynamic visage.

The next step in examination of the patient with nasal deformity should be anterior rhinoscopy and nasal endoscopy to fully determine the status of the nasal valves, septum, and turbinates. Palpation is also critical to determine the degree of tip support, underlying dorsal irregularities, and skin thickness. A comprehensive head and neck exam should always accompany a directed evaluation of facial proportions and aesthetic units, as should standard seven-view nasal photodocumentation. Additional photos during facial animation or deep inspiration can be taken at the discretion of the surgeon.
3.3.2 Nasal Deformity

The nose is a multipurpose organ whose functions include respiration, olfaction, immune defense, and cosmesis. Although nasal pathology can result in defects involving any of these functions, septorhinoplasty usually only corrects anatomical deformities causing any combination of nasal airway obstruction, hyposmia, and patients unhappy with their appearance. The box below lists many of the deformities the rhinoplasty surgeon should be familiar with.

Nasal Deformities
- Nasal trauma (laceration, fracture, septal hematoma, traumatic rhinectomy).
- Dorsal hump.
- Twisted nose.
- Asymmetric nares.
- Nare stenosis.
- Overprojection.
- Underprojection.
- Over-rotation.
- Under-rotation.
- Wide nasal base.
- Excessive columellar show (hanging columella).
- Columellar insufficiency (hiding columella).
- Septal deviation.
- Saddle nose.
- Septal perforation.
- Paradoxical lower lateral cartilages (concave domes, double dome break).
- Tension nose.
- Iatrogenic imperfections, e.g., bossae, alar retraction, polly beak, retroussé supratip, open roof, bony pyramid irregularity, inverted V deformity, visible grafts, alar scars.
- Mohs defects.
- Rhinophyma.
- Rhinoscleroma
- Dermoids, encephaloceles, gliomas.
- Vascular hemangioma.
- Craniofacial nasal anomalies (cleft lip nasal deformity, hemifacial microsomia, proboscis lateralis, arhinia).

3.4 Ethnic Variations

It is important that contemporary rhinoplasty surgeons understand characteristic features of ethnic noses as well as the motivations and desires of those patients belonging to various ethnic groups. Surgeons should always strive to respect ethnic nasal variation and realize that patients typically wish to refine their nasal appearance, yet preserve their ethnic features. Ethnic rhinoplasty should maintain facial harmony among the aesthetic units to achieve a natural, unoperated look.

3.4.1 The Caucasian Nose

The Caucasian, or leptorrhine ("tall and thin"), nose is associated with patients of Euro-American descent. For purposes of this discussion, it provides the basis for nasal analysis and comparison. The typical features of the ideal leptorrhine nose have been outlined above (Fig. 3.19).

3.4.2 The African Nose

The platyrrhine nose ("broad and flat") is associated with individuals of African descent. It is typically characterized by a lower radix, a short concave dorsum, an illusory widened intercanthal distance, a bulbous and underprojected tip, flared alae with round nostrils, and very thick skin. The NFR is frequently as large as 130 to 140 degrees. Hyperpigmentation, hypopigmentation, hypertrophic scarring, or keloids can occur as a result of rhinoplasty in these patients. As a result of racial intermingling, subclassifications of the platyrrhine nose have been described. In contrast to the African type, the Afro-Caucasian nose typically has a longer and more prominent dorsum, an occasional dorsal hump, modest alar flaring, and a more refined tip. A prominent dorsum, a bulbous tip, wide alae, and an occasional dorsal hump describe the Afro-Indian nose (Fig. 3.20).

3.4.3 The Asian Nose

The mesorrhine nose ("intermediate") is characterized as sharing features common to both the Caucasian nose and the African nose. Examination of an Asian patient (Fig. 3.21) will typically
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reveal a nose with moderately thick skin, a low broad dorsum, short nasal bones, a rounded underprojected and under-rotated tip, columellar recession, and somewhat rounded nostrils. A short columella is typical, causing the major axis of the nostrils to be oriented at a more acute angle with respect to the FP when viewed from the base.

Ethnic variation is challenging to rhinoplastic surgeons. Improving form and function while preserving ethnicity requires thorough preoperative analysis, an understanding of the patient’s desires, and facility with the various techniques of rhinoplasty. As races continue to intermingle, strict classifications will be less meaningful, and as with any rhinoplastic procedure, the surgery must be individualized.

3.5 Summary

Modern facial analysis is vital to the success of any facial plastic surgery procedure, especially rhinoplasty. It serves to define qualitative standards for facial beauty while providing a framework within which to quantify operative results, thereby providing a basis for comparison between surgeons, and improving the consistency of nasal surgery results. Modern facial analysis also aids communication between the patient and surgeon, which leads to more realistic expectations. With meticulous examination, the surgeon who encounters the patient with nasal deformity or a displeasing anatomical variation will be able to offer the correct rhinoplasty procedure, and enhance the complex interplay of outward appearance and perception called Beauty.

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Chapter 4
Physiology and Pathophysiology of Nasal Breathing

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4 Physiology and Pathophysiology of Nasal Breathing

Gunter Mlynář

4.1 Introduction

The nose is not only the gateway between the airways and the environment. One of the main roles of the nose is its respiratory function. During inspiration, the air has to be tempered, humidified, and cleaned. These are important prerequisites for an undisturbed exchange of gas in the lungs. Alveolar air temperature should be of body temperature and 100% humid. Additionally, the air must be cleaned for protection of the lower airways.

The respiratory performance of the nose is an enormous commitment, as, during breathing at rest, 6 liters of air per minute flow at a local speed of up to 20 m/s through it and have to be conditioned and cleaned in the meantime.

In order to fulfill this task, the nose has a specific shape. Sufficient knowledge of the interaction between shape and function of the nose helps the rhinosurgeon to not only improve air passage of the nose, but also to maintain and reconstruct structures that are important for the respiratory function of the nose. On the basis of experiments on fluid dynamics, we shall now review the structure of the nose from a functional point of view.

4.2 Preconditions for the Respiratory Function of the Nose

The most important precondition for nasal function is an undisturbed passage. High airway resistance consequently leads to mouth breathing and thus bypasses the nose. The reason for high airway resistance is a loss of energy due to friction of the streaming molecules with the wall and between each other. In a narrow section, molecules stream closer together and to the wall, thereby increasing the friction.

Another reason for high resistance is friction caused by turbulence. Turbulent streaming particles flow not only forward but also sideways. Therefore, the molecules frequently hit each other and the wall, releasing kinetic energy. For that reason, strong turbulence provokes high airway resistance.

The resulting high nasal airway resistance can be caused by narrowing as well as a pathologically increased degree of turbulence. Both factors induce airway resistance to varying degrees.

The second precondition for the respiratory function is contact between the streaming particles and the mucosa. In laminar flow (i.e., all particles streaming parallel to the wall), only the particles flowing nearest to the wall have contact with the mucosa. More central streaming particles are neither warmed, nor humidified, nor cleaned. Not until sideways movement arises, as in turbulent flow, do particles close to the wall leave their place and give way to particles moving from the center toward the mucosa. On the other hand, high degrees of turbulence extract too much thermal energy and moisture of the mucosa, causing sicca symptoms. The nasal airflow, therefore, should neither be overly laminar nor intensely turbulent. A well-balanced turbulent behavior as a warrant for sufficient air–mucosa contact is a prerequisite for the respiratory function of the nose.

The mucous surface of the nose is especially enlarged by the turbinates, which provide effective exchange of thermal energy and humidity.

Surgical consequence: As little mucosa reduction as possible!

4.3 The Correlation between Shape and Function of the Nose

In order to understand the correlation between shape and function of the nose, Bachmann assigned common structural elements with familiar effects on flow, known from the physics of fluid dynamics, to discrete sections of the nose. Bachmann's synopsis can be enhanced by additional experiments on fluid dynamics.

The actual functional area of the nose is its center, which contains the largest mucosal surface. There the nose serves its respiratory function.

4.3.1 Inspiration

The nasal vestibule, the internal ostium (isthmus nasi), and the anterior cavum are upstream of the functional area. This part is termed the inflow area. The posterior cavum, including the choana and the nasopharynx, is located downstream of the functional area. This part is named the outflow area.

The nasal vestibule has the shape of a bend with a decrease in cross-sectional area like a nozzle. The first effect is to direct the lateral and bottom-up approach of air toward the functional area of the nose. Therefore, the correct bearing of the vestibule to the cavum is of great importance. This is the case if the angle between nose and lip is 90 to 100 degrees. A downward rotated vestibule (nasolabial angle < 90 degrees) directs inspired air toward the upper cavum. The lower turbinate has no contact with the air and thus is not available for respiratory function. An oversized nasolabial angle (> 100 degrees) guides the air through the lower nose while not ventilating the upper parts.

Surgical consequence: Preservation and reconstruction of a nasolabial angle between 90 and 100 degrees should be aspired to in functional rhinosurgery.

The constriction of the cross-sectional area from the outer to the inner ostium of the nose produces a nozzle effect in the vestibule. The degree of turbulence is reduced in a nozzle. This effect is important because the inspired air has to pass through the narrowest part of the nose, the ostium internum, next. In this narrow sector, turbulent flow leads to very high flow resistance. Fig. 4.3 shows the flow in inspiratory direction in a nose model. Due to the forward movement of
4.3 The Correlation between Shape and Function of the Nose

Air molecules parallel to the wall during laminar flow, a sharp border between the flowing color particles and the flowing medium can be seen. During turbulence, additional sideward movements lead to a mixing of color and medium and thereby yield a diffuse coloring. In Fig. 4.3, laminar flow in the narrowest part of the nose, the isthmus, is shown. In the region of turbinates, flow is turbulent.

Expansion of the ostium internum reduces or suspends the nozzle effect of the vestibulum. Consequently, the flow entering the cavum nasi is turbulent (“ballooning phenomenon”).

Surgical consequence: In surgery of the inner ostium, the expansion must not be made too great.

In the inspiratory direction, the internal ostium is of a concave shape (Fig. 4.1). As is known from fluid dynamics, the effect of a concave opening on flow course is the same as a concave lens acting on beams of light. Thus, a diverging of the flow lines within the functional area is achieved, which has a positive impact on flow distribution all over the cross-sectional area of the functional area. Fig. 4.4 shows the flow in a nose model without a vestibule. The diverging flow lines after perfusion of the inner ostium can be seen.

Surgical consequence: Due to the fact that at its upper area the inner nostril is made of the caudal margin of the triangular cartilage, it is important to perform surgical procedures in the area of the inner nostril in such a way that when making resections at the caudal margin of the triangular cartilage the concave shape of the ostium internum is maintained.

As a result of the expansion of the cross-sectional area from the ostium internum to the beginning of the concha region, the anterior cavum is shaped and acts like a diffuser (Fig. 4.1a). In a diffuser, the local flow velocity is reduced and turbulence arises. Both effects are important preconditions for sufficient mucous membrane contact with the flowing particles in the functional area. The slowing of the flow as well as the arising turbulence is dependent on the dimensions of cross-sectional area expansion in the diffuser. With growing expansion of the
4 Physiology and Pathophysiology of Nasal Breathing

There is a mechanism in the nose to regulate such effects. The expansion of the cross-sectional area alters with the swelling of the septum’s erectile body and the erectile head of the inferior turbinate (Fig. 4.5). When swelling is at a minimum (right side in Fig. 4.5), the expansion of the cross section is great. This corresponds to the working phases in the nasal cycle. The flowing air becomes increasingly turbulent, while the local flow velocity decreases. These are the preconditions for the warming up, moistening, and cleaning of the air. During the resting phase, the increase of the cross-sectional area diminishes due to the swelling of the septum’s erectile body and the head of the inferior turbinate (left side in Fig. 4.5). The predominantly laminar flow allows the mucous membrane to accumulate thermal energy and moisture.

As a result of external nose deformations and septal deviations, the diffuser is often deformed. In such cases, the diffuser cannot fulfill its turbulence-regulating function.

Surgical consequence: One task of functional rhinosurgery is the reconstruction and/or maintenance of the diffuser. The important structures regulating turbulences (head of the inferior turbinate, septum’s erectile body) must be preserved.

In terms of flow physics, the region of turbinates is a slitlike space that increases mucous membrane surface area. A slitlike space is important in order to keep the flow path of particles close to the mucous membrane. An important precondition for the flow distribution over the entire cross-sectional area is a constant slitlike space. If partial or total resection of the turbinates in a small section is done, then a wider space is created. The flow yields to the narrow portion of the cavum and instead flows exclusively through this wide portion following the principle of least resistance (compare Figs. 4.3 and 4.6). This induces a decrease in the respiratory function of the nose because in the area of the healthy respiratory mucous membrane there is hardly any flow left.

Surgical consequence: In functional rhinosurgery, large volumes should not be formed but instead a continuous slitlike space ought to be created.

Due to a decrease in cross-sectional area, the posterior cavum works like a nozzle (Fig. 4.1a). A similar function exists in the vestibule, and turbulence is thus decreased here also. This is important as now the air must perfuse the bronchial and alveolar pathway with the least flow resistance possible.

In the inspiratory direction, the choana is a convex opening (Fig. 4.1a). A convex opening leads to converging streamlines. This constricts the air streamline and prepares it for the following more narrow breathing pathway.

The nasopharynx is an almost rectangular bend (Fig. 4.1a) which redirects the air flowing out of the nose to the lower breathing pathways.

4.3.2 Expiration

In order to keep enough thermal energy and moisture available for the respiratory function of the nose, it is important that the nasal mucous membrane regains energy and moisture from the airflow, which is 37°C and has 100% humidity on expiration. Lacking this process of regaining energy, the nose could keep up its respiratory function only over a short time period. Accordingly, sufficient contact between airstream and mucous membrane is necessary during expiration as well.

In the expiratory direction (Fig. 4.1b), the posterior portion of the nose with the choana and the nasopharynx becomes the inflow area. It is equipped with similarly shaped functional elements as the inflow area in the inspiratory direction.

Due to its bending effect, the nasopharynx redirects the air emerging from the lower airways to the functional area.
A nozzle effect is not required, as there is no constriction in the expiratory inflow area.

In this direction, the choana is a concave opening, which promotes diverging of streamlines.

With its increase in cross-sectional area, the posterior cavum has a diffuser effect and therefore leads to a slowdown in flow velocity and increases turbulence. With this, mucous membrane contact of the flowing particles is ensured.

The actual exchange of energy and moisture takes place in the area of turbinate, but now in the direction from the air to the mucous membrane.

For the expiration flow, the anterior cavum becomes a nozzle, which leads to a decrease in turbulence. With it, laminar flow can perfuse the narrowest opening, the ostium internum.

In expiration direction, the internal ostium is of concave shape, which promotes the converging of streamlines. This reduces the broad airstream to the smaller size of the cross-sectional area of the vestibule.

The bending effect of the vestibule causes the air to be blown out of the nose in a narrow beam in a lateral downward direction during expiration.

4.3.3 General Remarks

The shape of the nose is almost completely symmetrical (Fig. 4.1). Upstream of the functional area is an inflow area consisting of a bend, a concave opening, and a diffuser in each flow direction. Downstream is an outflow area with a nozzle, a convex opening, and a bend. As a result, during expiration the inspiratory inflow area can function as an outflow area, just as the inspiratory outflow area can take over the function of the expiratory inflow area.

The inspiratory inflow area is situated within the external nose. Thus, deformities of the external nose may lead to an altered shape of the inspiratory inflow area. Thereby an increased resistance, an impaired distribution of the airstream over the cross-sectional area of the cavum, and pathological turbulence behavior result. In many cases, this explains the frequent impairment of respiratory function due to deformities of the external nose, although the functional region is configured normally.

Surgical consequence: In external nose surgery, the inspiratory inflow area is to be preserved and/or reconstructed.

4.4 The Problem of Septal Deviation with Compensatory Turbinate Hyperplasia in Terms of Flow Dynamics

Nature is able to fit turbinates into almost any form of septal deviation that exists. This causes hyperplastic turbinates on the concave side of the deviation and hypoplastic turbinates on the convex side of the deviation. Given these properties, nature attempts to establish a continuous slitlike space with a constant width (Fig. 4.7). In functional terms, the hindrance of the hypoplastic turbinate within the nasal cycle is apparent. This side of the nose cannot take over a working phase. Thus, there is no resting phase for the opposite side.

The flow dynamics become evident in flow experiments done using functional models in the shape of small boxes (Fig. 4.8). One notes that on the side constricted by deviation, the streamlines are being considerably pushed together (Fig. 4.8a). This explains the increased resistance due to increased friction on the deviated side.

Many patients complain about obstruction on the opposite side as well. The flow experiment shows that on the opposite side there is no diverging of streamlines. The part of the area being perfused is relatively narrow. Laterally from here, a so-called dead-water area arises, in which a slow creep-flow turns retrograde. In this area, particles carried with the flow are deposited at the lateral wall. This causes crust formation in significantly expanded areas in the nose.

The simulation of a compensatory turbinate hyperplasia demonstrates that the turbinate fills out the dead-water area and thereby eliminates the problem (Fig. 4.8b). Computed tomography (CT) scans prove that, due to asymmetries, a straight septum would lead to two very unequal nasal sides (Fig. 4.9). The turbinates on the deviated side would have to be considerably augmented in size to meet its compensatory purpose. In the opposite side, the turbinate would have to be significantly reduced in size. Here, a decrease and increase in swelling within the nasal cycle would not be sufficiently possible.

Surgical consequence: The objective of septum surgery should not be a straight septum. The septum should rather be located in the middle of the space between the two lateral nasal walls. (Only in the area of the external nose should the septum be straight as the basis for a straight external nose.)

4.5 Inspiratory Nasal Wing Collapse

So far, we have considered the nasal breathing tube as being rigid. In fact, the soft parts in a healthy nasal cavum are not deformed by the airflow during breathing. The alterations in pressure during the breathing process are too small. The polyposis mucous membrane can change its position as a result of the airflow and thereby produce a change in resistance.

The vestibulum must not be seen as a rigid structure. The lateral wall of the anterior part of the inflow area is elastically deformable.

Elastic plasticity means a change in form by an external force, which returns to the original state when the external force decreases. With inspiratory nasal wing collapse, such
forces may be explained by means of Bernoulli’s law: the sum of static and dynamic pressure is constant. That means that with increasing dynamic pressure due to increasing flow velocity the static pressure decreases. Thus, the pressure in the vestibulum during deep inspiration is so low that the atmospheric pressure outside the nose predominates. If the negative static pressure within the vestibulum exceeds the elastic forces of the mobile lateral wall of the vestibule, the nasal wing collapses.

The nasal wing collapse during high inspiratory breathing velocity is physiologically important because it prevents very high perfusion of the nose and with this it protects the mucous membrane. At a decreased level of elastic forces on the lateral wall of the vestibule as well as increased local flow velocity in the vestibule, due to constriction of the stream course, an inspiratory nasal wing collapse at physiological breathing velocities can be observed.

Surgical consequence: In such cases, either the elasticity of the lateral wall of the vestibulum must be increased or the local flow velocity must be decreased by expanding the flow course.

4.6 Rhinological Functional Diagnostics

Unfortunately, insufficient scientific attention has been devoted to rhinological functional diagnostics so far. No method is yet clinically and routinely available for measuring the warming up, moistening, and cleaning of the inspired air in the nose.

The rhinomanometric assessment of the nasal airflow is an important condition for objectifying nasal obstructions. This method does not allow any essential assessment beyond these measurements. Therefore, this technique has not been used much to indicate and plan procedures in functional rhinosurgery. Additionally, since the introduction of the method, only little has been done to develop it further.

There follows an overview of currently available methods of diagnostics for the respiratory functions of the nose.

4.6.1 Rhinomanometry

In rhinomanometry, the nasal airflow as well as the transnasal loss of pressure during respiration is measured. The transnasal loss of pressure results from the difference between prenasal and postnasal pressure. Two methods for measuring the postnasal pressure are known. During “anterior rhinomanometry” (Fig. 4.10a), the pressure tube is fixed hermetically at the ostium externum on the side opposite to the side of the nose which has to be measured. Thus, this side of the nose acts as a lengthening of the pressure tube up to the choana. It is not possible to do anterior rhinomanometry while the used side of the nose is being totally obstructed or while the patient has a septal perforation. In such cases, we recommend the use of “posterior rhinomanometry.” In this instance, the pressure tube is located in the mouth, tightly enclosed by the lips. The cavum oris serves as the backward elongation of the pressure tube so that the oropharyngeal pressure can be measured. This shows that posterior rhinomanometry measures not only the transnasal loss of pressure, but also the epipharyngeal pressure loss. As the position of the soft palate has a significant influence on flow resistance in this area, the method for evaluating the nasal obstruction is often likely to produce false results.

The Standardization Committee on Objective Assessment of the Nasal Airway recommends registering the measured data in a coordinate system (Fig. 4.10b). Pressure data are assigned to the x-axis and flow data to the y-axis. Pressure–flow curves for the right and left side of the nose are shown as mirror images, with the inspiration of the right side of the nose running in the upper right quadrant, and the inspiration of the left side of the nose running in the lower right quadrant. Accordingly, the expiration phases for the right side of the nose are in the lower left quadrant, while phases for the left side of the nose are in the upper left quadrant.

An inspiratory flow of 150 Pa is used for the evaluation. Most of the available rhinomanometers nowadays offer the option of computer-aided data processing. They calculate the corresponding flow and resistance data at pressure levels of 75, 150, and 300 Pa for each side of the nose as well as for both sides together.
dimensions of nasal airflow, the rhinomanometric measurements may result in a false assessment.

4.6.2 Rhinoresistometry

Rhinoresistometry is a further development of the rhinomanometry.\(^7\) In rhinoresistometry, the transnasal pressure difference and the breathing airflow are measured simultaneously to the breathing, just as in rhinomanometry. Based on the measured data, functionally important parameters for the nose are calculated on the basis of physical flow laws.

On the arithmetic chart (Fig. 4.11), the right side of the nose is marked in red and the left side of the nose blue. The lightly colored curves were previously measured and the brightly colored curves were measured after decongestion of the mucous membrane. The flow resistance, dependent on flow velocity (Fig. 4.11, upper curves), is graphically depicted in the inspiratory as well as the expiratory directions for the dimensions of a nasal obstruction to be seen at once. The continuously lined curves correspond to the extent of the patient’s breathing during measurement. The dotted lines are extrapolated by the computer and represent the breathing curve during very deep breathing and a rigid lateral wall of the vestibule.

As a result of inspiratory suction of the lateral vestibulum wall, the measured resistance curve may take a steeper course during inspiration than that shown by the extrapolated curve (Fig. 4.16). The higher the loss of elasticity of the lateral vestibulum wall, the smaller the flow velocity at which the collapse begins to occur. The dimensions of the collapse can be seen by the dimensions of the diverging of the measured and the extrapolated curve.

The turbulence behavior of the nasal breathing airstream that is dependent on the flow is graphically depicted in Fig. 4.11 (lower curves). Only at very low breathing velocity is the flow completely laminar. The area of turbulent flow (blue-green bar) can be reached only at very high breathing velocities. This means that the normal nose works within the so-called transitional area between laminar and turbulent flow.

The hydraulic diameter is calculated as a measurement for the width of the nose. The friction coefficient \(\lambda\) must be determined as a characteristic value for the configuration of the wall relating to its effect on the triggering of turbulences.

In this way, causes for an increased resistance, a constriction, and/or an increased development of turbulences can be differentiated and assessed.

In a nonpathological nose (Fig. 4.11), after the mucous membrane swells down (corresponding to the working phase of the nasal cycle), the nasal breathing resistance at a flow of 250 cm\(^3\)/s is < 0.3 sPa/cm\(^3\), the hydraulic diameter > 5 mm, and \(\lambda > 0.025\). Purely turbulent flow may already occur at a flow < 750 cm\(^3\)/s.

In the state of physiological swaying during the resting phase of the nasal cycle, the resistance becomes higher than 0.3 sPa/cm\(^3\), the hydraulic diameter < 5 mm, and \(\lambda > 0.025\). Turbulent flow can be seen only at a flow velocity > 750 cm\(^3\)/s.

4.6.3 Acoustic Rhinometry

The method for calculating the cross sections of the breathing path taken from pulmonology has now also become established in rhinological diagnostics (Fig. 4.12). It is based on the physical phenomenon of sound reflection. A sound wave is conducted into the nose and is reflected there. Amplitude and frequency change depending on the cross-sectional area of the nose. This method allows measurement of the cross-sectional

![Fig. 4.12](Acoustic rhinometry. Block diagram (a) and measurement curves (b) of a nonpathological nose.)
area in the nose (x-axis) in relation to its distance to the ostium externum (y-axis) in 0.3-cm increments.

The curves for the right (red) and the left (blue) side of the nose are shown as mirror images.

With wide access from the paranasal sinus into the cavum nasi, the measurement data of the cross-sectional area are falsely calculated as being too large. Therefore, it is recommended that only the first 4 to 5 cm of the curve for assessment of the nasal cavum is used. Characteristic cross-sectional areas are to be found in the area of physiological constriction (minimal cross-sectional areas = MCA). They are described as MCA 1 (ostium internum) and MCA 2 (constriction by the head of the inferior turbinate and the erectile body of the septum). The volume of the nasal cavum can be calculated between any two borders.

The expanded cross-sectional area after MCA 1 explains the shape of the diffuser and consequently the arising turbulences (Fig. 4.12b). Additionally, the length of the diffuser is a classification number for the dimensions of arising turbulences.

Therefore, this method can be applied to making a diagnosis concerning the dimension and location of a narrowness. The curve course after the MCA 1 up to the highest point after MCA 2 explains the shape of the diffuser and thereby the arising of turbulences (Fig. 4.12b).

### 4.6.4 Long-Term Rhinoflowmetry

The rhinological measurement methods named thus far explain the state of the nose only at the moment of measuring. However, many patients complain at specific instances during the day or in certain situations. The aforementioned methods do not allow a complete assessment of the nasal cycle. This is the motivation for developing long-term rhinoflowmetry. This technique has made it possible to measure the airflow in each side of the nose separately over a period of time of up to 3 days using a portable, battery-powered device (Fig. 4.13). The method allows new insights into the functioning of the nose and disturbances of the nasal cycle and therefore leads to innovative indications for rhinosurgery.

### 4.6.5 Combination of Rhinoresistometry, Acoustic Rhinometry, and Long-Term Rhinoflowmetry

The combination of these three measuring methods allows a differentiated assessment of functional disturbances of the nose. This will be shown by means of diagnostics of nasal obstructions. In every case, a rhinoresistometrical and acoustic rhinometrical measurement has to be performed. Long-term rhinoflowmetry is only used if there are appropriate complaints.

Nasal obstructions may be caused by constriction or by disturbed turbulence behavior. Rigid (septum deviation) and changeable (nasal wing collapse, changes in swelling) are distinguished. Fig. 4.14 schematically shows how these three measuring methods contribute to the assessment of the dimensions and to the cause of a nasal obstruction.

Firstly, the dimensions of the obstruction are rated by the rhinoresistometrically determined resistance. Secondly, the causes for the obstruction are proportionately depicted. The differentiation of the causes is an essential basis for planning surgical procedures.

A permanent nasal obstruction results in increased airway resistance even after decongestion. Acoustic rhinometry locates the position and extent of the narrowness. However, the extent of the narrowness does not necessarily correlate with the extent of flow resistance. The shape of the constriction additionally influences the extent in loss of energy. Different shapes of the same cross-sectional area can cause different flow resistance. Circular areas imply lower resistance than slitlike spaces. Therefore, the rhinoresistometrical measured hydraulic diameter should be considered for flow dynamic assessment of narrowness. Pathological turbulence is assessed by a high reading of the friction coefficient and by interpreting the curve describing the flow-dependent transition of laminar to turbulent flow. The acoustic rhinometry curve between MCA 1 and the highest point after MCA 2 serves to identify the cause of pathological turbulence onset.
Case 1: Permanent Narrowness and Arising Turbulences

Fig. 4.15 shows the findings of a patient complaining of permanent nasal obstruction in the right side of the nose.

The resistance curves of the right side show a high-grade obstruction before decongestion and a middle-grade obstruction after decongestion. In acoustic rhinometry, a constriction of the anterior cavum is seen as the cause for this. Even after decongestion, the hydraulic diameter is still seen as the cause for considerable energy dissipation due to constriction. The \( \lambda \) value is high before decongestion and flow within the nose is pathologically turbulent. That in a swollen state the diffuser does not begin at MCA 1 is seen as the cause for this in acoustic rhinometry. The diffuser is deformed; its entry is shifted to the inside.

Apparently, the left side of the nose was in the working phase at the time the measurement was made. Therefore, only little change in resistance, change of the hydraulic diameter, change in the friction coefficient, and change in the turbulence behavior after decreased swelling were observed.

Long-term rhinoflowmetry shows that the left side of the nose has to take over the working phase almost continuously as, due to its constriction, the right side is not in the position to do so. Only during rest and at night, due to the reduced need for air, can the left side swell a little and have a resting phase.

These findings result in the indication for septum plastic with elimination of the narrowing and reconstruction of the right diffuser.

Case 2: Temporary Stenosis due to Inspiratory Nose Wing Collapse and Permanent Stenosis of the Isthmus with the Arising of Pathological Turbulences in a Tension Nose with Septum Deviation to the Right

Fig. 4.16 shows the findings of a patient with nasal obstruction on both sides.

The rhinorestometric resistance curves indicate an obstruction in the two nasal sides. A characteristic separation of the measured resistance curve from the extrapolated resistance curve is evident. The inspiratory curves run visibly steeper. Before decongestion, the nose wing starts collapsing, at 120 cm\(^3\)/s, a flow equivalent to breathing at rest. The distinct separation between the extrapolated curve and the measured curve indicates a considerable collapse, especially before decongestion. The nose wings are being pushed slightly outward during expiration.

Even after decongestion, the resistance on both sides does not normalize. Causes for this are additional permanent stenoses on both sides, which can be located in the isthmus area with acoustic rhinometry on the right side rather than on the left side. The low hydraulic diameter proves that the stenoses are flow-dynamically relevant.

Additionally, fully developed turbulences at low flow and high values for the friction coefficient \( \lambda \) can be found on the right side rather than on the left side. The curves for the acoustic rhinometry show that the cause is that the diffuser has a very small opening.

During long-term rhinoflowmetry, an impaired nasal cycle can be found. Due to the obstruction on both sides, both sides are in working phase throughout the day. Only during rest at night is the left side in a resting phase, taking over a working phase in the morning time.

The findings show that a septoplasty itself would not be sufficient to eliminate the deviation because it could lead to neither a sufficient decrease in resistance nor a normalization of the strong turbulences nor a solution to the problem of the inspiratory collapse. An additional widening of the nasal valve region is necessary. In this manner, the stenosis of the isthmus and thus the resistance must be sufficiently reduced. Simultaneously, the problem of pathological turbulences would be solved because, with a slightly widened entrance, the diffuser would be able to take on normal shape. Also, the problem of the inspiratory nose wing collapse could be considerably improved by this, as, due to a greater cross-sectional area within the isthmus, the local flow velocity is reduced and thereby the suction effect decreased according to Bernoulli’s law.

4.7 Concluding Remarks

Precise preoperative diagnostics are part of a surgeon’s responsibilities. This includes not only the detailed exploration of the patient’s medical history and a subtle clinical examination but also the use of all possible functional diagnostic means. For ear surgeons, this has been a self-evident duty for a long time. Poor rhinomanometric data lead to the fact that, for rhinosurgery, preoperative functional diagnostics has been optional up to now. We, as rhinosurgeons, should change such regrettable circumstances as soon as possible, because new techniques in rhinological functional diagnostics lead to new indications as well as to a new functional view. Consequently, in some cases, new surgical procedures are the result.
Fig. 4.15 Rhinoresistometric (a), acoustic rhinometric (b), and long-term rhinoflowmetry results (c) of a patient with septal deviation to the right side. Rhinoresistometric (a), acoustic rhinometric (b), and long-term rhinoflowmetry results (c) of a patient with septal deviation to the right side.
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Preoperative Management

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Hans Behrbohm

5.1 Evaluation of the Face and External Nose

5.1.1 The First Impression

Analyzing the features of the patient’s face and nose starts with something that is difficult to put into words: the first impression. Although the first impression takes but a moment, it conveys a variety of information on the rhinoplasty candidate, which the physician perceives mostly intuitively but interprets very quickly. This includes personality, warmth or antipathy, and the patient’s “manner,” which may be amiable or reserved.

The physician notices how the patient presents his/her desire for corrective surgery. It may be expressed clearly and emphatically, or the patient may be less communicative and withdrawn, and the physician has to “probe” to learn whether the patient is introverted or extroverted.

The first impression will inevitably include the patient’s body posture (erect or slumped) and body language, handshake (firm or limp), the patient’s voice (loud or soft, hoarse, clear, or dysphonic), and language (expression, grammar, vocabulary, humor).

Socrates once said to one of his pupils, “Speak so that I can see you.” Besides the general inspection and clinical examination, the physician should glean as much information about the candidate as possible. He should listen and observe attentively, because the key question—“Should I operate on this patient?”—can be answered in some cases before the facial anatomy is even analyzed.

By talking with the patient, the physician can tell whether he/she has an optimistic or pessimistic nature. It is important for the physician to learn what is motivating the patient to seek nasal surgery and find out what expectations the rhinoplasty candidate has for the proposed operation.

Openness and willingness to cooperate with the treatment are expressed by firm eye contact, while fleeting looks and lack of concentration in the interview signify communication problems.

Besides all of this general information, the physician also looks for evidence of underlying diseases that may or may not relate to the reason for the consultation. Signs of illness are often reflected in the patient’s face. These may include cyanosis of the lips due to ischemic heart disease, jaundice due to liver disease, xanthelasmas due to hypercholesterolemia, the flushed complexion of the hypertensive, and palsies, spasms, or tics of the facial musculature.

5.1.2 The Preoperative Consultation

The consultation, or initial interview, should take place in a quiet, stress-free environment with no time pressure. A full waiting room creates a pressured atmosphere that hampers open communication between the physician and the patient. The best way to do this in a busy practice is to schedule patients for a special appointment before and after rhinoplasties. A surgical office visit in a general hospital otolaryngology department may lead the patient to conclude that “The doctor has other problems; he obviously doesn’t have time for my nose.”

In our experience, it is best not to have a telephone in the consultation room, because being interrupted by phone calls during the consultation would serve to reinforce that fear. A computer in the office can also be problematical. By remaining riveted to a data screen, the physician may miss the chance to glean as much information on the patient as possible.

The basis for doctor–patient communication in aesthetic surgery must be openness and honesty on both sides. Surgeons must know what the patient really wants. They must honestly convey to the patient what can be done and what is unrealistic or impossible. This is the best way to correct false expectations and preconceptions and avoid failures. The basis for trust is that the physician has time for the patient. He should explain the proposed operation in nontechnical language and address any problems that may arise. If a trusting relationship can be established between the physician and the patient before the surgery, it may be easier for the patient to tolerate any touch-ups that may be needed after the primary operation. The patient must go into the operation with the knowledge that the surgeon has addressed his/her problem with time and dedication and will do everything necessary to carry out the jointly discussed plan of operation.

5.1.3 Conducting the Consultation

The interview should be conducted with open-ended questions, which invite patients to express themselves more fully. Examples of open-ended questions are as follows: “What brings you to me?” and “What bothers you about your nose?” Yes-or-no questions make it more difficult to sustain a dialogue. By conducting the interview in this way and listening attentively, the surgeon will learn why the patient desires a rhinoplasty. At the same time, he will gain an impression of the motivation and psychological makeup of the patient.

The goal of every rhinoplasty is a satisfied patient. A successful operation will do much toward achieving this goal. A good result, however, does not necessarily mean a happy patient because the surgeon and patient may evaluate the result differently. Ultimately, the preoperative consultation is designed to answer two questions:

- Can I solve the problem of the nose?
- Will the operation solve the patient’s problem?

While the first question can usually be answered after a detailed interview and examination, the second question is more difficult. It requires psychological insights and sensitivity on the part of the surgeon. Unlike a psychologist, he has only a short time in which to make his judgment. He need not make a precise psychological evaluation of the candidate, but he must be able to answer the two key questions as a basis for deciding, “Should I operate on this patient, or are his/her complaints ‘inoperable’?”

The physician should explain the effects of the desired changes on the face. A simple hump removal can result in a long nasal dorsum and may even worsen the overall appearance and “personality” of the face. Some patients require extra help in understanding the complex effects of rhinoplasty. Many patients also lack appreciation for small morphological variants such as a bifid tip, minor tip asymmetries, or an indistinct nasolabial angle. A smaller percentage has a very finely developed sense for all of the details in their own face.

Starting from these very diverse wishes and demands for the outcome of an aesthetic rhinoplasty, the physician can counsel and work with the patient to plan an individualized or even perfect result. Ultimately, however, the plan of operation is determined by the patient’s own desires.
5.2 Analysis, Clinical Geometry

During the preoperative consultation, the surgeon has already had a good opportunity to inspect the patient’s facial features. The nose should be assessed in relation to the overall appearance. A long nose is appropriate for a tall stature. A high nasal dorsum emphasizes individual characteristics more than miniaturized forms. The nose is evaluated within the context of the facial features from the front, from the sides, and from below.

5.2.1 Proportions and Symmetry

Polykleitus (ca. 450–410 BC) was the most important Greek sculptor next to Phidias. Many of his bronze statues, preserved as marble copies, are major works from the Classical era of Greek art. Doryphoros is perhaps his best-known statue and embodies the principles set forth in his treatise The Canon (preserved only in fragments) on the proportions of the human body. The Canon begins with a detailed system defining the ideal relative proportions of the various parts of the body, known in classical antiquity as symmetry. This symmetry of the human body became a guiding principle for painting, sculpture, and architecture, and a hallmark of aesthetics. The classical teachings on body proportions received renewed attention during the Renaissance. The monk Fra Piacoli di Borgo worked extensively with proportions and aesthetics in medieval Venice. In 1509, he published a book in which he announced the discovery of the golden section: If we are asked to divide a line asymmetrically, we can do so at any number of points, but there is one section that is most aesthetically pleasing to the eye. This section divides the line into two segments called a and b. The ratio of the shorter segment to the longer segment (a/b) is the same as the ratio of the longer segment to the whole line: $a/b = b/a + b$

This principle is reflected in the branches of trees, for example, and in the ratio of the longitudinal and transverse axes of an egg. It demonstrates that proportionality and aesthetics follow geometric laws. The practice of dividing the face into equal thirds was introduced by Leonardo da Vinci (1452–1519) and was later modified by Powell and Humphreys. Defining ideal proportions for the human face is an important aid for the facial surgeon (see Chapter 3). A much more common goal in any given case, however, is to restore or preserve the harmony of the face with due regard for personal as well as ethnic characteristics.

As Naumann put it, “The face must be viewed as a unit, and the nose should have a good structural relationship to the overall balance of the face.”

5.2.2 The Face from the Front

There is a certain hierarchy of facial features. The personality radiates chiefly from the eyes. The nose should be “subordinate” to the eyes, i.e., it should form a smoothly curved line from the medial point of the eyebrow to the tip-defining point. This line should highlight the eyes and not distract from them.

The nasal tip is defined by a roughly equilateral rhomboid. It is formed by the tip-defining points and by the supratip and infratip areas. The nasal contour of the alae should form a gently curved line (“gull in flight”) (Fig. 5.1).

Every face has two slightly different halves and shows some degree of physiological asymmetry. This becomes clear when photos of the right and left halves of the same face are assembled in a montage. Marked facial asymmetry, facial scoliosis, or unilateral hypoplasia may affect individual or multiple portions of the midface, for example, or may affect the maxilla or mandible.

Midfacial asymmetries often result in dysgnathia and are associated with axial deformity of the nose. The correction of combined facial deformities and asymmetries requires particularly careful planning (Fig. 5.2a, b).

Axial deformities of the nose may affect the bony or cartilaginous part of the nose or may affect both parts simultaneously, producing an S-shaped twisted nose. Two different eyebrow-tip lines create the impression of a pseudo-deviated nose. Saddle nose is marked by typical deformities that adversely affect facial symmetry. The dorsum and supratip areas are broad and depressed. The nasal base is broadened. The columella is low, and the nostrils have a transverse oval shape.

5.2.3 Skin and Connective-Tissue Type

The skin and connective-tissue type has an important bearing on the anticipated tissue reaction and wound healing, making it an important factor in preoperative planning. Thick, seborrheic skin is advantageous in that it can cover small irregularities in the osseocartilaginous supporting structures of the nose. Onlay grafts, tip grafts, and shield grafts can be used. Suture techniques are also available.

Thick skin is more susceptible to wound healing problems than thin skin. An example is the postoperative pollybeak deformity, which is most common in patients with a thick skin type. Thick skin and thin cartilage are an unfavorable combination for rhinoplasty.
Thin skin is advantageous for wound healing. Graft techniques should not be used on the nasal tip. In the cases where a bifid tip is present due to prominent alar cartilages, perichondrium or small fascial flaps can be placed beneath the skin of the nasal tip.

The ideal skin type for septorhinoplasty is moderately thick skin.

The connective-tissue type is indicated by skin wrinkling, tissue tension, and elasticity and mobility of the skin. A less firm connective-tissue type is often associated with an increased tendency for hematoma formation. The skin is loose and mobile.

Any cutaneous scars from previous operations (e.g., goiter surgery) should be inspected to gain information on individual scar formation and possible keloid formation. Preexisting scars would be a reason to avoid an open approach.

5.2.4 Profile Analysis

Numerous geometric points and lines can be used to assess the facial profile. They are used to evaluate the relative positions or displacements of specific structures, depending on the points that are emphasized in a given specialty. For example, an orthognathic surgeon will use completely different reference planes than an otorhinolaryngologist or facial surgeon. We are always dealing with one profile, however, and therefore we shall focus on several interdisciplinary landmarks.

The nasion corresponds to the nasofrontal suture and should be located at the approximate level of the supratarsal fold. The paranasion is located at the deepest point of the sella nasi. The nasofrontal angle between the glabella, nasal root, and nasal tip should be between 125 and 135 degrees.

The nasal dorsum consists of the bony dorsum and cartilaginous dorsum. The rhinion is located at the junction of the nasal bones and upper lateral cartilages. This region is called the keystone area because of its key importance in stabilizing the nasal dorsum. It marks the cranial point of attachment of the cartilaginous nose at the center of the face.

The nasal dorsum should be high and straight, or perhaps slightly convex, with the rhinion as its point of maximum prominence. From there the nasal profile descends straight to the pronasale in males, while in females it should form a slight depression at the level of the anterior septal angle, called the supratip break. From the pronasale, or tip-defining point, the profile curves smoothly to the subnasale, interrupted by a small break at the level of the columna–lobule junction. Thus, a double break exists in the nasal profile between the pronasale and subnasale. The size of the nasolabial angle determines the cranial or caudal position of the nasal tip and thus the length of the nose from the paranasion to the pronasale. The nasofrontal angle should be $>95$ degrees.

The length of the upper lip should equal the length of the columella. Ideally, the columella describes a slightly convex line several millimeters below the slightly concave alar margin.

We use our own modification of the “facial circle” described by Baud to define the three most important points for general profile analysis and evaluate their relationship in the facial profile. Instead of the external auditory canal, we use the upper border of the tragus (corresponding to the porion) for measuring the radius to the pronasale. This point corresponds to the reference point for the Frankfurt horizontal (canthomeatal plane) in the Krönlein system (Fig. 5.3).

The line from the porion to the pronasale forms the radius of a circular arc about the face. Ideally, the trichion and pogonion are located on the periphery of that circle.

Overprojection of the nose is characterized by a posterior displacement of the chin (soft-tissue pogonion) and the frontal hairline. A relative retrusion of the chin or forehead can also be recognized. This type of analysis provides guidelines for the best way to achieve a harmonious profile.

The goal of a septorhinoplasty is not just to alter the nose but to match the nose to the chin and forehead in a way that produces an aesthetically pleasing profile. The aesthetic impact of a sloping forehead or receding chin, for example, can be improved by nasal surgery alone (Fig. 5.4a–f).

The nasal dorsum consists of a bony and cartilaginous portion. The relationship of these two components influences preoperative planning. Long nasal bones will adequately stabilize the nose. Short nasal bones are an indication for spreader grafts. These grafts will prevent stenosis of the nasal valve and pinching of the alae (Fig. 5.5a–d).
5.2.5 Dentition and Profile

Besides nasal shape, the profile is critically influenced by the position of the maxilla and mandible and by the typical deviations that occur with gnathic anomalies.

Schwarz has identified nine different profile types in orthognathic surgery. The following reference lines are used:
- Canthomeatal plane (Frankfurt horizontal).
- Nasal perpendicular of Dreyfuss.
- Orbital perpendicular of Simon.

Three typical variants are distinguished based on the relationship of the subnasale to the nasal perpendicular:
- **Average face**: subnasale is anterior to a vertical line through the nasion.
- **Protruded face**: subnasale is posterior to a vertical line through the nasion.
- With a straight or retruded face, the pogonion shows the same degree of displacement as the subnasale. Anterior or posterior sloping facial types are distinguished according to the displacement of the soft-tissue pogonion.

Two facial reference lines are used in distinguishing between straight, convex, or concave profile types:
- A straight line from the margin of the upper lip.
- A straight line from the margin of the upper lip to the soft-tissue pogonion.

**Straight profile**: Both reference lines form a straight line.
**Convex profile**: Relative retroposition of the pogonion.
**Concave profile**: Relative anteroposition of the pogonion (Fig. 5.6).

The classic Angle classification of sagittal malocclusions was introduced in 1907. A concave soft-tissue profile signifies an Angle class II malocclusion, while a concave profile indicates an Angle class III relationship (Fig. 5.7).

There are several reasons why these concepts from orthognathic surgery are important for the rhinosurgeon:

- With regard to the timing of profile-correcting rhinoplasty in adolescence, it should be borne in mind that jaw growth continues until about 16 years of age in girls and until about 18 years in boys.
- Gnathic abnormalities lead to typical profile changes:
  - **Mandibular prognathism**: protrusion of the pogonion.
  - **Retrognathia**: retraction of the pogonion.
  - **Maxillary prognathism**: protrusion of the subnasale and upper lip.
- The position of the nasal tip is influenced by the position of the jaws and midface. For example, an anterior sloping face can cause overprojection of the tip.

5.2.6 The Nasal Base

The shape of the nasal base is determined by the height ratio of the lobule to the columella, which is normally 1:3. The nares have an elliptical shape. The shape of the tip can be accurately assessed by viewing the nose from below. A boxy tip has a squared-off shape. A long-pressed interdomal ligament does not exist. The width of the nasal tip is determined by the shape of the alar cartilages, the skin, and the interdomal fat. The critical anatomical structures that define nasal shape are the nasal septum and the lateral and medial crura and footplates of the alar cartilages.

**Bossing** occurs when the transition from the dome area to the lateral alar cartilages is not harmonious. Often it takes several years for bossing to develop after rhinoplasty.

5.3 Palpation

5.3.1 Manual Examination Techniques

Visual inspection of the nose is followed by palpation. Before palpating the nose, the examiner should inform the patient that it is the only way to obtain essential information on the resilience and tension of critical nasal structures. Cartilages can be reoriented and preserved only if the surgeon has been able to assess the cartilage tension by palpation. **Visual examination and finger palpation are equally important in the nasal evaluation** (Tardy).

Palpation

1. Palpate the junction of the cartilage and bony nasal dorsum in the keystone area. Rough spots, appositional bone growth following previous surgery, or an open roof can be appreciated in this way.
2a. Assess the **tip recoil** by pressing the nasal tip toward the anterior nasal spine with the index finger.
2b. Palpate over the anterior septal angle to assess the height and tension of the septal cartilage, especially in relation to the tip recoil.
3. The relationship of the bony nasal pyramid to the cartilaginous pyramid will affect surgical planning. Evaluate this by palpating over the nasal flank. Short nasal bones may be an indication for spreader grafts.
4. Palpate the structures of the nasal inlet to assess the shape and tension of the anterior septum, the size of the nasal spine, and the prominences of the premaxilla.
5. Bimanual palpation of the alar cartilage yields information on the shape, size, and consistency of the cartilage (Fig. 5.8).
Fig. 5.4  (a) Woman with a predominantly bony nasal deviation, a bony dorsal hump, and an overprojected nasal tip. The infratip triangle is too long. (b) Appearance 3 years after axial correction of the nose and shortening of the infratip triangle. (c) Preoperative profile: overprojection, bony hump, effaced nasolabial angle, relative retraction of the chin, and vestibular skin show. (d) Postoperative profile: the nasal dorsum has been lowered, and a supratip break has been created. The tip has been rotated upward and the upper lip lengthened. There is also a relative advancement of the chin. (e,f) Preoperative and postoperative three-quarter profile views.
5.4 Nasal Endoscopy

Nasal endoscopy should be a part of every nasal examination.

*Evaluation of the mucosa:* In allergic rhinitis, for example, hyperemia and increased vascular permeability develop in the mucosa as a result of local immune responses. The mucosa appears livid and edematous. In patients with a strong allergic disposition, inflammatory redness of the mucosa is the dominant finding. The initially watery discharge becomes purulent when bacterial superinfection occurs. Polyps that develop in the ethmoid and project into the nose assume a pale, glassy appearance when the polyp stalk becomes constricted, occluding its blood supply.

Nasal endoscopy has an important application in recurrent and chronic inflammatory diseases of the paranasal sinuses. The endoscope can reveal the often subtle signs of a mucosal disease (e.g., rheological mucous changes, purulent tracks, edema) or anatomical variants in the shape of the lateral nasal wall (e.g., concha bullosa or paradoxical curvature of the middle turbinate).
Acute inflammatory exacerbations and especially suppurative diseases of the nasal mucosa are a contraindication for functional–aesthetic rhinoplasty.

Endoscopy is also the best modality for evaluating noninflammatory diseases of the nose. Some lesions, such as polyps and papillomas, display pathognomonic features. There are other cases where polyps in the nose are not a pathogenetic entity but are a symptom of various diseases that can be identified by closer inspection.

Other diseases cannot be accurately classified by endoscopic examination (e.g., angiomatous tumors). When the 0-degree scope (4 mm) is used, endoscopy is useful for site-of-lesion determination in patients with obstructed nasal breathing.

Spurs, ridges, and displaced posttraumatic fragments, especially in the area of the posterior septum and perpendicular plate, can be evaluated and corrected as needed through an endoscopic approach (see Chapter 1).

The nasal valve can be assessed with a speculum without spreading open the vestibule. Inspiratory alar collapse can also be evaluated in this way.

5.4.1 Principles of Nasal Endoscopy

The patient can be examined in the sitting, semirecumbent, or supine position without premedication. If the mucosa is markedly swollen or vulnerable, it should be decongested and anesthetized with a tetracaine–epinephrine spray (10 drops epinephrine per 2 mL solution). In these cases, we recommend inserting soft, moist pledgets (same solution) for 5 minutes prior to the examination. The pledgets should be placed under endoscopic control to avoid mucosal injuries. Even the smallest hemorrhages caused by careless endoscopic manipulation or instrumentation in the nose will
seriously hamper the examination. The pledgets should be moist, not soggy, to avoid unnecessary wetting of the mucosa in the epipharynx, oropharynx, and hypopharynx.

- The basic instrument for nasal endoscopy is the 4-mm 0-degree wide-angle endoscope (Karl Storz, Tuttlingen, Germany).
- Endoscopy should always begin with the largest scope possible (4 mm), as this will provide maximum orientation within the nasal cavity.
- The primary use of a thinner scope (2.7 or 1 mm) is appropriate only as a second-line option, in small children, or if there is much deviation of the anterior septum.
- The endoscopic examination should always follow a systematic routine that covers specified regions.

### 5.4.2 Technique

The examination begins with the 0-degree endoscope. The nasal vestibule and nasal valve area are inspected first (Fig. 5.9).

By placing the endoscope at the entrance to the nasal cavity in front of the valve area, the examiner can assess the functional status of this region and check for collapse of the alar cartilages during normal and forced inspiration in a physiological position, without deforming the nares.

Next, the endoscope is advanced into the nasal cavity, and the nasal floor is inspected. The scope can be carefully advanced between the septum and the body of the inferior turbinate toward the choana. In the presence of a vomerine ridge, which usually runs upward and backward, the posterior part of the nose is reached by advancing the scope strictly along the nasal floor.

The inferior turbinate has the same sagittal orientation as the pharyngeal orifice of the eustachian tube. The examiner inspects the nasopharynx, assessing the motility of the soft palate and the function of the pharyngeal tubal orifice. In children, the size and condition of the adenoids are evaluated.

Next, the endoscope is partially withdrawn and redirected to inspect the middle turbinate. Endoscopy of this “window to the ethmoid” is of key importance for pathogenetic reasons. The middle turbinate is also the principal landmark for endoscopic operations (Fig. 5.10).
It's medial lamina extends up to the cribriform plate and bears respiratory epithelium. In this way, the upper part of the middle turbinate separates the cribriform plate from the ethmoid labyrinth located in the ethmoid part of the frontal bone.

The middle meatus of the nasal cavity is located between the middle and inferior turbinates. The middle turbinate is part of the ethmoid bone and also bounds the middle meatus medially. It inserts anterolateral to the cribriform plate and farther back on the lamina papyracea. Its basal lamina separates the mucus streams from the anterior and posterior ethmoids. The middle turbinate may be pneumatized by ethmoid cells and may reach considerable size (concha bullosa), leading to recurrent bouts of sinusitis.

The surface of the lateral nasal wall can be visualized by carefully displacing the middle turbinate medially with a narrow elevator. Anterior to the ethmoid bulla, which varies in size depending on its pneumatization, is the contour of the uncinate process. The inferior semilunar hiatus runs between the free posterior edge of the uncinate process and the anterior surface of the ethmoid bulla. It connects with the ethmoid infundibulum, which has a sagittal orientation. Continuous with the semilunar hiatus superiorly is the frontal recess.

The 30-degree endoscope is useful for locating the nasal orifice of the nasolacrimal duct. This orifice, usually elliptical in shape, can be found several millimeters behind the anterior attachment of the inferior turbinate.

The 30-degree scope is also useful for inspecting the sphenoethmoid recess, where the sphenoid sinus ostium is located. It is visualized by advancing the scope toward the choana, with the view angled upward, while keeping the barrel of the scope strictly on the nasal floor.

The entire nasopharynx can be inspected from below with the 45- or 70-degree scope. The olfactory groove, for example, can be examined to differentiate between a sensory or respiratory cause of hyposmia or anosmia.

5.5 Tips on Photographing Parts of the Body

Dieter Jaeger and Hans Behrmann

Gone are the days when silver halides still worked their magic and the photographer had to choose among portrait, daylight, or artificial-light films.

Today, in the age of digital photography, there is no trick to changing film sensitivity and color temperature. These parameters can be set very easily on the camera. When automatic film sensitivity and white balance are activated, the camera will automatically adjust to individual requirements and lighting conditions in any mode. Still, it is important to check settings and adhere to some basic rules. For example, the shutter speed should be 1/100 of a second or faster to eliminate motion blurring. And a small aperture such as f/8 or f/11 will extend the depth of field. This is particularly important for close-up and macro work.

One of the advantages of digital single-lens reflex (DSLR) cameras is that they let you look through the viewfinder to compose the image without troublesome reflections on the display. Most cameras are available with zoom lenses and focal lengths from 18 to 70 mm. It is best to use fast zooms (1:2.8) that are suitable for macro work, as this gives the camera a universal range of applications.

“Macro photography” means shooting at a magnification ratio of at least 1:1. All major equipment makers (Olympus, Canon, etc.) offer a line of macro products. A Nikon SLR digital camera combined with a zoom lens of traditional design (AF NIKKOR 35–70 mm, 1:2.8 D) is a good problem solver.

The lens is from a set originally made for use with the 35-mm Nikon analog (film) camera and is compatible with the Nikon digital camera. The advantage of using analog lenses on digital cameras is that they increase the focal lengths by half. Thus, a 70-mm zoom setting will provide a focal length of 100 mm, which is ideal for portraits. This example also applies to other SLR camera models.

At this point, we shall consider some key aspects of portrait photography.

To ensure that facial features are not distorted (nose too long, ears set back, etc.), portraits (face, head) should be photographed with a focal length of at least 70 mm. Portraits and photos of the chest have a very natural, distortion-free look when taken at a distance of approximately 1.5 to 2.5 m from the subject. Here is a good rule of thumb: two things that should not appear noticeably different in size should be separated by no more than 1/10 of the shooting distance. (Nose-to-ear distance approximately 15 cm × 10 = 1.5 m minimum distance from subject.)

The best background is a neutral surface of white, black, or any color that is free of distracting elements. Use of a wide-open aperture (e.g., f/2.8) will create a short depth of field that cleanly separates the model (portrait, person, subject) from the background.

The depiction of human beings by “artistry” is a very ambitious and challenging task. The pictorial representation of human individuality and physical form calls for a creative, sensitive approach. These considerations also apply to photography of the human face.

This is where lighting comes into play. In principle, portraits can be taken in any light. But if we want to create before-and-after documentation that is precise in every detail and has good overall aesthetic quality, we must recognize the key importance of light and the lighting setup.

Continuous lighting with light panels and studio sets is perfect for portrait lighting. A modern phototherapy lamp is another practical option. Emitting at a color temperature of approximately 4,800 to 5,400 K, these sources produce a soft light that is similar to daylight but without troublesome heat. They provide natural color tones and skin color without retouching.

5.5.1 Standard Photographic Views

The goal of photodocumentation is the lifelike, distortion-free portrayal of nasal findings in standard photographic views taken before and after rhinoplasty. The following facial views are recommended (a minimal setting includes the frontal, profile, and basal views):

- Frontal view (Fig. 5.11a).
- Basal view (projecting the nasal tip between the eyebrows) (Fig. 5.11b).
- Right and left profile (Fig. 5.11c, d).
- Right and left half-profile (Fig. 5.11e, f).
- Lateral smiling view (to show the effect of mimetic musculature) (Fig. 5.11g).
- Nasal dorsum with the head tilted slightly forward (Fig. 5.11h).

Care and professionalism in taking pictures are definitely noticed by patients and can only enhance the surgeon’s reputation.

5.5.2 The Lighting Setup

First, the subject should be illuminated with as few lights as possible. The front light is distinguished from the key light or side light. Softly modulating light sources are preferred.

The front light is placed at approximately the subject’s eye level and shines toward the subject from the direction of the camera. A light source in this position tends to flatten out the
The side light accentuates physical form. It is highly variable in its uses and, in extreme cases, will divide the face into a light side and shadow side. The side light should be at least twice as bright as the front light.

Portraits taken against a black background will benefit from, but do not strictly require, a third light source. This light is placed behind and above the subject to function as a hair light or backlight. It adds a nice sheen to the hair and enhances outlines. This classic lighting principle provides 3D qualities and ensures anatomically correct illumination of the head.

The situation is different for macro and body-part photography. This requires focal lengths with a long lens-to-sensor distance so that even objects extremely close to the lens can still be brought into sharp focus. A small aperture (f/8, f/11, or f/16) should be used to extend the depth of field. The classic lighting fixture for this type of photography is a ring flash.

Today the photo industry offers economical alternatives. Tubes or LED ring lights, unlike traditional flashes, provide continuous illumination that allows for precise viewing of the subject. These fixtures are recommended for macro photography owing to their diffuse light. A daylight tubular ring light with a large inside diameter (tubes with a 30-cm inside diameter are available commercially) also makes a suitable front light for portraits. In all cases, the diameter of the ring light must be compatible with the diameter of the camera lens.

Photographs that will be postprocessed using Photoshop or other tools should be duplicated before any postprocessing work is done. This rule applies even if it only involves cropping the image.

While the photographic slide or negative was once the gold standard of legal evidence in the days of analog photography, in the digital world it is the “original photograph.” This presumes, of course, that the original photo has not been altered in any way with image processing software.

### 5.5.3 Personal Recommendations

A good general recommendation is to have a room, or at least a special area, set aside for taking high-quality, standardized clinical photographs. In the case of the nose, of course, the requirements of clinical and portrait photography overlap. With increasing experience in this area, it will be recognized that photographs of the face capture much more than the actual clinical findings. The photographer should feel obligated, therefore, to exercise particular care.

Take a little extra time and help your subject overcome his/her natural inhibitions. Conversing with the patient during the photographic session will help to build trust and provide distraction. It does not matter whether the pictures are taken by a photographer, a dedicated assistant, or the surgeon, but the circle of photographers should be limited to experienced, committed colleagues. (The authors do all of their own clinical photography.)

### 5.6 Informed Consent

The physician is obligated to present the patient with timely, comprehensive information before performing a functional aesthetic rhinoplastic procedure. The scope of this disclosure depends on the nature of the procedure, its necessity, and its urgency.\footnote{15}

In the case of an aesthetic operation, the patient should receive a particularly thorough explanation of the agreed goals and potential complications.

Bilateral olfactometry should be done prior to any surgical procedure on the nose (threshold test or Cain’s identification.

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**Fig. 5.11** (a–h) Standard photographic views taken before and after nasal operations.
5.6.3 Personal Recommendations

During the office consultation, the patient has an opportunity to ask questions on the conduct of the operation, its risks, and possible complications. The surgeon should address these questions in detail. He/she should also be available for any further appointments that are needed to address unanswered questions or to review certain details.

Upon request, patients should receive an information sheet that they can bring with them when on hospital admission, which may be scheduled weeks or months ahead.

On the day before the operation, the patient is again informed about all possible risks and complications.

While physicians have an obligation to fully inform the patient, they should do this without inducing needless uncertainty or anxiety. They should put the numerous possible risks into a realistic context by evaluating them with respect to the individual case. The tenor of the preoperative consultation should be optimistic and reassuring and ultimately should reinforce the informed decision for surgery.

5.7 Psychological Issues in Rhinoplasty

All symptoms and complaints have a psychosomatic aspect, but the relative proportions of the "psychic" and "somatic" elements of a disorder are highly variable. Aesthetic surgery is always a form of psychosurgery. On the one hand, it can free the patient from the suffering and distress of a facial abnormality or deformity that is perceived as a stigma. In this way, the surgery can contribute to a new feeling of self-worth and make the patient happy. But on the other hand, even a successful rhinoplasty that makes the patient more physically attractive may not solve his/her real problems. It may be, for example, that the patient is projecting problems of social interaction into an organic problem. This patient may expect that solving an aesthetic problem will also solve conflicts that he or she believes are rooted in the physical condition. As a result of this, the patient may reject the successful result of a rhinoplasty because it has not solved the other problems. Common warning signs or possible contraindications to predominantly aesthetic septrhinoplasties are listed in the following section.

5.7.1 Potential Problem Patients

1. Be careful if you notice a disparity between a mild physical abnormality and a high degree of patient distress ("I can't stand to look at myself"). If physical examination reveals only a subtle finding that does not definitely require surgical correction, this may mean that the patient has body dysmorphic disorder (BDD). BDD is present in 4.5 to 7% of persons who seek aesthetic surgery. Patients with this disorder are dissatisfied with the surgical result, lack insight, and are usually eager to have touch-up surgery after the first operation. A standardized scale can be used to assess these patients for BDD prior to the initial surgery. The following features are characteristic of BDD:

- An obsessive preoccupation with an imagined defect or slight physical abnormality.
- The preoccupation with the imagined defect causes significant distress or impairment in social, occupational, or other important areas in the person's life.
- The preoccupation cannot be explained by some other mental disorder, such as whole-body image dissatisfaction (as in anorexia nervosa).
A score of 3 on all of these criteria (1 = no, 2 = may be, 3 = yes) warrants a diagnosis of BDD. A score of 2 on any of the criteria may be an indication of BDD. Psychiatric consultation is advised for these cases, and the patient is not considered a candidate for rhinoplasty.

2. There is no “simple” rhinoplasty. The more minor the anatomical problem, the greater the expectations that the surgeon must meet. Unrealistic expectations in a patient with perfectionist traits are a sign that surgery should be reconsidered.

3. Every operation, especially when elective, requires clear motivation and resolution on the part of the patient. Any uncertainties about the operation can be clarified through verbal discussion. It is not up to the surgeon to find a motivation for the operation. Unmotivated patients should not undergo surgery.

4. There are candidates for aesthetic operations who go to doctor after doctor, shopping around for the best deal. Bargain hunters are poor candidates because they are reluctant to embark upon a trusting doctor–patient relationship and tend to renew their bargain hunt when the slightest problems arise. Also, these patients will try various ways to recoup their expenses after the operation.

5. The motivation for cosmetic rhinoplasty may be unclear in patients who are unkempt or seem disinterested in their appearance. These patients should first be told that their appearance can be improved by clothing, hairstyling, makeup, or beauty consulting, and that surgery may not be necessary.

6. Be careful with patients who have already been operated elsewhere and come to you for a revision. It is always best...
when the same surgeon performs both the original operation and the revision. An even more difficult situation arises for the surgeon who “operates into” a lawsuit that is in progress.

Fortunately, the typical rhinoplasty patient is motivated, active, optimistic, and cooperative. The average degree of satisfaction with the surgical outcome varies depending on the patient’s age and gender. For example, young women are pleased with their outcomes much more often than middle-aged men.\textsuperscript{23,24} Surgeons are warned against the combination of factors known as SIMON: single, immature, male, overexpectant, narcissistic.\textsuperscript{10}

5.8 Preoperative Workup

5.8.1 Rhinological History
The patient is questioned specifically about a sensation of nasal obstruction (constant or variable) as well as olfactory impairment and facial pain. Is there prior history of cranial trauma? Is there evidence of perennial or seasonal allergy, analgesic intolerance, or asthma? Has the patient had otitis media or sinusitis?

5.8.2 Aesthetic History
During the preoperative consultation, the physician acquires information on the wishes, motivation, and mental status of the rhinoplasty candidate. He obtains vital information about whether or not to operate (see p. 104 for more details).

5.8.3 Evaluation of the External Nose
Inspection of the nose begins when the history is taken. Palpation should include the external and internal nose. Further details are presented in the Analysis, Clinical Geometry section earlier in this chapter.

5.8.4 Endoscopic Examination
The goal of the endoscopic examination in a broad sense is to detect all endonasal disease. The capabilities and technique of nasal endoscopy are reviewed in the section Nasal Endoscopy earlier in this chapter.

5.8.5 Diagnostic Imaging
A survey radiograph of the paranasal sinuses is sufficient for preoperative screening in patients who have no history of sinusitis. Otherwise, coronal computed tomography (CT) is standard.

5.8.6 Laboratory Tests
Detailed information can be found on pages 199 and 213.

5.8.7 Function Testing
Before any nasal surgery is performed, the nasal airflow (in cm\(^3\)/s) should be objectively determined by active anterior computerized rhinomanometry, and olfaction should be assessed with a threshold and identification test. If parallel signs of tympanic ventilation problems are noted, pure-tone audiometry and tympanometry should be performed.

5.8.8 Photographic Documentation
The face should be photographed in standardized positions under the reproducible conditions of a small studio. The photos are used for the preoperative documentation of findings and for postoperative comparison (see p. 112 for details).

5.8.9 Informed Consent
The patient is informed about all the risks of the operation and the desired goals. The information is presented verbally and must be documented in writing. The principles of informed consent are reviewed in the section Informed Consent earlier in this chapter.

5.8.10 Planning the Operation
The surgeon consults with the patient and obtains his/her input in planning the operation, taking into account all preoperative findings including the clinical photographs. Preoperative planning is aided by the use of drawings, templates, or animated graphic computer programs.

5.9 Immediate Preoperative Preparations

5.9.1 Positioning
For septorhinoplasties and for endoscopic paranasal sinus operations, the patient is positioned supine with the head resting flat on the table. The surgeon should double-check the position, since any flexion or extension of the head will alter the inclination angle of the skull base. Gravity acts differently on the supine face than the upright face, and therefore the patient photographs (at least frontal and lateral) should be posted in the operating room along with CT scans and other images.

5.9.2 Local Anesthesia
The nasal mucosa is de congested 15 minutes before the operation with nose drops (xylometazoline hydrochloride). A local anesthetic (ultracaine with 1:100,000 or 1:50,000 epinephrine) is injected to induce local anesthesia, hypoemia, and hydrodissection. The agent should be injected at standard sites (see Fig. 5.13) beneath the superficial musculoaponeurotic system in the cartilaginous and bony nose and beneath the perichondrium of the septal cartilage.

The infiltration technique depends on the intended approach. The nasal dorsum is infiltrated in the supraperichondrial plane with a long, ultrathin needle inserted by the intercartilaginous route. Agent is injected over the perosteum and below the nasal mucosa (0.5–1 mucosal) along the lines for lateral osteotomies. For the cartilage-splitting approach, agent is injected beneath the vestibular skin until skin blanching is noted. A marginal incision in the alar cartilage requires only sparing infiltration along the cartilage rim. A small depot should always be placed over the nasal spine, premaxilla, and if necessary over the footplates of the medial crura. For skin incisions in the nasal base, agent is infiltrated along the intended lines of incision.
5.10 Anesthesia for Rhinoplasty

Mario Hensel

In nasal and sinus surgery, the anesthetist must share the operating field with the surgeon. Resulting problems include difficult airway management because the head of the patient is covered by sterile surgical drapes and is therefore hard to reach for the anesthetist. Anesthesia for rhinoplasty or nasal surgery can be performed in several ways such as general anesthesia, intravenous sedation (twilight anesthesia), or local anesthesia.

5.10.1 General Anesthesia

In many respects, general anesthesia creates the most controlled situation possible during rhinoplasty or endoscopic nasal surgery.

In patients undergoing septorhinoplasty, control of bleeding and hemodynamic variables such as blood pressure is of great importance. Combined with endotracheal intubation, general anesthesia affords greater protection from the aspiration of secretions and blood compared to intravenous sedation. As blood is a potent emetic, any major postoperative nausea and vomiting in the immediate postoperative period may result in aspiration of gastric contents. Accordingly, one of the main factors in patient satisfaction following an operation procedure is the absence of nausea and vomiting. Due to the higher risk of blood ingestion in nasal surgery, oral and pharyngeal packing

5.9.3 Marking the Operative Site

The proposed incisions should be marked on the nose before the operation is begun (Fig. 5.14). A rhinoplasty template (Karl Storz, Tuttlingen, Germany) can be used for preoperative marking that is accurate to the millimeter (Fig. 5.15).
is frequently used to minimize the risk of vomiting. It has been found that placing packing in the retropharyngeal space after intubation absorbs most of the blood loss and reduces the risk of aspiration of blood, bone, and tissue fragments into the airway and digestive tract. However, it has been shown that packing does not provide full protection and that the patient can experience sore throat. There is also the risk of leaving the pack inadvertently in place after extubation, which can lead to airway obstruction and intestinal occlusion. It was reported recently that pharyngeal packing has no effect in reducing the incidence of nausea and vomiting. Therefore, pharyngeal packing is no longer recommended as routine use for rhinoplasty and nasal surgery.

An essential component of anesthetic management is a detailed, confidence-building preoperative consultation with the patient. During this consultation, the risk for postoperative nausea and vomiting should be assessed and antiemetics such as dexamethasone, ondansetron, or droperidol should be prophylactically prescribed. If required, the patient should receive an oral premedication for anxiolysis (e.g., midazolam) 45 to 60 minutes before the start of the operation.

Controlled hypotension should be used to reduce bleeding and to provide a satisfactory bloodless surgical field. It has been indicated particularly in oromaxillofacial surgery. Controlled hypotension is defined as a reduction of the systolic blood pressure to 80 to 90 mmHg, a reduction of mean arterial pressure (MAP) to 50 to 65 mmHg or a 30% reduction of baseline MAP. Newer techniques of controlled hypotension utilize the natural hypotensive effect of modern anesthetics with regard to the definition of the ideal hypotensive agent. It must be easy to administer, have a short onset time, an effect that disappears quickly when administration is discontinued, a rapid elimination without toxic metabolites, negligible effects on vital organs, and a predictable and dose-dependent effect. Modern inhalational anesthetics such as sevoflurane or desflurane provide the benefit of being hypnotic and hypotensive agents at clinical concentrations, and are used alone or in combination with adjuvant agents to limit tachycardia and rebound hypertension, for example, inhibitors of the autonomic nervous system (clonidine, beta-blockers). The greatest efficacy and ease of use to toxicity ratio is for techniques of general anesthesia that associate analgesia and hypotension at clinical concentrations without the need for potent hypotensive agents. The most satisfactory technique is a combination treatment of the highly potent analgesic remifentanil with either propofol (total intravenous anesthesia [TIVA]) or with an inhalational anesthetic (balanced anesthesia) at clinical concentrations. However, because of the antiemetic effect of propofol, TIVA is the preferred technique. The reduction in the frequency of postoperative nausea and vomiting increases postoperative well-being, but also reduces events (vomiting) that are associated with severe blood pressure elevation in the operative area.

The simplest method for the induction and maintenance of TIVA is the use of conventional syringe pumps, in which the dosage of propofol and remifentanil is adjusted for the patient's body weight and delivered at a specified rate in milliliter per unit time. Propofol anesthesia based on target-controlled infusion (TCI) has been shown to be superior to a manually controlled infusion technique. In TCI systems, specially programmed syringe pumps are used to set and maintain the target concentration of the agents in the blood plasma. After the anesthetist enters the desired blood level for inducing and maintaining the anesthesia, along with the patient's age and weight, the TCI perfusor calculates and injects the necessary dose of the agents. The tendency of propofol to accumulate is taken into account by reducing the administered volume with increasing duration of anesthesia. In this way, TCI can avoid overdosing and reduce costs.

The use of clinical signs such as blood pressure, heart rate, pupil reaction, or lacrimation is not reliable in measuring the hypnotic component of anesthesia. The intraoperative use of electroencephalogram-based monitors to measure the depth of anesthesia such as the bispectral index (BIS) is suitable to guide the dose of anesthetic. The combination of both TCI and BIS-guided anesthesia can reduce the risk of intraoperative awareness in surgical patients (probability of awareness: 0.2% vs 1 case in 500 general anesthesias). In addition, anesthesia guided by neuromonitoring kept within the recommended range improves anesthetic delivery and postoperative recovery from relatively deep anesthesia. Due to the absence of analgesic hangover effects, TIVA with propofol and remifentanil requires the intraoperative initiation of pain therapy using opiates such as oxycodone and/or nonopiates such as paracetamol or COX-II inhibitors. Local anesthesia administered by the surgeon while the patient is still under general anesthesia, combined with systemically administered analgesics, will provide several hours of postoperative pain reduction or relief, which is then continued on the ward with an individual pain control regimen. The resulting increase in subjective well-being will generally shorten the duration of postoperative immobilization. Furthermore, it has been shown in nasal surgery that the perioperative use of systemic corticosteroids results in significantly reduced blood loss, shorter operative time, and improved surgical field quality.

Many patients undergoing rhinoplasty suffer additionally from bronchial asthma, nasal polyposis, and intolerance to aspirin. In this case, the anesthetist must be aware of their pulmonary dysfunction, because the anesthetic management of asthma requires a specific approach. Marked cross-sensitivity
with nonsteroidal anti-inflammatory drugs (NSAIDs), which may also precipitate severe bronchospasm and adverse reactions, is the main problem faced by anesthetists in postoperative pain management. Prevention in these patients is essential to prevent perioperative complications.

As alternative devices for airway management during anesthesia for rhinoplasty, supraglottic airways such as laryngeal mask or laryngeal tube can be used as well. These airway devices are less invasive than the endotracheal tube, but they do not provide protection against aspiration.

5.10.2 Intravenous Sedation (Twilight Anesthesia)

Intravenous sedation relies upon the skillful dosing of very potent anesthetics (propofol + opiate) through an intravenous catheter without the use of an airway device. The sedated patient still maintains his upper airway protection and the related reflexes and can react to any physical stimulus or any verbal command. This method has been used for some types of surgeries such as septrhinoplasty. However, intravenous sedation for rhinoplasty relies on careful patient selection and patient and surgeon compliance. Patients should have an American Society of Anesthesia (ASA) score of 1 or 2 and should be devoid of certain comorbidities, including obstructive sleep apnea, gastroesophageal reflux disease, and obesity. Before the procedure begins, clinicians must explicitly communicate to patients that they will feel no pain; however, because they are being sedated, they may know what is occurring during surgery, but they should not care. The lack of airway security is the most critical problem. Therefore, the clinicians must reassure the patients that the anesthetist will be with them the entire time, and any discomfort can be dealt with immediately and the anesthesia can be titrated to an acceptable level. As well as during general anesthesia, patients must be monitored for respiratory, heart, and cognitive function.

5.10.3 Local Anesthesia

Only for operations at the nose tip or other minor rhinoplasties is local anesthesia without any sedation possible. In most cases, general anesthesia or intravenous sedation should be performed. Nevertheless, a combination of one of these techniques with local anesthesia is recommended. Local anesthesia injection should be given after induction of general anesthesia or intravenous sedation to avoid discomfort for the patient. The local anesthetic used is long acting and the pain relief lasts long after the rhinoplasty is completed. Usually, the local anesthetic also includes a vasoconstrictor such as ephedrine. The supplementation of vasoconstrictor agents has many advantages, such as delaying the absorption of local anesthetics, increasing patient welfare due to the lower epinephrine. The supplementation of vasoconstrictor agents has many advantages, such as delaying the absorption of local anesthetics, increasing patient welfare due to the lower epinephrine. The supplementation of vasoconstrictor agents has many advantages, such as delaying the absorption of local anesthetics, increasing patient welfare due to the lower epinephrine. The supplementation of vasoconstrictor agents has many advantages, such as delaying the absorption of local anesthetics, increasing patient welfare due to the lower epinephrine. The supplementation of vasoconstrictor agents has many advantages, such as delaying the absorption of local anesthetics, increasing patient welfare due to the lower epinephrine.

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Chapter 6
Principles of Modern Septoplasty

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6 Principles of Modern Septoplasty

6.1 Introduction
The cartilaginous septum is the central structural element of the nose and has much the same function as a tent pole. It provides suspension for the upper lateral cartilages and anchors the anterior nose to the facial skeleton. Certainly, most of the nasal deformities are associated with septal problems due to the septum’s key role in the nasal framework.

Functionally, the nasal septum is part of the aerodynamic system of the nose that, inter alia, facilitates mass and heat transfer. Therefore, septum deformities can affect not only the nasal resistance, but also the inner milieu and the condition of the mucous membranes. Due to the septum, two parallel airstreams pass through the nose during respiration. They interact according to the laws of fluid dynamics. The result is a functional interrelation between both nasal cavities, which, in a way, is determined by the septum’s anatomy. In other words, the septum subdivides the nose into two functionally corresponding units that is, e.g., also reflected in the occurrence of the nasal cycle.

The evolution of septoplasty in a brief retrospect synopsis might illustrate the basic issue of this operation. In the early 1900s, Killian and Freer developed the concept of the submucous septal resection. Unlike their predecessors, they stressed the need to preserve the mucosal layers and took into account the supportive function of the septal cartilage, feeling it was essential—but also enough—to preserve a dorsal and caudal cartilage strut for support. This is a relatively straightforward procedure that can achieve reasonably good short-term results in many patients. As such, it was still being used by many surgeons in the 1980s, even though Cottle, Fomon, and Metzenbaum had already laid the foundation for modern septoplasty several decades earlier. This modern approach is based on the principle of preserving or reconstructing cartilaginous and bony structures as much as possible. Typical long-term complications such as saddle nose deformity or septal perforations are considerably less common when this principle is followed. Currently, the development is driven by increased functional and aesthetic demands. Consequently, the so-called extracorporeal septal correction became more common. It is a versatile, precise, and reliable method, but needs experience and advanced surgical skills.

Rather than exploring all aspects of septal operations in detail, this chapter deals more with underlying principles that will help the surgeon to view the nasal septum within the context of complex rhinosurgery and take into account the long-term effects of specific procedures. Viewed in this manner, procedures on the nasal septum should actually not be considered as operations for beginners.

6.2 Indications
A successful concept of functional–aesthetic rhinosurgery requires studied consideration of the nasal septum. The septum has special significance because it is involved in almost every rhinological problem to some degree.

There are two basic goals of septal surgery that are intrinsically tied to each other:
The first is to promote optimum nasal airflow distribution, which does not necessarily mean to create an overall straight septum, but to aim for an approximate symmetric flow domain in both sides of the nasal cavity. This is of particular importance at the isthmus nasi, which has to be considered as the bulk flow formation structure. By that, it creates up to 80% of the entire inspiratory nasal resistance. Consequently, the isthmus area requires the most attention in diagnosis and surgery.

The second general goal of septal surgery is to maintain or to provide sufficient structural support for the cartilaginous nasal framework and, thus, for the soft tissue envelope as well.

The septum cartilage accounts for the nose’s profile and its axial orientation. Therefore, surgical measures can be applied in order to implement desired modifications of the shape of the nose on functional or aesthetic grounds. For example, a saddle nose, tension nose, or crooked nose usually cannot be satisfactorily corrected without septoplasty. Altering the septal cartilage might also affect the appearance of the nasal tip (Fig. 6.1).

Adjunctive septal procedures can be necessary in order to provide sufficient access for treating diseases of the paranasal sinuses and pituitary.

One must not forget the indication to close or minimize symptomatic perforations. However, this needs in particular through consideration of chances and risks.

Besides elective procedures, septal revision is a very common operation in patients who have sustained midfacial trauma.

6.3 Contraindications
Septal deviation in itself is not an indication for surgery. It is rare to find a perfectly straight septum, and ridges on the premaxilla or posterior spurs are considered normal to some degree. Ideally, functional deficits should be detectable by measurements before they are considered an indication for surgery. However, perception of nasal breathing is a multifactorial issue and the patient’s discomfort is not necessarily reflected in the objective tests. In some circumstances, subjective influences can be as much of a concern in functional septal surgery as it is in pure aesthetic nasal surgery.

When there is evidence of a more or less active Wegener’s granulomatosis or comparable conditions that are based on vasculitis of small vessels, the septum should be left alone. Once the disease is in remission, opinions differ. I would recommend not to touch the septum or to be extremely conservative.

Strict criteria have to be applied in selecting children for septal surgery. Through the growth of the nose, a septum deviation can also lose relevance for the nasal resistance and, not infrequently, after puberty a predisposition of congested

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![Image 6.1 Possible effects of the septal cartilage on the shape of the external nose.](image-url)
membranes declines due to hormonal changes. Surgery might be indicated only in severe cases. Whenatraumatic, structure-conserving techniques are used, the surgical correction of an obstructive deviated septum may be considered as early as 4 to 6 years of age. Whenever possible, major resections of the vomer should be avoided before 12 years of age.11

6.4 Preoperative Considerations

It should be established preoperatively whether the septoplasty is being done purely for functional improvement, is part of a complex operation with both functional and aesthetic goals, or is a means for effecting purely aesthetic changes in the shape of the nose. The intents of septoplasty can have various implications, even such as the deliberate decision to leave a functionally significant septal deviation alone in selected patients. In some rhinoplasties that involve the broad mobilization of anatomical structures, the septum may provide a secure pillar that can prevent dynamic instability of the nasal skeleton. Consequently, the patient should understand that it may be necessary to accept a certain disparity in nasal breathing between the two sides of the nose—although a severe airway obstruction should not be allowed to persist. Similarly, the patient must be informed that undesired changes in the shape of the nose may occur that require immediate additional rhinoplasty or that become apparent only at follow-up. For this reason, it is advisable to obtain photographic documentation even for a “simple” conventional septoplasty.

Septal surgery comprises several variants and modifications. The method used depends on the patient’s findings, the intent of the operation, and on the individual preferences, experiences, or skills of the surgeon. Usually there is always a continuous intraoperative situational adaptation of the surgical measures. However, one question should be clarified well in advance of the intervention: Is an extracorporeal procedure via an open approach necessary? When I am uncertain, to be on the safe side, I usually decide in favor of the extracorporeal septum correction.

The condition of the mucosa is an important factor for successful surgery. It is a good idea, whenever improvement seems possible, to suggest preoperative treatment of the mucous membranes to the patients. Intraoperative bleeding, postoperative complications, and morbidity in the healing period can be prevented.

6.4.1 Septum and Turbinates

The goal of function-improving septoplasty or septorhinoplasty and optional turbinectomy surgery must not be to transform the nasal airway into a clear cavity that allows maximum theoretical airflow through the nose. A certain resistance is inherent to healthy nasal breathing. It is important to recognize that the septum, the turbinates, and the lateral nasal wall act in concert to create and maintain a cleft-like airflow providing physiologic airflow. Especially the inferior turbinate is able to compensate alterations of the flow space geometry in order to restore or preserve its cleft-like configuration. This implies not only a reactive hyperplasia, e.g., in the case of septal deviation or saddle nose deformity, but also, vice versa, the potential of flow-depending regression when the airstream is normalized through nasal framework correction. Consequently, the treatment of turbinate hyperplasia consists, in the first instance, of changing the flow conditions that primarily affected the erectile tissue. There is no justification for a “routine” turbinopecty that aims for lowering nasal resistance.12 This is supported by computational fluid dynamics (CFD). It revealed the turbinates as being only secondary flow formation structures.8,13 However, before correcting the septum, it may be necessary to lateralize or “trim” the middle and/or inferior turbinates to create sufficient space on the concave side. In rare cases, even an ethmoidectomy might be considered in order to position the middle turbinate more laterally. Regardless of the specific surgical method that is applied to the turbinates, the surgeon should always bear in mind that it can influence the inner milieu in the long term.8,15

6.4.2 Structural Implications

The narrowest part of the nasal cavity is the isthmus nasi—also named internal orifice. It is located behind the nasal vestibule and represents, literally and figuratively, the bottleneck of the nose (Fig. 6.2). The isthmus is bordered by the septum, the nasal floor, and the nasal sidewall, where the upper and lower lateral cartilages are overlapping (Fig. 6.3). Already smallest alterations of the size and/or shape of the nasal cavity’s cross section in this region can significantly influence the airflow with, according to Hagen–Poiseuille’s law, a disproportional increase of the nasal resistance. Furthermore, the relative size of this airway constriction is one determinant of the nasal valve’s reaction to the inspiratory airstream—besides the strengths of inspiration and the elasticity of the nasal sidewall. For a better

![Fig. 6.2](image-url) Example of computational fluid dynamics. The picture displays the calculated pressure drop in the right versus left nasal cavity. It shows a significant side difference due to a septal deviation in the isthmus area. Resistance is 0.08 Pa s/mL (left) and 0.03 Pa s/mL (right).
understanding, one has to distinguish between the primary airway constriction and the consecutive valve mechanism referring to a Starling resistor. Now, the circumscribed isthmus area can be pinpointed using CFD. The visualized pressure drop within the nasal cavity exactly displays its location and narrow extent with clear distance to the inferior turbinate (Fig. 6.2).

The isthmus’ morphology and dimension are essentially determined by the anatomy of the quadrangular plate. Not only deformations or deviations, but also its dorsal and caudal extent within the sagittal plane as well as the cartilage thickness are forming factors. The quadrangular plate at the isthmus, however, has to support the nasal dorsum (Fig. 6.4). This poses a considerable challenge to correct the septum cartilage in situ without compromising its supportive function. The application of a complete extracorporeal procedure with an open approach might usually be the best option in such cases.

The shape, size, and resilience or stiffness of the septum cartilage relates to intrinsic factors, on the one hand, and to the way in which the cartilage is embedded in the surrounding structures, on the other. This superimposing of extrinsic and intrinsic factors ultimately affects the shape of the external nose (Figs. 6.1, 6.5–6.7). Consequently, for conservative and effective work on the septal cartilage, a considered partial or even complete release from the adjacent bone is necessary. Note that, at the end of any septum surgery, at least two stable connections of the cartilage to the bone must have been preserved or reestablished, at the K area and at the nasal spine.

The possible effects of substance loss in the septal cartilage on projection, rotation, and definition of the nasal tip become apparent in the development of a saddle nose deformity. Through the depression in the middle third of the nasal dorsum, the tip loses projection, shows relative cranial rotation, and has an amorphous appearance (Fig. 6.5). The opposite effect is visible in the condition of a tension nose. The small angle between the lateral crura is partially due to a high septum. This illustrates that balanced work on the septum cartilage, coordinated with alar cartilage surgery, can help to sculpture the tip.

### 6.5 Preoperative Analysis

The basis of successful nasal surgery is, besides the detailed history, a thorough clinical examination. This includes anterior rhinoscopy and endoscopy before and after decongestion. Through that and a possibly complemented computed tomography, the surgeon is able to get a picture of the airway geometry, the membrane’s condition, and can recognize evidence of chronic diseases of the paranasal sinuses.

Palpation of the entire nasal skeleton also adds essential information for preoperative planning. Especially important is to feel the anterior septum between two fingers. This can reveal a significant deviation in the isthmus area that is camouflaged from the eye.

Cottle’s maneuver or one of its variants helps to diagnose an isthmus stenosis, which is frequently caused by the septum. But these tests have a tendency toward false-positive results. A more reliable clinical sign is the occurrence of a strict unilateral nostril collapse during forced inspiration. Fluid mechanics suggest that this indicates the existence of a relevant obstruction or isthmus stenosis on the contralateral side, provided the nasal sidewalls are relatively symmetrical. However, the physical effect can be camouflaged by facial muscle activity.

Today modern rhinomanometry methods, such as four-phase rhinomanometry, are routinely used to quantify the total resistance of the nose, which is, however, only one aspect of nasal breathing. In contrast, computational fluid dynamics (CFD), also called numerical flow simulation, is able to calculate arbitrary flow parameters in a high spatial and temporal resolution within the nasal cavity, including the total nasal resistance (Fig. 6.2). The only requirement is a computed tomography that provides data for the reconstruction of the three-dimensional geometry of the nose. CFD, maybe, will replace rhinomanometry in the near future.
6.6 Surgical Technique

Generally speaking, one could distinguish between two fundamental ways to deal with septal problems. The first option is to execute a complete extracorporeal septoplasty using an open approach. The second is the preference of endonasal procedures and altering the septum to a great extent in situ.

The latter involves the “swinging door” concept, established by Cottle, and represents the standard method in ear, nose, and throat. The extracorporeal technique, however, might not be restricted to exceptional complex and severe deformities. As explained above, it is of particular importance that the quadrangular plate in the crucial isthmus area is definitely straight with an appropriate thickness, size, and rigidity. Even in cases of seemingly minor septal deviation, it is best practice to accomplish this by employing the extracorporeal technique.

Sometimes, there are concerns only about the bony septum, suggesting a limited surgical procedure through an endoscopic posterior access. This has to be distinguished from a comprehensive septoplasty that generally comprises the following measures: dissection, mobilization, resection, reshaping, and reconstruction.

Dissection starts with a suitable incision, i.e., a transfixion/hemitransfixion incision or separating the two alar cartilages when using an open approach. This is followed by developing the mucoperichondrial flaps or tunnels. The surgeon should take the findings and the overall goal into account when creating the mucosal tunnels. The routine development of bilateral superior and inferior tunnels is not advised, but more extensive tunnels can be helpful for more complex deformities. The inferior tunnels are often easier to develop in a retrograde fashion. The maxillary–premaxillary approach described by Cottle (exposure of the spine and crest of the piriform aperture) is only occasionally necessary. Attention has to be paid to the incisive nerve when defining the lateral extent of the inferior tunnels.

In certain cases, parts of the mucosa can be left adherent to the cartilage. This will effectively hold the cartilage plate in position and facilitate the reconstruction or support the overall concept. However, a unilateral elevation of the mucosa may change the tensile force equilibrium within the cartilage and, therefore, has the risk of consecutive deformations in the postoperative healing period and beyond.

The key to an atraumatic dissection is to maintain a strict subperichondrial and subperiosteal plane of approach. Connective tissue fibers at the osseocartilaginous junction in the area of the premaxilla should be sharply divided. The same generally applies to scars in postoperative or posttraumatic cases.

Once the septum has been exposed, it is usually a good idea to separate the quadrangular plate from the surrounding bony frame by a posterior vertical chondrotomy and the “disarticulation” from the premaxilla. Then, a “swinging door” is created. Disconnecting the bony and
Fig. 6.6  (a–d) Osseocartilaginous deviation as a result of early childhood trauma with a tension septum and overprojected nasal tip. The condition was corrected by an open septorhinoplasty.

Fig. 6.7  (a–d) Long, humped nose. Managed by complementary correction of the septum and alar cartilage complex through an open approach. (continued)
cartilaginous portions of the septum is most effective and provides the best exposure when combined with partial resection of the perpendicular plate and vomer. Possible subsequent detachment of the upper laterals is able to remove remaining tensions from the septal cartilage, allowing for a definitive assessment of the intrinsic pathology. Alternatively, when required, the remaining septum can also be completely taken out for correction. This is referred to as the extracorporeal technique. One could even strive from the beginning to remove the cartilaginous septum together with the lamina perpendicularis in one piece. I usually prefer the described incremental approach.

The reconstruction of a straight septum plate with an adequate size and stability can require an elaborate combined application of resections, morselization, scoring, and splinting as well as suturing. When the quality or quantity of the existing septal cartilage is not sufficient, one could harvest ear or rib cartilage. Note that morselization and scoring bear the risk of secondary deformations of the cartilage.

Finally, the septum must be able to provide enough support to the nasal dorsum, and at least be stable connected to two points—the nasal spine and the rhinion.

Any defects that remain in the bony septum should be repaired in mosaic fashion with suitable pieces of bone and/or cartilage. This will prevent the development of mucosal atrophy. The flexibility of the repaired area, similar to that of a chain link, allows for good adaptation of the postoperative packing.

In contrast to corresponding perforations of the mucosa, a unilateral one must not necessarily be sutured. But a closure prevents blanç cartilage or bone and resulting prolonged secondary wound healing.

Silicone endoprostheses (e.g., Doyle splints) are particularly advantageous for temporary postoperative packing or splinting. They provide mechanical strength, reduce edema formation, and create a moist milieu that promotes mucosal regeneration. Generally these splints are well tolerated and can be left in place for several days if necessary. I personally prefer them compared to quilting the mucosa-septum layers or using tamponade.

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Chapter 7
Structural Grafting via the External Rhinoplasty Approach

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7 Structural Grafting via the External Rhinoplasty Approach

7.1 Introduction
Rhinoplasty is consistently ranked in the top five cosmetic surgical procedures performed annually in the United States. The primary objective of rhinoplasty is to create predictable changes in nasal contour while maximizing nasal function. Reproducible, consistent outcomes in rhinoplasty come with the surgeon's ability to create a stable nasal structure and predict the effects of scar contracture on this structure over time. In complex cases, endonasal approaches may not provide the exposure needed to execute complex grafting. The external approach allows maximal exposure of the cartilaginous nasal structures, bony vault, and septum. The surgeon is thus able to directly visualize the repositioning, alteration, and augmentation of the nasal structures.

Joseph and Gillies both reported cases using an open approach to rhinoplasty in the early part of the 20th century. Over the ensuing decades, the technique evolved to include a transcolumellar incision that extended onto the vestibular skin, allowing for wider exposure. In North America, the approach has gained in popularity since its introduction by Padovan in 1970. Early criticism of the visible columellar scar has been addressed by numerous reports of favorable results with scar camouflage.

One must remember that external rhinoplasty is only a means to access the underlying nasal structures. Once exposure is achieved, there are a multitude of maneuvers that may be executed depending on the patient's individual anatomy. A description of the external approach itself and the maneuvers commonly performed during structural rhinoplasty is presented in the following.

7.2 Indications
While there are no absolute indications to external rhinoplasty, there are certain problems that are best corrected through techniques requiring wide exposure. In general, these methods involve extensive rearrangement of existing structures or addition of structural grafts. Indications include the following:
1. Significant tip deformity with an asymmetric, ptotic, overprojected/underprojected, bulbous, or buckled tip structure.
2. Secondary rhinoplasty—previously disrupted structural supports may need to be reconstituted or replaced.
3. Non-Caucasian rhinoplasty—may require significant increases in projection and support of inherently weak alar cartilages.
4. Cleft lip nasal deformity.
5. Crooked nose—may require precise repositioning of upper lateral cartilage (ULC) or lower lateral cartilage (LLC) or extensive septal correction or reconstruction.
6. Major nasal reconstruction.
7. Diagnosis—in the cases in which the surgeon is uncertain as to the anatomical cause of the deformity, the external approach allows for accurate diagnosis prior to structural modification.

7.3 Contraindications
A relative contraindication to the external approach for rhinoplasty is the presence of severely damaged or thinned skin. Such conditions may occur following multiple previous operations, particularly in thin-skinned individuals. The presence of acquired cutaneous telangiectasias, purple or blue discoloration of the nasal skin with cold temperature, and visible irregularities are signs of such a condition. In these cases, an endonasal approach with limited soft-tissue elevation may reduce the risk of further cutaneous compromise.

7.4 Alternative Techniques
Although there are no absolute contraindications to the external approach during rhinoplasty, an endonasal approach may be a reasonable alternative in the cases in which minimal changes are required.

Nondelivery approaches have the advantage of preserving all major tip support mechanisms of the nose. Access may be gained through a cartilage-splitting or retrograde approach. The main disadvantage of these approaches is the limited exposure of the tip cartilages. While the delivery approach provides greater exposure than nondelivery approaches, it does so at the cost of potentially compromising tip support. Specifically, the intercartilaginous incision disrupts the attachment of the ULCs and LLCs. Although the lower lateral crura are widely exposed with this method, the chondrocutaneous flap is delivered in a nonanatomical orientation, creating potential difficulty for the inexperienced surgeon.

7.5 Preoperative Considerations
In all rhinoplasty, a clear understanding must be reached between surgeon and patient regarding the perceived nasal deformities, surgical plan, and expected outcomes. The relationship between nasal airway function and appearance must be emphasized.

It is imperative that the patient understand that the postoperative period is a prolonged and dynamic process. Initially, the patient must anticipate a significant amount of swelling which will slowly subside. Over the ensuing months and years, ongoing resolution of edema and contraction of the soft-tissue envelope will create more definition to the nose. The patient must therefore be prepared to wait for several months for a significant improvement from surgery. This is especially true for thick-skinned individuals, revision patients requiring extensive manipulations, or patients with only subtle problems. The patient should be aware that the incision on the columella will be visible for several weeks and will fade with time.

Photographic documentation is essential before and after surgery. Full face frontal, oblique, lateral images, close-up base views, and smiling views are essential. Images should be obtained with dual flash sources angled 45 degrees toward the patient. An additional frontal view taken with a single flash placed in front of and above the patient allows for shadowing that highlights the dorsal line. A blue screen or wall is ideal for establishing contrast between the patient and the background. Photography views include the following:
- Full face (expressionless) frontal, three-fourths, and lateral views, as well as (smiling) frontal and lateral views.
- Close-up views of nose (brow to philtrum) from frontal, three-fourths, lateral, and base views.
- Brow to mentum frontal view expressionless and smiling.
Computer image modification programs are becoming increasingly important for consultation of cosmetic surgery patients. In rhinoplasty, these programs allow the consultant to alter an image on a computer screen in order to display the postoperative appearance of the nose. Such technology can facilitate a mutual understanding between patient and surgeon regarding surgical goals and expectations. As many patients enter the process with vague or unrealistic wishes or with an aesthetic sense that conflicts with that of the surgeon, such programs may help to focus the patient’s expectations toward a defined and reasonable goal.

This is especially important in ethnic rhinoplasty as some patients will request cosmetic enhancements that preserve their unique ethnic characteristics, while others seek a more westernized Caucasian standard. A consensus can be quickly reached with the visual aid that the computer image modification provides.

A NOSE questionnaire is used to ascertain a subjective preoperative nasal obstruction score. A rhinoplasty preference sheet is used to subjectively obtain aesthetic goals related to the morphed images for intraoperative reference.

### 7.6 Special Surgical Requirements

The patient should be advised to stop all blood thinning agents such as aspirin, ibuprofen, and vitamin E for at least 2 weeks prior to surgery. The individual should be in relatively good health and free of active nasal infection at the time of surgery. Any concerning medical condition should be cleared by the patient’s primary care physician or appropriate consulting specialist. It is our preference to perform the operation under general anesthesia in order to protect the airway from dependent blood drainage. A single dose of intravenous cephalexin is given prior to the start of the case. If ear or costal cartilage is to be harvested, an antipseudomonal agent such as ciprofloxacin is administered.

A standard rhinoplasty set should be available. The following is a list of essential instruments—the preference of the senior author is indicated in italics:

- #11 and #15 blade scalpels.
- Assorted fine skin hooks.
- Fine dissecting scissors—Converse.
- Fine needle holders—Webster and Castroviejo.
- Fine forceps—Toothed Adson and Bishop-Harmen.
- Tissue forceps—Brown-Adson.
- Freer elevator.
- Retractors—Converse.
- Suture—5.0 and 6.0 polydioxanone suture (PDS) for stabilization of cartilaginous grafts; 5.0 clear nylon for permanent suture for modification to the shape of native cartilage; 4.0 plain gut on a straight septal needle (SC-1) for closure of septal flaps; 5.0 chronic for closure of vestibular skin incisions; 6.0 PDS for subcutaneous closure of columellar incision; and 7.0 nylon for columellar skin closure interspersed with 6.0 fast absorbing gut.

### 7.7 Preoperative Analysis

The surgeon must note the thickness and sebaceous quality of the nasal skin—soft-tissue envelope (SSTE). In darker skinned individuals with thick skin, incisions may take longer to heal with increased potential for a visible scar. In addition, the underlying structural framework of the nose must push into the thick soft-tissue envelope in order for form to project through.

Moreover, a significant tissue void in such patients will result in exuberant scar formation and poor definition, particularly in the tip and supratip areas. Thus, the postoperative soft-tissue pollybeak may be prevented by avoiding overreduction of the structural framework of the thick-skinned nose and opting instead to achieve balance by augmentation to areas of relative deficiency (Fig. 7.1). In thin-skinned patients, there is more tolerance for leaving a small amount of dead space as a greater degree of soft-tissue contracture will allow for “truer” redraping. This advantage in thin-skinned noses is counterbalanced by the added risk of contour irregularities becoming visible or palpable over time. Care must therefore be taken in ensuring that all existing bony and cartilaginous structures, grafts, and implants are precisely positioned and smoothly contoured. It is crucial to obtain a clear idea of the patient’s nasal airflow. Many patients present to the rhinoplasty surgeon with functional complaints, while others display variant anatomy that predisposes to postsurgical obstruction. Assessment should be undertaken prior to and after decongestion in order to differentiate between inflammatory and anatomical causes of obstruction. The surgeon must note the external stigma of an obstructed nose or one that is prone to develop postoperative problems. These characteristics include thin SSTE, a narrow middle vault, short nasal bones, supra-alar pinching, and reasonable goal.

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narrow nasal base, a prominent supra-alar crease, narrow nostrils, and thin lateral nasal walls. Intranasal exam may reveal a narrow internal valve angle, dynamic lateral wall collapse, septal deviation, and inferior turbinate hypertrophy. All of these factors must be considered in formulating a surgical plan that will preserve a functional airway.

Cosmetic nasal analysis begins with a global assessment of the most apparent deformities. Often one or two areas tend to be more noticeable to the observer. These may include a crooked dorsum, a large dorsal prominence, a bulbous tip, a dependent or foreshortened tip, or a wide base. It is useful to conceptualize a nose in terms of such traits so that priority can be given to these deformities during surgery. In rhinoplasty, each subunit of the nose affects the appearance of the other subunits. Thus, in order to create a natural well-proportioned appearance, the surgeon modifies a given subunit based on the status of adjacent structures. Knowing that one aspect of the nose is particularly problematic allows the surgeon to focus on it and modify the rest of the nose around those corrections. For example, in a patient with a long nose and ptotic tip, the surgeon may wish to estimate tip projection and rotation first, and then set the dorsal height appropriate to the anticipated tip position.

Analysis should then continue with a systematic assessment of each view of the nose. While analysis of the patient is done in the office setting, quality preoperative photographs allow for more detailed study at a later time. On the frontal view, symmetry and width should be assessed in each of the vertical thirds of the nose. The brow-tip aesthetic lines should follow a gentle, unbroken curve following the relative normal variation of nasal width: slightly wider cephalad at the brows nasal root transition, narrower in the middle vault, and wider again at the tip. If the brow-tip aesthetic lines are irregular or asymmetrical, the anatomical cause of the problem should be noted. Bony and cartilaginous vault irregularities are easily discernable with a single light source placed above the patient to enhance shadowing. The general tip shape should be determined from the frontal and base views (e.g., bulbous, deviated, wide, amorphous, asymmetrical). The base view also provides information about the shape and size of the columella, alar base, nostrils, and lobule. In general, the frontal and base views should reveal a triangular shape of the nose in which the nasal base (interface of nose and face) is wider than the tip and dorsal line. The triangularity of the tip depends on the presence of an unbroken line from the nasal tip-defining points to the lateral alar margin. Poor structural support in this area will manifest as alar pinching or concavity of the alar margins on frontal and base views. In cases of variant anatomy in which the base is excessively narrow or the tip is too wide, the correct relationship must be restored.

On the lateral view, the nasofrontal angle should be approximately 120 degrees. This angle is measured at the nasal starting point and is determined by the height of the radix and the angle of the forehead. A deep nasofrontal angle creates an illusion of a shorter nose, independent of the actual vertical position of the nasal starting point. Conversely, a shallow angle creates an appearance of a longer nose. The dorsum is assessed for smoothness, convexity or concavity, and presence of a supratip break. In the lower third, the overall projection and rotation of the nasal tip must be assessed. Using Goode’s method, the nasal tip projection, as defined from the alar crease to the tip-defining point, should be just over half the length of the nose. The nasolabial angle should be between 90 and 95 degrees in men and between 95 and 105 degrees in women. This angle can be affected by variations in the size and shape of the upper lip and premaxillary bone. Therefore, the nasolabial angle does not always reflect the degree of tip rotation. The alar–columellar relationship and degree of infratip break should also be noted.

In ethnic rhinoplasty, the relationships may be different from the traditional ones above. They frequently require increased tip projection and augmentation and may have weaker cartilage than Caucasians to begin with.

### 7.8 Surgical Technique

#### 7.8.1 Incisions: Nuances and Technique

Prior to injection, preoperative photos and measurements are made. These measurements and photos are repeated intraoperatively and postoperatively. They include nasolabial/nasoseptal angle, projection, subnasale and infratip length (medial canthus as reference point), dorsal nasal length (nasion to nasal tip), upper lip length, and base width and flare. This information allows for accurate manipulation, within 1 mm, of each parameter during rhinoplasty.

Up to 10 mL of local anesthetic with 1:100,000 epinephrine is placed intranasally in the submucoperichondrial plane on both sides of the septum, nasal floor, and inferior turbinate if turbinate surgery is planned. This larger volume generally will not cause significant hemodynamic disturbances in a healthy patient. The anesthetic is useful in providing vasoconstriction and hydrodissection. The external nasal SSTE is infiltrated with a smaller volume in order to prevent distortion of the baseline shape. The areas injected include the columella, the intradomal area to the nasal spine, the tip and supratip, and the dorsum and side walls. It is useful to mark the salient anatomy and abnormalities with a pen prior to injection.

The marginal incisions may be scored lightly with a 15 blade while everting thealar rims with a wide skin hook to provide direct visualization. The incision should be designed at the caudal margin of the lateral crus. The cephalic border of the nasal vibrissae is an inconstant landmark that may help in localizing the caudal edge of the lateral crus. Palpation of the cartilage with the back of the scalpel is a more reliable localizing technique. The transcolumellar incision is then made with an 11 blade at the level of the midcolumella in an inverted V orientation. The apex of the V should form an angle approaching 90 degrees (Fig. 7.2). Creating an overly acute angle will increase the chance of skin ischemia and breakdown at the apex. The incision should be connected to the columellar extension of the marginal incisions that follow the caudal margin.
of the medial crura and lie 2 to 3 mm posterior to the lateral border of the columella. Particularly in thin-skinned patients and in patients with prominent medial and intermediate crura, these incisions must be placed superficially in order to avoid cutting the underlying cartilage.

Elevation of the soft-tissue envelope is then performed in a supraperichondrial plane. The columellar flap is elevated sharply off of the medial crura. Often there are small columellar arteries at the inferior skin flap that may need to be controlled with a fine tip bipolar cautery.

Elevation of the soft-tissue envelope then proceeds cephalad toward the domes. Three-point retraction greatly aids in the development of the correct plane of dissection. A fine double-prong skin hook retracts the superior flap of the columella cephalically; another fine skin hook is placed at the undersurface of the dome in order to retract the intermediate crus and dome inferolaterally; and a third wide double-prong skin hook is placed at the alar rim margin to expose the marginal incision. Dissection is performed with Converse scissors in a plane immediately superficial to the perichondrium. The scissors should be slightly angled downward toward the cartilage and the plane developed using the tips of the scissors rather than through a spreading motion. As the dissection plane is developed cephalad, the vestibular skin is incised flush with the caudal border of the lateral crus. The second fine double-prong skin hook may be advanced laterally on the lateral crus as dissection continues cephalad and laterally. Dissection should be taken to the lateral 25% of the lateral crus in order to gain enough exposure for work in the upper two-thirds of the nose.

Once both lateral crus are exposed, dissection may be continued cephalad over the middle vault. Dissection below the muscle is critical to avoid thinning the overlying skin–soft-tissue envelope.

Dissection of the soft-tissue envelope over the upper third should be elevated in a subperiosteal plane. Starting at the rhinion, a Joseph elevator is used to incise the periosteum. Dissection proceeds cephalad in this plane. The size of the subperiosteal pocket depends on the planned surgical maneuvers. If significant reduction or rasping of the bony dorsum is needed, a wider area of dissection may be required. If placement of a radix graft is planned, a narrow pocket may be preferred over the radix for better positioning of the radix graft.

**Middle Nasal Vault**

The middle vault has significant functional and cosmetic implications for the nose. Functionally, the internal nasal valve area is partly dependent on the relationship of the ULC and the dorsal septum. Excessive narrowing of the angle between these structures will lead to obstruction at the internal valve. Previous surgery causing destabilization of this area will result in inferomedial collapse of the ULC into the airway. In particular, patients with short nasal bones and long ULCs are at risk of collapse. The width and symmetry of the front view of the nose depends on symmetrical reconstruction of the ULC and septum.

Spreader grafts are long, rectangular cartilaginous grafts placed between the dorsal cartilaginous septum and ULC. These grafts are useful for correcting functional and cosmetic problems related to a narrow or asymmetrical middle vault. In addition, these grafts should be used in primary rhinoplasty to prevent middle vault collapse in high-risk patients such as those with shorter nasal bones and thin skin. In particular, when reduction of a cartilaginous dorsal hump leads to excision of the horizontal articulation of the dorsal septum and ULCs, spreader grafts will stabilize the middle vault and help restore appropriate horizontal width.

The dimensions of spreader grafts will vary depending on specific needs and anatomy, but range from 10 to 30 mm in length, 3 to 5 mm in height, and 2 to 4 mm in thickness. More than one graft may be needed depending on available grafting material and the deformities. In general, the thicker aspect of the spreader graft is beveled and then positioned cephalad at the rhinion in order to create the normal appearance of slightly increased width in this area ([Fig. 7.3](#)). The grafts may be placed from a dorsal approach after the ULCs are freed from the septum. Mucoperichondrial flaps must first be elevated from the junction of the ULC and septum in order to prevent injury to the mucosal lining and subsequent cicatrix. Two 5.0 PDS mattress sutures placed through the ULC, spreaders, and septum should be used for stabilization. The caudal ULC should be pulled caudally during the suture stabilization in order to straighten any redundancy or curvature. The dorsal profile of the spreader grafts, ULC, and septum should be coplanar and smooth. In situ trimming of the grafts may be needed to ensure an even dorsal surface.

An alternative method of placing spreader grafts is through a tight subperichondrial tunnel at the junction of the ULC and dorsal septum. In this method, elevation of the septal flaps during septoplasty must not include the dorsal aspect of the quadrilateral cartilage. A mucoperichondrial incision is made high on the septum just caudal to the junction of the ULC and septum. A narrow dissection instrument, such as a narrow Cottle elevator, is then used to create a long, tight pocket just beneath the dorsal junction between the ULC and septum. Snug placement of a spreader graft into this tunnel will cantilever the ULC away from the dorsal septum, effecting additional widening of the internal nasal valve, as compared to placing spreaders through an open dorsal approach. In the latter, the ULC is lateralized, but the absolute angle between the septum and ULC does not change. The precise pocket spreader graft placement of spreader grafts. Note bevel of spreader graft so graft can be advanced under the nasal bone.
placed under an intact connection between the ULC and dorsal septum creates a cantilever effect and lateralization and mild flaring of the ULC, leading to increased width and angulation (Fig. 7.4). This effect is achieved because of the bulk of the spreader graft placed below the intact connection between the dorsal margin of the septum and the ULC. This translates to additional airway improvement. This method should be considered in patients with severe obstruction referable to the internal valve where the middle nasal vault does not need to be opened (no dorsal hump reduction and not deviated). A drawback to this method is the additional width that is incurred. Careful patient selection is therefore required.

Other methods to modify middle vault width have been described in the literature and include flaring sutures, suspension sutures, and butterfly grafts. In our experience, these methods are less predictable and/or less durable than properly placed spreader grafts.

**Stabilization of the Nasal Base**

Refinement of the nasal tip is one of the most difficult aspects of rhinoplasty. The main variables that are addressed are tip shape and position. Typically, modifications to the inherent shape of the tip are performed through a combination of conservative cartilage excision, suture modification, and structural grafting of the LLCs. The specific maneuvers performed vary tremendously, depending on the size, shape, position, and strength of the existing LLCs and caudal septum.

Equally important is establishing the appropriate tip position. The projection and rotation of the nasal tip may be conceptualized through Anderson’s tripod paradigm. The two lateral crura and the conjoined medial crura create the three limbs of the tripod. Other factors notwithstanding, shortening the medial crura will counter-rotate and deproject the tip; lengthening the medial crura will rotate and project; shortening the lateral crura will rotate and deproject; and lengthening the lateral crura will counter-rotate and project. Certain maneuvers will lead to immediate changes to the tripod architecture. These maneuvers may be performed through a combination of repositioning techniques such as suture repositioning of the medial crura onto the caudal septum in order to decrease projection and rotation; modification of structural shape such as dome suturing to increase projection (variable effect on rotation); structural grafting such as tip grafting, caudal septal extension grafting, or lateral crural strut grafting to increase or decrease projection/rotation or to change the shape of the tip; or overlapping techniques such as lateral crural overlap in order to deproject and increase rotation. It is preferable to avoid excessive reduction, excision, or weakening of tip structure. In fact, at this time the senior author rarely performs cephalic trim and if performed it is usually limited to the dome region and does not extend laterally. Details of refinement to tip shape and position are discussed elsewhere.

Often overlooked in rhinoplasty are the dynamic changes that the tip will undergo long after surgery. The combination of the long-term effects of scar contracture, gravity, and mimetic forces stresses the structural integrity of the nasal tip. The tripod nasal tip paradigm is valid only if one understands that the entire tripod is a mobile and compressible structure. The concept of nasal tip support is well established. The major support mechanisms are the integrity of the LLCs, and the ligamentous attachments between the LLC and the ULC and between the LLC and the septum; surgical destabilization of these structures often occurs during rhinoplasty. The senior author believes another major support mechanism is the caudal septum and plays a major role in the majority of his rhinoplasty cases. Cartilage excision, morselization, and cross-hatching will weaken the inherent structural support of the LLC architecture. Separating the medial crura from the septum and the ULC from the LLC compromise the main ligamentous tip supports. Unless the tip is soundly resupported at the time of surgery, a high risk of postoperative loss of tip projection is incurred. For these reasons, stabilization of the nasal base is essential in order to achieve durable results in tip modification.

The method chosen to stabilize the nasal base depends on the particular anatomy and surgical goals. Typically, any given method of base stabilization may be adjusted to effect subtle changes in tip projection and rotation as well. The techniques most commonly employed by the senior author to stabilize the nasal base include fixation of the medial crura onto the caudal septum or use of a caudal septal extension graft with extended spreader grafts. In each of these techniques, a stable midline cartilaginous structure is employed to add support to the nasal base and tip. The tripod is effectively stabilized to the caudal septum or the caudal septal extension graft extending off of the existing caudal septum and may be differentially positioned relative to it in order to create alterations of tip position.

The medial crura may be suture stabilized onto the caudal septum in patients with a relatively long midline caudal septum (tongue in groove technique). Such patients may present with a hanging columella, tension nose deformity, or overprojected tip and usually require trimming of the caudal septum. If the medial crura are sutured to a normally positioned caudal septum, then retraction of the columella may be created. The medial crura are separated and dissected free of the caudal septum. Bilateral mucoperichondrial flaps are raised on the septum so that mucosal redundancy created by tip repositioning may be distributed cephalically. The medial crura are fixated with horizontal mattress sutures in a tongue-in-groove manner. An initial fixation suture may be placed full thickness through the medial crura, caudal septum, and vestibular skin of the membranous septum with a 4.0 plain gut on a straight needle (SC-1). Once the desired positioning is achieved, 5.0 PDS suture may be used to reinforce the fixation between the inner surface of the medial crura and septum. The septal flaps must be redistributed evenly and tightly to the midline with several passes of a 4.0 plain gut suture on a straight needle (SC-1). Care must be taken not to make
The caudal septal extension graft relies on the same principle as setting back the medial crura on a midline caudal septum. The difference is that the caudal septum is effectively lengthened with a cartilage graft so that the medial crura may be readily sutured to it. Patients with a relative caudal septal deficiency may present with columellar retraction and an underprojected, over-rotated tip. Many patients with a normal alar columellar relationship may have a short caudal septum as well. The senior author uses a caudal septal extension graft in most patients in lieu of a columellar strut. The graft is placed end to end with the existing caudal septum and typically stabilized with two extended spreader grafts (Fig. 7.5). The caudal aspect of the graft should be in the midline so that the medial crura may be stabilized in a midline position. Both setting back the medial crura on an overly long midline caudal septum and the caudal septal extension graft allow for changes in projection, rotation, nasolabial angle, and columellar show by variably positioning the medial crura onto the septum or caudal extension graft. The caudal septal extension graft has the potential for a greater degree of tip alteration as the shape and orientation of the effective caudal septal margin may be altered. For instance, if the caudal septal extension graft is longer anteriorly toward the tip, counter-rotation may be achieved (Fig. 7.6). If the graft is longer posteriorly near the nasal spine, the nasolabial angle may be opened with a resultant appearance of increased tip rotation (Fig. 7.7). These techniques rely on the stability of the septum to stabilize the tip. Therefore, the caudal septum itself must be structurally intact and securely attached to the nasal spine and maxillary crest in order to ensure durable stabilization.

The columellar strut is a technique which may be used to stabilize the nasal base. This technique is useful in the cases in which tip position and alar columellar relationship is not changed and tip support is adequate. The strut should be rectangular and may vary from 5 to 12 mm in length, 3 to 6 mm in width, and 1 to 3 mm in thickness. The strut is placed in a pocket between the medial crura and sutured to the medial crura in a horizontal mattress fashion. Because the strut does not extend to the nasal spine, it cannot push the tip beyond its existing projection. Thus, while the floating columellar strut will provide some support to the medial crura, such struts may not be adequate for patients with a deficient nasal base.
As a columellar strut extends closer to the nasal spine, a theoretical increase in tip support is gained. The strut, however, must be strong enough to withstand the downward tension of the tip, particularly if it is designed to push the tip beyond its current projection. This is the concept of the extended columellar strut. This technique aims to create a significant increase in projection in patients with a major deficiency of tip support. The non-Caucasian patient and the patient with a congenital nasal deformity often exhibit this scenario. Other anatomical findings indicative of a patient with a deficient nasal base include a ptotic or underprojected nasal tip, and the nasolabial angle can be overly acute. The graft is typically harvested from costal cartilage in order to impart sufficient strength to the nasal base and tip. The strut is suture fixed to the periosteum of the nasal spine. A notch in the undersurface of the strut may be made to articulate with the spine and prevent migration from the midline. Alternatively, the graft may be incorporated with a separate premaxillary graft in a tongue-in-groove manner. This may be necessary in patients with an exceptional degree of premaxillary deficiency. When the nasal septum is absent or severely deformed, the caudal septal replacement graft is sutured into a notch made in the nasal spine using a 5-mm straight osteotome (Fig. 7.8). As in the other techniques, the medial crura are sutured to the extended columellar strut to achieve the desired projection. If the patient has an acute nasolabial angle and the tip is underprojected, the nasal base can be advanced anteriorly to increase tip projection and open the nasolabial angle (Fig. 7.9).

Once the nasal base is stabilized, dome binding sutures can be used to set the width of the domes. Dome sutures will also provide a slight increase in tip projection and rotation. Dome sutures, however, run the risk of deforming the lateral crus, creating lateral bulging of the lateral crus. Alternatively, straightening curved lateral cartilage may create the appearance of a less bulbous tip. Lateral crural struts are useful grafts in such cases. These also have the benefit of allowing the surgeon to reposition malpositioned LLCs, which is helpful in patients with retracted ala, pinched nasal tip, and vertical asymmetry of the alar base insertion. These flat cartilage grafts are placed between the undersurface of the lateral crura and the vestibular skin. The vestibular skin should be carefully elevated from the lateral crura from cephalad to caudal. If repositioning is needed, the lateral crus may need to be detached laterally. The graft should extend from just lateral to the domes to the lateral aspect of the lateral crura. The lateral crural strut graft should be stabilized to the crus with a 5.0 PDS suture and then a pocket should be made in the ala to insert the strut graft (Fig. 7.10). Dome sutures may be used after placement of the lateral crural strut grafts in order to provide definition. Once the width of the domes is set, the distance between the domes can be set with an interdomal suture. This suture goes through both intermediate crura and should not be tied too tight; otherwise, the columellar lobular angle can be effaced. If a cleft remains between the domes, a small piece of crushed cartilage or soft tissue can be placed between the domes. Often a piece of cartilage or soft tissue is placed horizontally over the tip to provide tip definition and smoothing. In patients with thick nasal tip skin, we frequently use a sutured-in-place tip graft to provide additional projection and tip contour. Shield grafts frequently measure 10 to 12 mm in length, 5 to 7 mm in width, and 2 to 4 mm in thickness. Tip grafts are sutured to the caudal margin of the medial crura with four to six 6.0 Monocryl sutures. Tip grafts should not be used in patients with thin skin and cautiously in medium skin as these grafts may become visible over time.

Secondary Rhinoplasty

Several special considerations must be made for secondary rhinoplasty. The external approach is an excellent method to gain exposure of the cartilaginous structures as dense scar often impedes dissection. In such cases, the direct visualization provided by the external approach may be needed to perform complex cartilage grafting and tip reconstruction. In the cases with severe scar formation, even with direct visualization, it may be difficult to differentiate scar from cartilage. As in primary cases, three-point retraction while applying downward pressure with the tips of Converse scissors will aid in finding and maintaining the correct plane. The surgeon should always protect the integrity of the SSTE.

A common reason patients seek secondary rhinoplasty is for the correction of postoperative nasal obstruction. In such cases, previous surgery has led to overreduction, destabilization, and/or collapse of normal nasal support structures. The most common causes of postrhinoplasty obstruction are lateral wall collapse, middle vault collapse, and persistent

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**Fig. 7.8** Caudal septal replacement graft sutured to notch made in nasal spine with notch of the septal extension graft abutting the spine notch to avoid superior migration. Note the bilateral extended spreader grafts stabilizing the extension graft in the midline.

**Fig. 7.9** Caudal septal replacement graft fixed to nasal spine. Nasal projection increased by advancing nasal base anteriorly on graft to increase projection and create more favorable nasolabial angle.
Fig. 7.10  Patient with cephalic positioning of lateral crura who underwent repositioning of lateral crura. (a) Lateral crura are cephalically positioned. (b) Lateral crura dissected from underlying vestibular skin. (c) Lateral crura repositioned with lateral crural strut grafts. (d) Side view showing lateral crural strut grafts under the lateral crura. Frontal views: (e) preoperative and (f) 3-year postoperative. Lateral views: (g) preoperative and (h) postoperative. (continued)
Fig. 7.10  (continued)  

(i) Preoperative oblique view.  (j) Postoperative oblique view.  
(k) Preoperative base view.  (l) Postoperative base view.  
(m) Preoperative base view with inspiration showing collapsing nostrils.  
(n) Postoperative base view with inspiration showing intact airway.
or inadequately treated septal deformities. Certain cosmetic stigmata are associated with these functional deficits. These include a narrow middle vault, an inverted-V deformity at the cartilaginous–bony junction of the dorsum, supra-alar pinching, and alar pinching. Prevention of these deformities during primary rhinoplasty is far better than secondary correction. Avoidance of over-resection of the LLCs, stabilization of the base and tip, and reconstitution of the middle vault using spreader grafts are key steps in avoiding such complications.

One complicating factor of secondary rhinoplasty is the lack of septal cartilage available for grafting material. In these cases, it is often necessary to harvest cartilage from the auricle or the chest to harvest rib cartilage. The senior author typically harvests ear cartilage using the postauricular approach.

In the cases when ear cartilage is insufficient or exceptionally strong grafting material is needed, costal cartilage may be harvested. Typically, the cartilage is taken from the sixth or seventh rib. A 1.0 to 1.2 cm incision is made over the medial aspect of the selected rib medial to the osseocartilaginous junction. The muscle is separated in the direction of its fibers to access the surface of the rib. Subperichondrial dissection around the rib is performed with an elevator (Fig. 7.11). It is important to retain a subperichondrial dissection on the deep surface of the rib in order to avoid injury to the pleura. Under direct visualization, the graft is freed from the surrounding perichondrium and the desired segment is sharply excised. A needle may be inserted into areas of the rib in which it is unclear whether bone or cartilage is present. Closure should be performed in a layered fashion after hemostasis is achieved.

The harvested segment of the costal cartilage is carved into three separate segments and then observed for tendency to curve (Fig. 7.12). This allows the surgeon to select the cartilage segments with the proper curvature for specific grafts.

The presence of damaged or incomplete nasal cartilages poses one of the biggest challenges during secondary rhinoplasty, and components of the structural framework of the nose must often be strengthened or completely reconstructed in order to restore appearance and function. Common problem areas in secondary rhinoplasty include the nasal tip, the lateral nasal wall, the alar margin, and the middle vault.

Postoperative tip weakness may occur if the nasal base is inadequately supported during primary rhinoplasty. In some cases, this manifests as an underprojected tip and pollybeak deformity. In other cases, concurrent maneuvers such as caudal septal resection or scarring from lateral crural excision may create forces that result in a tip with excessive tip rotation. The corrective technique depends upon the status of the alar cartilages. Often, the LLCs have been weakened and have lost inherent structural strength. The base must be restabilized through one of the techniques outlined above. In cases of previous caudal septal resection, medial crural stabilization with a caudal extension graft will achieve base stabilization as well as setting tip position. In cases of severe loss of tip support and projection, a costal cartilage extended columellar strut may be indicated.

Tip shape is determined by the size, shape, and orientation of the cartilage of the intermediate and lateral crura. Asymmetries, bossae, bulbosity, and other abnormalities may result from previous surgery. In many cases, the cartilage is so damaged that reorientation of existing structures cannot create adequate tip support. Particularly in thick-skinned patients, a robust tip structure must project into the thick skin envelope to transmit shape through the skin. In such cases, a shield-shaped tip graft with lateral crural grafts may be used...
to this end (Fig. 7.13). The graft is sutured to the intermediate and medial crura. The dimensions of the shield graft depend on the desired augmentation to the infratip lobule and tip. The leading edge of the shield graft may project beyond the domes by as much as 8 mm when a significant increase in projection is needed. A buttress or cap graft may be placed cephalad to the leading edge of the graft in order to support the graft and camouflage the transition to the supratip. However, these grafts should not be used in thin-skinned patients and very sparingly in medium-skinned patients as they can become visible with time. Lateral crural grafts are placed on the existing lateral crura to the posterior surface of the shield graft if the tip graft projects more than 3 mm above the existing domes. The lateral crural grafts are different from lateral crural strut grafts that are placed on the undersurface of the lateral crura. The lateral crural grafts prevent the shield graft from rotating cephalically.

Lateral nasal wall narrowing and collapse is often the consequence of excessive cephalic trim of the lateral crura. Patients with a long, narrow nose and a preexisting prominent supra-alar crease are susceptible to this complication. Examination of such patients may reveal pinching in the supra-alar area with dynamic collapse during inspiration. Correction of this problem requires strengthening the lateral nasal wall and may be performed with alar batten grafts, in addition to the lateral crural strut grafts mentioned above. Lateral crural strut grafts with repositioning is the primary mode of supporting the lateral wall when deficient. Alar batten grafts are typically thin grafts that are placed along the caudal margin of the ULC. This area may have been exposed when the lateral crura were moved caudally with the repositioning.

Like other complications, secondary deformities of the alar rim may result from over-resection or weakening of the alar cartilages. Aggressive cephalic trim may cause cephalic retraction of the alar rim margin and excessive columellar show. Weakening at the alar margin may lead to notching and collapse, most evident by a loss of the favorable triangular base view. This deformity is corrected using lateral crural strut grafts with repositioning caudally. In some cases, a small residual asymmetry may remain and can frequently be improved using alar rim grafts. These are narrow cartilaginous grafts placed into precise pockets along the alar rim just caudal to the marginal incision (Fig. 7.14). They measure 2 to 3 mm in thickness and width, and 5 to 10 mm in length. Softer material, such as cartilage harvested from
7.9 Key Technical Points

1. A limited volume of local anesthetic should be used in order to prevent distortion of the anatomy.

2. A transcolumnellar incision in an inverted-V orientation at the level of the midcolumnella is connected to bilateral marginal incisions.

3. Use of 3-point retraction and sharp dissection will allow development of a plane immediately superficial to the perichondrium at the domes, lateral crura, and middle vault.

4. Septal cartilage is approached in a subperichondrial plane through an intranasal hemitransfixion, or Killian's incision, or through an external approach with dissection between the medial crura.

5. The upper vault is exposed in a subperiosteal plane with a narrow pocket preserved for possible graft placement.

6. The horizontal junction of the ULC and dorsal septum must be stable and symmetrical. Placement of spreader grafts may aid in restoring support to this area and setting middle vault width.

7. The nasal tip shape and position depend on surgical manipulation of the LLCs. Durable effects depend on stabilization of the nasal base in order to support the tip against forces of scar contracture, gravity, and facial musculature. The main techniques for base stabilization include securing the medial crura onto the caudal septum, caudal septal extension graft, sutured-in-place columellar strut, extended columnellar strut, and lateral crural strut grafts.

8. Secondary rhinoplasty often aims to correct the functional and cosmetic sequelae of the weakened or deficient structural framework of the nose. Corrective surgery must restore the support structures of the nasal tip, lateral nasal wall, alar margin, and middle vault. The dependable techniques for these problems include shield grafts, alar batten grafts, alar rim grafts, lateral crural strut grafts, and spreader grafts.

9. The columnellar incision should be closed with fine sutures and skin edge eversion.
7.10 Postoperative Care

In most cases, the patient is discharged home a few hours after surgery. Antibiotics are given for at least 10 days postoperatively. A first-generation cephalosporin is used for simple primary cases in order to cover skin and intranasal flora. In complex secondary cases, particularly if ear or costal cartilage is harvested, a quinolone such as ciprofloxacin or levofloxacin is used in order to add antipseudomonal coverage. Viscodin is given for pain control, but the patient is encouraged to change to acetaminophen once discomfort begins to subside. The patient is also instructed to clean the nasal lining with hydrogen peroxide on a cotton-tipped applicator and apply Bacitracin ointment over the incisions. Patients are also started on antibiotic soaks for the first several days after surgery to prevent infection. The patient is instructed to avoid salt in his or her diet, exertion, and overheating, all of which may induce increased edema.

After this point, frequency of follow-up depends on the complexity of the surgery and the individual postoperative course. On average, patients are seen 3 times within the first month, 5 to 10 more times over the next 12 months, and at least yearly after that. These repeat visits are critical so that the nose may be closely monitored as edema resolves and the SSTE contracts. Over time, slight asymmetries may become apparent at the tip, supratip, or dorsum. If the fullness is compressible, it may be caused by unequal resolution of edema. An area in which more dissection or manipulation was performed may be swollen to a greater degree and duration.

Local steroid injection is another technique to improve areas of soft-tissue fullness that are slow to resolve. This technique may help alleviate slight asymmetries that are not fully corrected by digital exercises. Injections will also expedite the resolution of tip and supratip fullness, a process that is particularly extended in the thin-skinned patient. Steroid injections may expedite this process.

Frequent follow-up is crucial in order to detect abnormalities as early as possible and to correct them through the methods described. Long-term visits are important as the nose continues to change for many years after surgery. Photographs should be taken throughout the postoperative course in order to follow these changes. Only through repeated follow-ups, study of photographs, correlation to operative worksheets, and ongoing analysis will the rhinoplasty surgeon learn from previous mistakes and gain better surgical results.

7.11 Complications

Bleeding is the earliest common postoperative complication following rhinoplasty and is usually self-limited. Rarely, bleeding continues beyond several days after surgery. In such cases, a careful intranasal examination with rigid endoscope and suction may be required to identify source of bleeding. In these cases, it may be an exposed vessel on the inferior turbinate, septum, or granulation tissue around the septal splint that may be the source of the bleeding. Typically, small hemostatic dressings can be used to stop this bleeding. Rarely, cautery will be necessary.

Postoperative infection is rare and is characterized by increased pain, swelling, and erythema. If infection occurred despite taking antibiotics, a broader spectrum may be considered. If infection progresses despite these measures or if fluctuance develops, the intranasal incisions need to be opened to allow drainage and irrigation beneath SSTE and any granulation tissue that is present must be removed. The presence of infection is compounded in the presence of multiple grafts or alloplastic materials.

Long-term complications related to collapse of nasal structures and contracture of the SSTE may manifest as lateral pinching, collapse of the middle vault, alar retraction, and ptosis. As stated previously, these complications are avoided through stabilization of these structures and avoidance of over-resection during primary surgery. These types of problems may not become apparent for several years after surgery. If severe, revision surgery to reconstruct the deficient areas may be required.

References

Chapter 8

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8 Endonasal Tip Rhinoplasty Approaches and Techniques

Scott Shafar and Stephen W. Perkins

8.1 Introduction

Often, the most challenging part of rhinoplasty is modifying and refining the nasal tip. Endonasal delivery flap techniques have an extensive and successful history. This chapter will focus on the beauty, versatility, and the simplicity of endonasal tip surgery.

Achieving tip definition has evolved since Joseph introduced cosmetic rhinoplasty in the late 1800s. This evolution is described well by Tebbetts. Initially, nasal tip-shaping techniques were destructive, consisting mostly of incising and resecting cartilage. Often the tip was approached in either a retrograde or a cartilage-splitting fashion. The limited visibility of these approaches increased the likelihood for possible asymmetry, with the destructive techniques that were implemented resulting in consistent loss of tip support and increased risk of secondary deformities.

In contemporary rhinoplasty, primary outcomes such as solid structural support and unimpeded nasal airflow have taken on an equivalent and justified level of importance as the aesthetic outcomes and refinement. Focus has now turned towards cartilage preservation, and an emphasis has been placed on using various cartilage grafting techniques for support and contouring.

With this shift in philosophy, there has been an increase in the amount of open structure rhinoplasty being performed. Supporters of the transcolumellar incision, and resulting broader exposure, maintain that there are more opportunities to use certain grafting techniques, and therefore more methods at their disposal to achieve more refined results and prevent late complications. Despite the approach, we now have evolved into an era of nondestructive tip-shaping techniques. These methods allow achievement of the desired aesthetic appearance while maintaining or recreating projection and functional tip support. This assures excellent results not just at 1 year, but also at 5 years, 10 years, and more.

Our approach is based on the creation of the double-dome unit as described by McCollough and English. In addition, individual treatment of each dome to create the correct contour is further described. Long-term success using these techniques has been well described. We will first describe our basic surgical technique, followed by specific nasal tip deformities and the steps utilized to correct them.

8.2 Indications

The ideal patient for these techniques has been described by Tardy et al. The ideal patient has a slightly bifid or broad tip with double-dome highlights. Thin to moderate thickness skin and sparse subcutaneous tissue allow for more refined results from these endonasal techniques. The alar cartilages themselves must be firm and strong. Finally, the alar sidewalls should be thin and delicate, yet resist collapse and recurvature. Most patients do not have these ideal features. Yet by using the endonasal approach and a progressive method with each tip, excellent aesthetic results can still be achieved.

8.3 Contraindications

There are certain conditions in our experience that favor the use of the external columellar approach and allow accomplishing specific techniques much more easily. It is often difficult to deliver, in a safe and adequate manner, alar cartilages in a patient with scar tissue in the lobule from previous reconstructive nasal surgery or trauma. Additionally, in the setting of “cocaine nose”, preserving the mucosal integrity of the nasal vestibule, maintaining as much mucosal integrity as of utmost importance, and an endonasal approach would not be the ideal choice. Similarly, if one is trying to manipulate a cantilevered graft, place a caudal septal extension graft, or repair a markedly crooked or twisted nasal tip with discrepancies between the two medial crura, the external approach affords the surgeon a wider exposure to accomplish these goals. Again, while the endonasal approach is not contraindicated in these settings, some maneuvers are more easily performed with an open technique. Other indications for the external columellar approach include when a patient presents toward the extremes of overprojection, overrotation, underprojection, and under-rotation of the lobule.

8.4 Preoperative Considerations

All patients are initially seen in consultation with their selected surgeon. The consultation room is designed to put the patient at ease while still maintaining a professional environment. The nasal analysis begins with the patient on a comfortable swivel stool with the back in front of a three-way mirror with the physician directly behind him or her. Together they analyze the nose with the physician gently guiding the discussion. The three-way mirror offers a more three-dimensional conversation.

An in-depth nasal history is taken during the consultation (Fig. 8.1a, b). Inquiries include any previous nasal trauma or surgery, difficulties breathing through the nose, any history of sinus disease or allergies, and current nasal medications. The physician reviews a more extensive medical history form, completed by the patient prior to consultation. Intranasal exam is also performed at this time to detect deformities of the septum, enlargement of the turbinates, or other intranasal pathology.

The procedure should be thoroughly discussed at this time and goals summarized with the patient. The physician reviews with the patient what to expect on the day of surgery, including the length of surgery, anesthesia, recovery, and discharge. Initial postoperative care and restrictions regarding certain activities are also discussed. Finally, the limitations of the surgery as well as possible complications are given as part of obtaining informed consent.

The consultation is then continued in the photography suite, where computer imaging is used to illustrate the physician's goals for surgery. This allows for confirmation that both the patient and the surgeon agree on the desired aesthetic goals to be achieved. Following this, a full set of nasal images are taken for preoperative documentation.

The last phase of the consultation is spent with the scheduling nurse, where questions can be answered in what often is a more comfortable setting for the patient. Fees are reviewed with the patient and signed copies of the procedures and fees are given to the patient. Any necessary lab work is arranged at this time.

Prior to surgery, all patients receive folders with detailed instructions on surgery, prescriptions, and a booklet reviewing postoperative healing and expectations. All patients start an oral antibiotic the day prior to surgery, most often either oral cephalaxin or azithromycin, and continue this for 5 days.
8.5 Preoperative Analysis
The preoperative analysis is the foundation of any successful rhinoplasty operation but is even more crucial for tip reconstruction. The surgeon should assess the tip complex by inspecting the external contours, and interpret how the exam translates into the underlying nasal architecture. Both static and dynamic intranasal inspection of the external nasal valve, septum, turbinates, and internal nasal valve should be included and documented. A modified Cottle's maneuver can be helpful in eliciting feedback from a patient presenting with obstructive symptoms. The tip shape should be described, for example, as bulbous, twisted, or infantile. Both the degree of rotation and the extent of projection should be evaluated. It is critical to assess skin thickness and this issue alone may dictate approach and/or procedure to be performed. Palpation is helpful in determining the nature, volume, strength, and resiliency of the lobular cartilages as well as in evaluating tip support. Finally, it is important to note columellar abnormalities and their relation to the alar cartilages.

8.6 Surgical Technique
The patient is taken to the operating room and general anesthesia is induced prior to injecting local anesthesia. First pledgets soaked in 5% oxymetazoline are placed intranasally. After adequate time for decongestion, infiltration is started with 2% lidocaine with 1:50,000 dilution of epinephrine. No more than 7 to 8 mL is injected to avoid volume distortion of the nasal tissues.

Individual variations in anatomy and expectations preclude the rote use of a single technique for each patient, and the technique and approach should be tailored to meet the operative goals. Several approaches exist including the caudal approach, transcartilaginous incision, retrograde approach, or our most commonly used delivery flap technique, which offers visualization of the entirety of the alar cartilages.

The delivery flap technique begins with a high septal transfixion incision, and depending on existing tip projection, the septal transfixion incision can be carried down inferiorly into a complete transfixion incision, releasing the medial crural feet from the septum if further deprojection is desired (Fig. 8.2a, b). This is then connected with bilateral intercartilaginous incisions (Fig. 8.3). A plane of dissection is created at the superior septal angle over the dorsal aspect of the cartilaginous septum and upper lateral cartilages up to the bony cartilaginous junction when indicated. When further tip refinement or grafting is necessary, bilateral marginal incisions are made, and the lower lateral cartilages (LLC) are delivered. The delivery technique makes use of thin, outwardly...
beveled, Metzenbaum scissors to elevate the skin–soft tissue envelope off the underlying LLC, and the alar domes are individually delivered with a single hook and supported with the Metzenbaum scissors (Fig. 8.4). In this fashion, each dome is assessed and recontoured separately. The authors have found that the endonasal approach (incorporating bilateral marginal and intercartilaginous incisions) allows for excellent visualization of tip anatomy by presenting the alar cartilages as bipedicled chondrocutaneous flaps as previously described by the senior author.3

The first step in achieving improved tip definition is the removal of fibrofatty tissue between the domes. This allows
greater approximation of the two alar domes. Next, the authors perform a conservative cephalic margin trim allowing for tip rotation and adjustment of the LLC and supratip fullness for further tip and supratip dorsal refinement. The maneuver is performed by gently dissecting the vestibular skin off the undersurface of the LLC, and then excising the cephalic margin strip of cephalic LLC (Fig. 8.5). Care must be taken not to destabilize the tip, and only a conservative resection should be used, leaving an adequate amount for lateral wall support by maintaining approximately 7 to 9 mm of LLC. In a few select cases, this may be all that is required and the cartilages may be replaced in situ. In most cases, however, other techniques are required to achieve satisfactory tip definition and symmetry.

The ideal alar configuration has been described as the domal segment being convex, the adjacent lateral crura being slightly concave, and the overlying soft tissue being thin. Most often, individual dome treatment with suture is required, such as an intradomal or single-dome suture. The technique begins by dissecting vestibular skin off the undersurface of both intermediate domal areas (Fig. 8.6). Once freed, each dome is gently pinched together and using a resorbable horizontal mattress suture, in our case 5–0 Monocryl (Ethicon, Sommerville, NJ, United States), the dome is reshaped and used to narrow and refine each tip-defining point (Fig. 8.7a, b). Reevaluation of the domes should be performed at the time of the procedure, and if any asymmetry is noted, the sutures can be removed and resutured as necessary. If the individual domes remain asymmetrical or improved supratip definition is desired, individual dome trimming can be performed. This involves “beveling” the cephalic portion of the single-dome unit (Fig. 8.8).

With achievement of symmetrical, aesthetically pleasing individual domes, the entire tip is reevaluated. Utilization of the endonasal approach allows this continual critiquing. A double-dome or transdomal mattress suture is next used to bring the individually defined domes together and stabilize these into one unit. Stabilization is the key to maintenance of long-term results.

To use this technique, vestibular skin must be elevated away from both domes, separating the crural cartilage from the overlying fascial attachments. Once freed, a single nonabsorbable suture, undyed 5–0 Prolene (Ethicon, Sommerville, NJ, United States), is inserted into the incision and brought through the dome. The suture is then tied, securing the dome in place. The process is repeated for the remaining domes, ensuring that they are positioned symmetrically and aesthetically pleasing.
Fig. 8.7 (a,b) Single-dome suture placed at the junction of lateral and medial crura in a mattress fashion.

Fig. 8.8 Dome narrowing by beveling the cephalic portion of the single-dome unit.

States), is placed in a horizontal mattress fashion between each dome taking care to place the knot medial to the domes (Fig. 8.9a–d). With the domes replaced, the amount of narrowing can be seen as one tightens the knot. It is important to avoid cinching down the suture and creating a unitip appearance. The tip is then reevaluated. At this point, the decision is made whether or not more aggressive steps will be required to achieve the desired tip aesthetics. This could include steps such as lateral crural flap, dome division, or the medial crural overlay maneuver. However, when there are variations in the length of the medial crural portions of the LLC, the medial crural overlay is performed to reestablish symmetry (Fig. 8.10a, b). These techniques require the vestibular skin to be elevated off the medial crura through marginal incisions which must be extended along the columella. Once exposed, the medial crus is incised within the intermediate section, and a segment is overlapped (1–3 mm), and sutured with a 6–0 polydioxanone (PDS) (Ethicon, Sommerville, NJ, United States) suture, to reconstitute the integrity of the medial crus. This effectively will lower the treated unilateral dome, which can then be secured using the double-dome suture, medial crural suture, or columellar strut graft, maintaining structural integrity and natural domal highlights. This technique is especially helpful in thin-skinned individuals, or those individuals with curved medial crura or twisted medial crura (Fig. 8.11a–f).

Removing or replacing the double-dome mattress sutures and addressing the anterior–posterior or caudal–cephalic placement of a suture in relation to the other dome may address minor asymmetries.

Dome division is utilized sparingly for the rare instances when the above more conservative techniques have not been successful. Dome division can allow for more tip narrowing, which is especially required in those with thick skin. Dome division can also be used to achieve upward rotation and increase or decrease tip projection. Finally, correction of tip asymmetries may be more easily addressed with dome division. Dome division can be performed medial to the dome, lateral to the dome, or at the dome.

Conservative upward rotation of the tip is typically achieved by resection of an inverted triangle of caudal septum with corresponding vestibular skin and using a columellar strut to assist in “pushing” the lobule cephalically. If further rotation is required following this, the lateral crural flap or overlay technique can be employed. This can involve a full incision of the lateral crura or simply a cephalic wedge excision. A cartilaginous incision is then made in the lateral crus from cephalic to caudal, and the anterior edge of the cartilage is then overlapped over the crus and sutured into place using absorbable 5–0 Monocryl suture taking care to camouflage the knot. Often there is an excess triangle of caudal cartilage, which is sharply excised to restore alar contour.

Following achievement of a symmetrical and well-defined tip, attention is then turned to the septum, the dorsum, and lastly, osteotomies. A columellar strut fashioned from septal cartilage is placed between the medial crura and anterior to the nasal spine prior to osteotomies. Intranasal incisions are closed with interrupted 5–0 plain gut sutures. In closing the marginal incisions, it is important to avoid the lateral crura when suturing. Retraction of the lateral crura could lead to possible alar collapse and nostril asymmetries.

8.7 Case Studies

8.7.1 Boxy Tip

The boxy tip falls under the category of a wide or broad nasal tip. Tips that demonstrate minimal deformity and minimally excess width can be addressed in the most conservative fashion. The boxy tip is similar to the trapezoidal deformity; however, the intermediate crura are not divergent. Often the cartilages are strong and weakening of the cartilages may be required. The ideal sutures for correction of the boxy tip include the single- and double-dome suturing techniques (Fig. 8.12a, b). These can be used to narrow and refine the nasal tip through an endonasal approach. If further refinement is needed, the soft tissue between the domes may be removed.
8.7 Case Studies

8.7.2 Bulbous Tip

The bulbous tip is an extension of a wide or broad tip in that the cartilages are more bulky and require a greater degree of individual dome refinements and narrowing. The authors begin to address the bulbous tip with a cephalic margin trim to help reduce the volume of the LLC. In addition to single- and double-dome suture modification, lateral alar support is often required because the bulbous tip often has some component of cephalic malpositioning or vertical orientation to the alar cartilages. Alar strut grafts or alar turn-in grafts should be considered, to flatten the excess convexity and reduce supra-alar width (Fig. 8.13a–f). Although difficult, alar strut grafts can be placed endonasally, after elevation of the vestibular skin from the undersurface of the LLC, using a caudal margin approach for the elevation. Additionally, placement of an alar spanning suture might be required to complete the appropriate aesthetic narrowing of the excessively convex cartilages. Lastly, if supratip fullness persists, the cephalic portion of each dome can be beveled for further refining the supratip.

8.7.3 Bifid Tip

The bifid tip describes the clinical appearance of midline furrowing of the nasal tip. Correcting or effacing infratip or columellar bifidity often requires the same suture maneuvers as correcting the boxy tip. Additionally, narrowing the separation of the medial crura can address divergence and further narrow the infratip region using suturing techniques.

Fig. 8.9 (a–d) Double dome (interdomal) sutures are placed using a single nonabsorbable suture, placed in a horizontal mattress fashion between each dome, taking care to place the knot medial to the domes. The suture must be passed to the contralateral dome, and passed back to be tied.

Fig. 8.10 (a,b) Illustration of a unilateral medial crural overlay maneuver.
Fig. 8.11 Preoperative asymmetric nasal tip (a,c,e) and 24-month postoperative views (b,d,f) following endonasal rhinoplasty with medial crural overlay and chin augmentation.
Fig. 8.12  (a) Preoperative basal view of a boxy tip. (b) Postoperative basal view of tip refinement of a boxy tip.

Fig. 8.13  A 17-year-old female presenting with a preoperative broad/bulbous nasal tip (a,c,e), and 9-month postoperative improvement in tip contour and symmetry using interdomal and intradomal sutures in addition to cephalic margin trim (b,d,f). (continued)
Augmentation of the infratip lobule or the length of the columna with cartilage batten grafts, morselized cartilage, or overlay with a full-length shield graft may be necessary. If further refinement is needed, the soft tissue between the divergent domes may be removed.

8.7.4 Trapezoid Tip

The trapezoid tip deformity is due to divergent intermediate crura, and trapezoid tips may additionally involve some cephalic malposition of strong alar cartilages (Fig. 8.14a–d). Cartilage splitting or transcortilaginous cephalic margin resection is unwise in these patients as both can often lead to the late development of bossae. Similar to the bulbous tip, the trapezoid tip may require a reduction in volume with the use of a cephalic margin trim. Cephalic margin trim should be conservative to avoid lateral crural recurvature, further weakening of the lateral alar walls, or collapse of the external nasal valve. Further structural stabilization may be required using a columellar strut, tip grafting of the infratip lobar area in a sutured or nonsutured fashion, and possible alar strut graft placement when cephalic malpositioning is noted. The surgeon should attempt to reorient the cephalic position of the alar cartilages more caudally. This can be necessary if the lateral alar sidewalls are weak and tend to collapse or recurve inward when the domes are brought together. Reconstitution of the interdomal ligament—single- and double-dome suture techniques—is required for correction. Rarely, after attempting all the above-mentioned techniques, the surgeon may still not be able to achieve an aesthetically pleasing tip. In such cases, dome division may be indicated to narrow the tip and straighten the lateral ala.

8.7.5 Asymmetrical Tip

A variety of techniques can be used to correct the asymmetrical tip, depending on the degree and the exact deformity. Suture techniques, such as single- and double-dome techniques, are often successful maneuvers to correct domal divergence and height discrepancies. If continued asymmetry is due primarily to a disparity in medial crura length, the medial crural overlay procedure may be employed as described above. For marked asymmetry between the domes not corrected with the above maneuvers, dome division is used. Typically the overprojected dome is truncated and the double-dome unit is reconstituted. When the entire nose is overprojected, bilateral dome truncation may be performed.

8.8 Postoperative Care

After all incisions have been closed, a folded postage stamp size of absorbable hemostatic mesh is placed underlying the vestibule of each newly constructed dome to add stability and prevent hematoma. A nonadherent gauze dressing is placed in the nasal vestibule to tamponade the osteotomy sites, which are removed on postoperative day 1. A drip pad is also utilized the first 24 to 48 hours. The nose is taped, and a modified tin splint is used for the external dressing that is removed at 1 week. Patient instructions include no strenuous activity for 2 weeks, no heavy lifting for 3 weeks, and avoidance of glasses on the nose for 4 weeks. Patients are closely followed for the entire first year. Revision surgery is considered only following a full 12 months of healing. Annual follow-up is strongly encouraged following the first postoperative year.

8.9 Complications

8.9.1 Bossae Formation

Knob-like prominences of the LLC can become visible with healing. Typically this is due to weakening of the lateral crura secondary to either over-resection or cartilage-splitting techniques. Patients with thin skin, strong cartilages, and nasal tip bifidity are at the highest risk for this. Resecting the deformed cartilage through a marginal incision can treat bossae. Further camouflage can be provided by either morselized cartilage or use of temporalis fascia grafts.
8.9 Complications

8.9.2 Alar Retraction

Abnormal and unsightly retraction or notching of the alar rim results from either buckling of the lateral alar crus, over-resection of the lateral crus, interruption of the alar cartilage lateral to the domes (rim strip), complete removal of the lateral crus, or late contracture that overpowers the inherently weak lateral crura. Improper suture placement during closure of the marginal incision can also retract the alar rim. Preservation of a complete strip of 7 to 9 mm or more in patients with a thin alar rim will help to prevent retraction.

Correction of alar margin retraction can be accomplished using several grafting techniques based on the degree of retraction. Mild forms of notching and retraction (< 2 mm) can be addressed using alar rim grafts without significant risk or need to permanently alter the alar cartilage. Moderate degrees of retraction (2–4 mm) often require the use of alar batten grafts to correct deformities of the alar margin. More severe presentation of alar retraction can be corrected by taking a composite graft from the cymba concha of the ear. A marginal incision is made in the area of retraction and a small pocket is dissected. The graft is then sutured into place, in effect pushing down the alar rim.

8.9.3 Tip Asymmetry

Postoperative asymmetry of the tip can be due to a variety of causes. Most often, it is due to uneven placement of the double-dome stitch. Healing forces can alter what was symmetrical initially during the postoperative period. Minor asymmetries not noted before surgery may become more obvious with a more overall symmetrical nose. Preoperative identification of tip asymmetries and meticulous technique can help to prevent their occurrence.
8.9.4 Improper Projection

Intercartilaginous as well as transfixion incisions do lead to decreased tip support as well as decreased projection. This is usually counterbalanced by the increased strength of the medial crura with creation of the double-dome unit. Columellar struts provide further strength and projection.

Most commonly, due to the inherent strength achieved with the double-dome unit, overprojection is the more common minor complication. Preoperative planning and continual intraoperative assessment will help to avoid either overprojection or underprojection.

8.10 Summary

The evolution in endonasal rhinoplasty has departed from the former cartilage resecting methods, with focus turned towards cartilage preservation, and grafting techniques for support and contouring. The modern era of nasal tip suturing techniques reshape existing cartilages in the nasal tip, modifying the tip through precise placement and tension control. These cartilage suturing techniques have been proven to be a reliable alternative for tip modification, and with proper execution, endonasal suturing techniques can be used to address unique and characteristic nasal tip deformities while still preserving the key structural support mechanisms.

The disadvantages of these techniques include the need for greater surgical finesse in delivering and suturing the alar cartilages. Also, techniques for the correction of certain deformities may be better addressed through the external columellar approach. Nevertheless, for most primary cosmetic tip rhinoplasties, the beauty and expedient nature of the endonasal delivery flap approach with double-dome techniques provides consistent, long-term results and few complications.

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Alar Reduction and Sculpture

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9 Alar Reduction and Sculpture
J. Regan Thomas and M. Eugene Tardy, Jr.

9.1 Introduction
Modification of the alar base and lobule anatomy during rhinoplasty by various forms of alar reduction, repositioning, reorientation, or sculpturing assists in balancing the final appearance of the nose. Aesthetic narrowing of the nasal skeleton and tip must, in selected patients, be balanced by concomitant reduction refinement of the alar base (usually as the final step in the operation), else the nose appears “bottom-heavy” and disproportionate. Classically, a vertical line dropped from each inner canthus alongside the nose should define, in most ethnic types, the lateral limits of the alae for an ideal normal appearance on frontal view (Fig. 9.1). Wider or more flaring alae suggest consideration for alar base reduction techniques (Fig. 9.2). These, like nasal tip sculpture techniques, are best executed in a graduated fashion, planned entirely upon the individual anatomy encountered and the aesthetic appearance desired. In most retropositioning tip techniques employed to correct the overprojected nose, lateral flaring of the alar sidewalls results, inviting alar reduction in both width and overall alar sidewall length.

Weir is credited with the first published reference to alar base narrowing. Therefore, alar base narrowing is traditionally referred to by surgeons as the “Weir procedure”; we prefer the term “alar base reduction,” since the exact procedure recommended by Weir is indistinct. His seminal article fails to illustrate the exact technique recommended. Others throughout the 20th century, however, have refined precise indications for and techniques of alar base reduction and narrowing during rhinoplasty.

9.2 Indications
The exact alar reduction technique chosen will be dependent upon the individual anatomy encountered, the aesthetic outcome desired, and the need to camouflage resultant epithelial scars. Alar modifications are rather consistently required to balance the nasal anatomy in certain ethnic anatomical types (i.e., black, Asian, oriental, and mestizo noses), while the need to perform alar reduction in the more typical Caucasian nose is less frequent. Nonetheless, alar base modifications are indicated when alar flaring, bulbosity, or excessive width of the nasal base are present, or when retropositioning of excessive tip projection results in a displeasing postoperative alar flare on the operating table. An excessively wide nostril floor dimension may also dictate the need for alar sill or nostril floor modifications. If preoperative asymmetry exists (as in the cleft lip/nose complex anomaly), alar modification should be considered.

Fig. 9.1 In faces with normal proportions, an imaginary line dropped from the inner canthi defines the normal width of the nasal alar base.

Fig. 9.2 (a) Unusually wide nasal base, significantly narrowed with a sliding alar flap procedure combined with improvement of tip projection (b).
Alar surgical modifications are usually most accurately performed as one of the final steps in aesthetic rhinoplasty, after all major and adjunctive procedures have been completed. At this time, the general appearance of the surgically modified tip may be assessed, and the indicated method of alar sculpturing may be selected and carried out. If any doubt exists about nasal proportions, it is best to defer alar reduction until a later date, when postoperative nasal-tip healing is more exact, and more accurate evaluation of the modified, healing nasal anatomy becomes clear.

Alar reduction of any type must be carried out in a conservative and symmetrical manner, lest one deformity be substituted for another. Even subtle or minimal asymmetries or over-reductions may create a major deformity where only a minor balance abnormality preexisted. If overaggressive resection of the alar base occurs, correction is difficult. In addition, it is important that the surgeon bring all his skills into play in the effort to minimize and camouflage the resultant alar scars, which can draw unwanted attention to an otherwise excellent rhinoplasty outcome.

In revision rhinoplasty, alar base reduction or modification is indicated if a widened or asymmetrical alar base exists. Similarly, poor or visible scars resultant from primary alar base reduction deserve improvement and camouflage.

9.3 Contraindications
Only relative contraindications exist for alar base reduction surgery. Infantile nostrils, even in patients with a widened alar base disproportion, should not be rendered to an unacceptably smaller dimension by alar reduction. Overly small nostril openings resultant from previous surgery should not be made unacceptably small by attempts to camouflage unsightly alar lobule or nostril sill scars.

Alar reduction of major magnitude should be contemplated with caution when revision open rhinoplasty is carried out. Compromised blood supply to the tip has been reported in a few patients in this category.

9.4 Alternative Techniques
Internal buried alar cinch suture techniques can narrow the alar base modestly, but generally at the expense of alar base tissue distortion and possible asymmetry. Moreover, long-term continuous tension created by permanent suture cinching is always subject to eventual suture tear-out and failure. Precision surgical alar excision and repair remains the more acceptable surgical choice.

9.5 Preoperative Considerations
Thorough informed consent is essential before alar reduction is contemplated. Patients must understand that bilateral alar–facial junction scars will be present (although generally nicely camouflaged). If available, preoperative computer imaging can assist in confirming for the patient the benefit of surgical alar base reduction. Standard five-view rhinoplasty photographic documentation is essential, with the close-up basa view most helpful.

9.6 Special Surgical Requirements
The following is a list of special surgical requirements:
1. Fast-absorbing catgut suture: 5–0.
2. Polydioxanone suture: 5–0.
3. Needlepoint microcautery.
4. Histacryl Blue or Dermabond tissue glue.
5. A 15C Bard-Parker knife blade.

9.7 Preoperative Analysis
Nothing equals the importance of extremely accurate and precise preoperative analysis and diagnosis in planning alar reduction surgery. The frontal and base views play the most important role in preoperative evaluation. A vertical line dropped from each inner canthus helps to define the aesthetic appropriateness of alar base anatomy (Fig. 9.1). On base view, the same vertical lines from the inner canthus define the correct alar–facial junction (Fig. 9.3). If the alar lobules fall outside (lateral to) this vertical line, alar base reduction is generally indicated to avoid a postoperative “bottom-heavy” nasal appearance.

The preferred terminology, desirable ideal normal anatomy, and preferred aesthetic relationships of the alae and nostrils to the face and nose are depicted in Fig. 9.4. In general, the alar lobule is composed of fibrofatty areolar tissues covered by epithelium both internally and externally (Fig. 9.5). Completely devoid of alar or sesamoid cartilage, the alae assume markedly different shapes, sizes, and configurations in different ethnic groups and even within similar ethnic groups (Fig. 9.6). In the typical Caucasian patient, the alar sidewalls serve as minor or adjunctive supportive mechanisms for the nasal tip, but if thin, delicate, and somewhat anatomically frail, they may contribute nothing to tip support and are in danger of potential eventual collapse if an overabundance of supportive alar cartilage is resected during tip sculpturing.
The site and position of insertion of the alae into the face influence nasal proportions and aesthetics dramatically. A more cephalic location of the alar–facial junction may create a high, arched appearance to the alae, exposing an excessive and undesirable amount of columella; when this anatomical variant is even more profound, a snarl-like appearance may result. More caudal insertions of the alae into the face produce the appearance of a disproportionately large and bulbous alar lobule, resulting in alar “hooding,” and inadequate exposure of the aesthetically appropriate amount of columellar anatomy. More commonly, less profound variations of anatomy between these two extremes exist, and are among the easiest to correct. Thick, fat sidewalls detract from the overall delicacy and balance of the nose. Although not always amenable to total correction, defatting and thinning through skin incisions at the nostril border (or if possible just internal to the alar margin) may be justified to improve appearance and balance of the nasal base.
The width and shape of the nostril are carefully evaluated (etry of incisions and excisions, the following anatomical fac-
tion and asymmetry, conditions almost impossible to correct
are assessed and integrated into the surgical plan. Conserva-
tive surgical nostril reduction is mandatory to avoid overreduc-
tion and asymmetry, conditions almost impossible to correct satisfactorily.

To determine the planned approach and the site and geometry of incisions and excisions, the following anatomical fac-
tors are carefully evaluated (Fig. 9.7):
1. The internal (medial) length, shape, thickness, and lateral flare of the alar margin (A–B).
2. The external (lateral) length, shape, thickness, and lateral flare of the alar margin (A–B).
3. The width and shape of the nostril floor and sill.
4. The shape of the nostril aperture.
5. The shape (anatomy) of the columella and related medial crural footplates, including both the length of the medial crura and lateral flare of the medial crural footplates.
6. The length of the lateral alar sidewalls of the nose, determined by the site of insertion of the alae to the face.

9.8 Graduated Surgical Techniques

The decision to perform alar base reduction during rhinoplasty is best made prior to surgery, when surgical edema and infiltration anesthesia have not temporarily distorted the true anatomy. Once a decision is reached about which of the above anatomical factors are in need of modification, a graduated surgical scheme is employed to achieve the desired aesthetic outcome. Based upon the anatomy encountered, alar excision and sculpture will range from minimal to major, depending upon the anatomy encountered. Like much of rhinoplasty, alar reduction represents a compromise operation, in which greater reductions exact the penalty of a larger and perhaps potentially more visible scar.

9.8.1 Internal Nostril Floor Reduction

In patients who require only minimal narrowing of the alar base dimensions, excision of a small wedge of epithelium and soft tissue from the nostril floor only will reduce the slight alar flare by reducing the dimension of the internal (medial) border of the alar sidewall. Although the outward curve of the sidewall is slightly altered, no medial repositioning or the alar–facial junction is created. The scar is effectively hidden within the nostril floor and the sill is not violated. Subtle, conservative but effective improvements are possible with this approach (Fig. 9.8).

9.8.2 Wedge Excision Nostril Floor and Sill

Further reduction of alar flare is accomplished by carrying the incision across the sill into the alar–facial junction. Reduction of lateral flare as well as slight reduction of the bulk is effected (Fig. 9.9).

9.8.3 Alar Wedge Excision

If the alar development is excessive and bulbous, excision of a wedge of ala just above the alar–facial junction will reduce the overall bulkiness of the alar anatomy (Fig. 9.10). Some medial repositioning of the alae will be effected with this maneuver. Reduction of the overall length of the alar sidewalls occurs when generous wedges are excised, ideal in the overall reduc-
tion of the overprojecting tip.

9.8.4 Alar Flap

Minimal alar reduction and slight medial repositioning of the alar–facial junction with excellent scar camouflage is accom-
plished with the approach described by Sheen (Fig. 9.11). In this approach, the incision remains on the alar surface and does not traverse the nostril sill, thus avoiding a potential “notched” appearance of the sill. Only very modest changes are possible with this technique.

9.8.5 Sliding Alar Flap

Maximal alar reduction with medial repositioning is effected with a generous incision in the alar–facial junction with various degrees of alar excision (Fig. 9.12). Reduction of the volume, curve, and flare of both the internal and the external alar mar-
gins will result from this procedure, the extent of each being dependent upon the angulation of the alar incision. A back-cut placed 2 mm above the alar–facial junction allows the alar flap to slide medially, narrowing the alar base significantly.

Of equal importance to the planning of the indicated tech-
nique for alar sculpturing is the precision plastic repair of the resultant scar. The ultimate appearance of far too many alar junction scars is compromised by imprecise opposition of the cut edges, resulting in level discrepancies and notches, which

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![Figure 9.7 Analysis of the anatomy of the alar base](image-url)
Fig. 9.8  (a) Subtle alar base narrowing by removing a diamond- or crescent-shaped segment at the junction of the floor of the nose with the alar sidewall. (b) Before narrowing. (c) After narrowing refinement.

Fig. 9.9  (a) A wedge removed off the alar base, which is carried across the nostril sill into the alar sidewall. (b) Before narrowing. (c) Improved appearance after this type of subtle alar base narrowing.
Fig. 9.10  (a) Excision of a major wedge of the alar sidewall to effect a more profound medial rotation of the alar sidewall, significantly narrowing the alar base. (b) Before narrowing with this technique. (c) Result obtained.

Fig. 9.11  (a) Method developed by Sheen\textsuperscript{6} to create modest medial translation of the lateral alar sidewall without compromising the alar sill. (b) Before and (c) result obtained after this subtle type of alar base narrowing.
cast shadows, and thus diminish scar camouflage. Abundant sebaceous glands at the alar–facial junction in many patients tend to compromise precise healing.

Skin sutures placed across the junction often lead to permanent suture marks, typical of any incision that traverses an epithelial concavity. The key to ideal scar camouflage of alar and nostril sill scars lies in exacting everting approximation of the cut edges with fast-absorbing catgut sutures, supplemented by tissue glue. Although bleeding from small alar vessels usually diminishes as the abundant small alar vessels retract and clamp down soon after alar incisions, exacting hemostasis may be hastened with needlepoint microcautery. If the tissue gap is large (as in major sliding alar flaps), buried interrupted sutures of 5–0 polydioxanone suture material (PDS) are initially placed subcutaneously to accurately oppose the wound edges and relieve tension on the delicate catgut sutures. External suture marks may thus be largely eliminated with this sequence of steps. Nonabsorbable sutures are always best avoided, since suture marks almost inevitably result. Effective camouflage at alar–facial junction may be facilitated by positioning incisions 1 to 2 mm above the alar–facial crease (Fig. 9.13), avoiding the thick sebaceous glands located in this junction. The 1- to 2-mm cuff of skin remaining above the exact alar–facial crease facilitates exact edge-to-edge closure; magnification is helpful in achieving precise closure. This simple but critical approach to incision sitting almost completely eliminates visible scars, suture marks, and widened visible sebaceous gland openings. Tissue glue reinforces the gentle suture closure (Fig. 9.14). At approximately 5 to 7 days, the tissue glue generally spontaneously falls away, carrying any suture remnant with it. Tedious suture removal is thus avoided.

9.8.6 Key Technical Points

1. Exacting preoperative analysis is critical to planning the extent and type of excision.
2. Precise, gentle suturing with gently tied fast-absorbing catgut suture negates possible suture marks.
3. Siting the scar 1.5 to 2 mm on the alar lobule side of the alar–facial junction improves ultimate scar camouflage.
4. Symmetrical excision and repair is essential (unless preoperative asymmetry exists).
5. Slight eversion of the opposed skin edges is desirable, although this is more difficult on the fibrofatty alar lobule than in skin elsewhere.
6. Avoiding incisions across the nostril sill (when made possible by existing anatomy) avoids potential notching of this delicate landmark.

9.9 Postoperative Care

The patient should avoid rubbing or manipulating the alar base for 2 weeks.
1. If not already fallen away, the tissue glue seal may be gently teased away at 5 to 7 days.
2. A Neomycin–steroid ophthalmic ointment is applied to the healing incisions for 2 weeks.
3. Photographs are taken at 1 week, 1 month, 3 months, 12 months, and regularly at intervals for as long as the patient is willing to return. (Long-term follow-up and critical evaluation constitutes the most important factor in self-education and feedback to the rhinoplasty surgeon.)
9.10 Complications

Complications, which are uncommon, include the following:
- Visible alar scars.
- Asymmetrical alar resection.
- Notching of alar sill.
- Overreduction with nostril distortion and overnarrowing.
- Infection.
- Wound separation and avulsion.

9.11 Conclusions

If the alar base appears disproportionate or inordinately wide before or at the conclusion of rhinoplasty, alar base reduction and narrowing should be considered. Judgments regarding the siting of alar reduction incisions and the geometry of alar excisions must be based upon the existent anatomy. The magnitude and extent of alar reductions are determined based on an assessment of the internal (medial) length and the flare of the alar margin, the external (lateral) length and flare of the alar margin, the width and shape of the nostril floor and sill, the shape of the nostril aperture, the anatomy of the columella, and the overall length of the lateral alar sidewalls.

The surgeon should assess which of the above factors must be surgically modified, and then formulate a progressive graduated formulation for alar base reduction, calculated to achieve a balanced, symmetrical alar base appearance with minimal scar sequelae.

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10 The Deviated Nose

Stephen S. Park and William Dougherty

10.1 Introduction

There is no universally ideal nose, especially as one crosses ethnic and gender boundaries, although one consistent aesthetic trait found across all cultures is a straight dorsum. Correcting the deviated nose is a formidable rhinoplastic challenge for many reasons. The frontal view is often seen in photographs but is not otherwise a common perspective during normal interpersonal encounters. For this reason, many individuals will notice small dorsal deviations in photographs, which then prompt the surgical consultation. This true frontal view is the most challenging to perfect because even a subtle, focal area of fullness or depression can be conspicuous and readily detected as a dorsal asymmetry. Furthermore, correcting the twisted nose can be unpredictable because it relies on both sides of the nose healing in an identical way, with the same degree of swelling, scarring, and contracture. This may not always be the case.

In some ways, a rhinoplasty can be viewed as two operations: one on the left side and the other on the right. Although the same technical maneuvers may be performed on each side, the rate of healing and degree of scar contracture can vary and lead to unpredictability. Rhinoplasty is a four-dimensional operation. Manipulating the bony and cartilaginous framework in a three-dimensional space is the first challenge. The fourth dimension is time. This powerful force is an essential consideration in surgical planning and its recognition and appreciation has had a tremendous impact on contemporary rhinoplasty techniques.

There is a marriage between the cutaneous nasal deformity and the underlying anatomical cause, one that must be studied as a routine part of all preoperative analyses. After successfully identifying the external nasal problems, it is imperative to go the next step and investigate what bony or cartilaginous deformity is causing those findings. Such an exercise allows one to approach the surgical plan in a precise and targeted manner. This chapter will highlight the preoperative analysis and surgical repair of the deviated nose. The correction can be approached through a graduated algorithm that begins with a simple, minimally invasive maneuver and progresses toward destabilization and reconstruction. Representative cases will be used to demonstrate the analysis and rhinoplasty techniques.

10.2 Indications

The indications for repairing a twisted nose can fall under two general categories, i.e., cosmetic and functional. Naturally, the cosmetic group is integrally involved with the patient’s perspective and complaints. Functionally, the twisted dorsum can be an active contributor to the cause of nasal obstruction, and correcting this deformity is often an important part of restoring nasal patency. Most twisted noses are the result of blunt trauma, where the nasal skeleton is displaced and immediately apparent. While we often think of bony injuries with blunt trauma, significant distortion to the cartilaginous framework can also occur and may be amenable to immediate repair. Most long-standing nasal deformities can be related to a history of nasal trauma, albeit remote or minor, and occasionally forgotten by the patient. Relatively small injuries to the lower two-thirds of the nose can disrupt the balance of intrinsic cartilaginous forces, which, over time, may result in progressive distortion and nasal twisting. Moreover, injuries at a younger age may influence the nasal growth centers and lead to asymmetrical development.

Iatrogenic dorsal deformities can occur during a dorsal hump reduction, which inadvertently unmasks a midseptal deviation. Other rhinoplasty procedures can also heal and contract in an asymmetrical way and give rise to the twisted nose. The indications for a specific rhinoplasty maneuver to correct a dorsal deviation are dependent on the causes, which may be traumatic, iatrogenic, or idiopathic. A careful preoperative analysis of the structural aberrancy often dictates the approach and optimal surgical plan. At times, one must apply a stepwise approach such that a series of maneuvers are applied in a sequential fashion. For this reason, it is important to be facile with a host of surgical maneuvers before embarking on the repair of a twisted nose.

10.3 Contraindications

There are relatively few contraindications to performing this type of rhinoplasty. One may encounter philosophical contraindications to repairing the crooked nose, such as an individual who will be exposed to repeated trauma (e.g., a boxer or rugby player). Under these circumstances, the timing of surgery is more at issue than the surgery itself. There are circumstances where straightening the deviated nose may compromise the nasal lumen and be relatively contraindicated. This could occur with a patient who desires a straighter nose with the collapsed side being considered more aesthetically pleasing. To create a symmetrical dorsum, the patient may request to have the normal side pinched medially, potentially giving rise to valve narrowing and obstruction.

10.4 Preoperative Considerations

Identifying the good rhinoplasty candidate is as important as the surgery itself. A thorough history should include a commitment to get to know the patient as a person, seeking to understand a few specific personality traits.

The motivation of individuals seeking a rhinoplasty can be diverse and some are considered healthy, while others are felt to be unstable. Ideally, a patient should pursue a rhinoplasty only after adequate contemplation and understanding of the procedure. The motivating force should be a personal wish to correct some specific deformity that is bothersome. After proper patient selection, a successful outcome can have far-reaching effects on self-image and self-esteem. Poor motivational factors include seeking cosmetic surgery to please others, correcting problems in their personal or professional lives, or in response to exogenous stresses in their lives.

The physical expectations must also be carefully evaluated to ensure that they are realistic and within the realm of surgical possibility. The single most essential step toward realistic expectations is clear communication between the surgeon and the patient. There are physical limitations to some rhinoplasties, such as those relating to skin thickness or dramatic
deviations to the dorsum, and these must be clearly defined preoperatively. It is also important to explain the balance between the nose and the face, such as the twisted nose on a person with preexisting facial asymmetry.

Psychological factors and personality traits can influence the outcomes and final patient satisfaction. A history of psychiatric illness, impulsive behavior, and use of mood-influencing drugs should prompt further investigation to determine psychological candidacy. Some traits interfere with the ability to accept one's body image, while others cannot tolerate the change. The following are some common personality types that should alert the surgeon preoperatively:

- **The dependent personality**: overly compliant and leads the patient to interact in a subservient fashion to the surgeon.
- **The passive–aggressive personality**: nonconfrontational but may display self-deprecating behaviors.
- **Obsessive–compulsive personalities**: questions every detail yet remains indecisive, making effective communication difficult.
- **Histrionic personality**: charming and dramatic, but insists on special attention and responds in an exaggerated and inappropriate way.
- **Paranoid personality**: secretive, distrusting, and less tolerant of discomfort.

### 10.4.1 Age

Minors represent a special subset of patients as they may be brought to the surgeon by their parents. It is essential to determine who is seeking the cosmetic change and to ensure that the communication and instruction are mutual. The general teaching is that nasal cosmetic surgery should be delayed until the age of 15 for females and 17 for males. The two variables to consider before a pediatric rhinoplasty are emotional maturity and completed pubertal growth of the nasal skeleton. Both probably occur sooner in females than in males.

Rhinoplasty in the older age group also involves unique emotional and anatomical factors. Older patients have lived with certain facial features for their entire lives and dramatic facial changes can be difficult to adjust to, occasionally having a negative impact on their self-image. As such, a conservative approach is further emphasized with this patient demographic. The older patient often has more brittle nasal bones, making osteotomies more challenging.

*Bony habitus* is worth noting, particularly any preexisting facial asymmetries that can occur. A perfectly straight nose on a crooked face may not appear balanced.

Ethnicity and gender are important preoperative considerations for rhinoplasty but are less relevant in the management of the twisted nose because a straight dorsum is desirable in all cultures.

### 10.5 Preoperative Analysis and Diagnosis

#### 10.5.1 Normal Anatomy and Diagnosis

An accurate preoperative analysis of the deviated nose goes beyond recognizing the external deformity; it requires a deliberate investigation into the underlying cartilaginous and bony anatomy, and the complexity with which it shapes the nasal dorsum. Each area of the nasal skeleton is responsible for a discrete cutaneous subunit of the nose, such as the nasal bones defining the upper third, the dorsal septum and upper lateral cartilages shaping the middle third, and tip being supported by the lower lateral cartilages and anterior septal angle. Cutaneous deviations, on the other hand, can be the result of more than one anatomical structure. The ideal nose blends into the face without calling attention to asymmetry, imbalance, or disproportion, allowing the casual observer to be drawn to other areas that typically define facial beauty, such as the eyes and lips. The aesthetic dorsum is straight, remains in the midline of the face, and may have a subtle concavity that reflects a narrower middle vault. The “brow-tip line” is a useful landmark that helps define an aesthetic dorsal contour. It begins from the medial brow, curving inferiorly along the dorsal border, gently blending with the tip-defining point. These lines should remain parallel and uninterrupted (Fig. 10.1).

It is often useful to evaluate the nasal dorsum in segments rather than just a gestalt from the frontal view. Dividing the nose into an upper, middle, and lower third can help with delineating discrete aberrancies. The upper third of the nose is formed by the paired nasal bones and the frontal processes of the maxilla. The skin along the caudal border of the nasal bone is characteristically thin and allows small irregularities of bone, cartilage, or scar to be readily evident. Conversely, the skin and soft tissue at the nasion is much thicker and includes subcutaneous fat and the procerus muscle. Changes in the bony skeleton along this area tend to be camouflaged by the thicker overlying soft tissue, which drains between the higher...
The nose is composed of cartilaginous and bony structures, including the nasal bones, which define the width and projection of the upper nose. The nasal bones also contribute to the tip projection and support. The bony septum is a minor contributor to the dorsum in normal circumstances, but deviations to the upper third can involve the septum and must be considered. More will be discussed on this later in the chapter.

The middle nasal vault is normally slightly narrower than the upper or lower thirds and creates a gentle concavity to the brow-tip line. The middle third of the nose is shaped primarily by the dorsal septum and upper lateral cartilages. These structures are firmly adherent to one another and any intrinsic deviation to one will directly impact the other. The dorsal border of the normal septum should be straight and has a widened area that functions as physiological spreader grafts, contributing positively to the width of the middle vault as well as opening the internal nasal valves. Surgical reduction of the dorsal septum can create an iatrogenic narrowing of the middle vault with the "hourglass" deformity occasionally seen in revision rhinoplasty.

The upper lateral cartilages are also significant contributors to the dorsal width and provide support, symmetry, and fullness to the nasal sidewalls. Displacement of the upper lateral cartilage can create an imbalance to the natural concavity and the illusion of a twisted nose. The intimate relation between the upper lateral cartilage and dorsal septum is an essential consideration of the middle vault anatomy and must be a part of the preoperative analysis for every twisted nose.

The nasal tip should appear elegant, indiscrete, and in the midline. While the tip is not often discussed with the twisted nose, it too can be deviated and contribute to dorsal deviations. The midline position of the tip is dependent on both the lower lateral cartilages and caudal septum, especially the anterior septal angle. Like the middle vault, the culprit for a deviated tip may lie with either anatomical structure (or both) and a preoperative distinction is needed in order to develop a focused surgical repair. The anterior septal angle is often camouflaged by the thick tip skin and lower lateral cartilages, and palpation may be necessary to identify its position. When the caudal septum is deviated, it can bring the lower lateral cartilages with it and cause a passive tip deformity.

### 10.5.2 Analysis of Aberrant Anatomy

Evaluation of the twisted nose is a challenging aspect of rhinoplasty and is best done in a methodical and systematic manner. An accurate diagnosis is a prerequisite for developing a preoperative surgical plan that is direct and target oriented. For these reasons, it is useful to evaluate the rhinoplasty patient with an algorithm that highlights some nuances that might otherwise go unnoticed. Preoperative nasal analysis should be organized and repeated several times.

First, multiple views of the nose are useful. Clearly, the frontal perspective is most revealing of dorsal deviations (and the most difficult to perfect surgically), but different abnormalities can be appreciated from the submental, oblique, and lateral views. Photography serves two important functions in terms of analysis. It allows for repetitive, preoperative analysis, including within the operating room. Second, the physical act of taking photographs allows a unique perspective of the patient not typically achieved during normal consultations. The camera's view finder, cropping, standardizing views, and the Frankfurt horizontal all contribute to a form of tunnel vision that leads to an objective analysis of the nose, apart from room décor, attire, and emotional expression. For example, one often asks the patient to lower his/her chin and refrain from smiling, two interpersonal habits that are prevalent during the consultations but influence the analysis. A hypoplastic chin or preexisting alar-columellar disproportion can be easily overlooked during an informal encounter but become readily apparent through a camera lens.

During the physical examination of a rhinoplasty patient, there are two useful tools that are occasionally omitted. First, palpation of the nose is an invaluable asset that can reveal much in terms of bony and cartilaginous framework, stability, resilience, and soft-tissue problems. There are aspects of the nose that are best evaluated through careful palpation, such as the location of the anterior septal angle, the contour of the dorsal septum, tip support, and skin thickness (Fig. 10.2). During the examination, one must make it a point to investigate these areas and become familiar with the unique anatomy of each

**Fig. 10.2** Depressing the nasal tip helps identify the position of the anterior septal angle.

**Fig. 10.3** An objective midline reference can assist in identifying which areas of the nose are deviated.
patient. A second useful tool when analyzing a twisted nose is to use a straight reference, such as a stick or cotton-tip applicator, in the precise midline of the face. With the midline clearly defined, one can inspect each third of the nose independently and better determine which component of the bony/cartilaginous framework is creating the cutaneous deformity (Fig. 10.3).

The deviated dorsum comes in many forms and in no way can a single operation be universally applied to all patients. It is critical to separate the cutaneous deformity of the nose from the underlying structural cause and anatomical pathogenesis. One must take a step backward from the cutaneous deformity to understand its anatomic etiology, and proceed forward with a surgical repair targeting this framework problem. The nose with a bony deviation is entirely different from the collapsed upper lateral cartilage or the dislocated caudal septum, although both may resemble a “twisted nose.” The nasal dorsum can be linear but deviated to one side, where all components of the nose are involved and need correction (Figs. 10.4 and 10.5). The bony dorsum can have a solitary irregularity, usually in the paramedian position, that creates an asymmetry and the appearance of a twisted nose. The causes of such isolated lesions can be related to old bony fractures, including where small osteophytes have grown from the disrupted periosteum (Fig. 10.6). The remedy for such problems may be as simple as sharp excision or rasping of the lesion.

Some deviated noses are limited to the upper third and are the result of displaced nasal bones, while the dorsal septum and lower two-thirds are normal, as seen with nasal fractures (Fig. 10.7). Deflections of the bony pyramid, however, are not all identical and it is important to delineate (1) which side is aberrant, (2) the contour of the bone itself, and (3) potential involvement of the posterior bony septum. Bony deviations may involve only one side where an isolated segment is medially displaced. One must be alerted to the depressed nasal bone segment, as its repair may be unstable and require unilateral intranasal packing. Alternatively, these circumstances may be more efficiently managed with camouflage, onlay grafts.

Careful palpation of the bony pyramid is done to identify any intrinsic concavity or marked asymmetry in width to the nasal bones. This analysis will influence the location of osteotomies as well as the need for intermediate osteotomies. It is difficult to predict which bony septal deflections will hinder realignment of the nasal pyramid and it is not uncommon to see significant endonasal deviations that do not interfere with dorsal repair. When the sepal deviation is significant, it can be addressed either with endonasal closed reductions or percutaneous osteotomies.

The twisted middle vault is possibly the most complex in terms of preoperative assessment. The majority of cases involve a primary deviation to the dorsal septum and passive distortion to the upper lateral cartilages (Fig. 10.8). This anatomy is best appreciated with direct palpation of the dorsum as well as by tightening the nasal skin across the lateral nasal walls, which can outline the dorsal septum. Because the upper lateral cartilages are firmly adherent to the dorsal septum (in the primary nose), they are equally distorted and contributing to the external concavity. Releasing the fibrous attachments between these two structures will typically reveal a persistent deflection to the dorsal septal cartilage and a correction of the upper lateral deformity. This identifies the anatomical cause of the middle vault deviation and permits a targeted surgical correction. One should bear in mind that a twisted nose can be unmasked during a dorsal hump reduction when a preexisting midseptal deviation becomes the new dorsal strut. This iatrogenic twisted dorsum can be anticipated with careful intranasal inspection and corrected with traditional methods outlined below. A cartilaginous hump reduction also redefines the middle vault dorsum with an area of septal cartilage that is usually thinner, thus requiring prophylactic spreader grafts.

There are two instances of middle vault deviations where the upper lateral cartilages are the primary culprit rather than the dorsal septum. The upper lateral cartilage may be disarticulated off its supporting structures (usually the dorsal septum but occasionally the nasal bone) and the result is a gradual medial displacement and depression that creates a unilateral concavity. There will be a disruption of the aesthetic brow-tip line on one side and the illusion of a twisted nose. When this occurs bilaterally and symmetrically, such as following a reduction rhinoplasty, it creates the typical “inverted-V” deformity encountered during many secondary rhinoplasties. The second
scenario is when the primary causes are with the size, shape, or form of the upper lateral cartilages themselves; although less frequent, there are times where an intrinsic upper lateral deformity exists with a concavity or buckling of cartilage. This sidewall asymmetry will be interpreted as a twisted nose and can be addressed directly, through either repair or camouflage.

The lower third may also be twisted to one side and create the appearance of a twisted dorsum. Tip position is dependent on numerous forces that must work in concert in order to hold the tip in the midline; a disruption of this balance of forces can lead to marked asymmetry. Lateral displacement may be due to a malposition of the caudal septum (particularly the anterior septal angle) (Figs. 10.9 and 10.10). Tip structure and stability is best assessed with careful palpation because simple inspection can be misleading in terms of the causative agent. It is not uncommon for the anterior septal angle to be significantly deflected to one side and the cutaneous tip only slightly twisted. The caudal septum may be bowed or dislocated off the anterior nasal spine, causing deformities to both the columella and the nasal tip. Similarly, marked asymmetry of the paired lower lateral cartilages can be associated with enough twisting of the tip such that the entire dorsum appears irregular.

The deviated nose can be associated with functional problems that are complex and related to pathology of the internal nasal valve, i.e., the area between the upper lateral cartilage and dorsal septum. Although this cross-sectional...
area represents a proportionally small amount of the intranasal lumen, it is responsible for a disproportionate amount of laminar airflow and small degrees of obstruction can quickly be symptomatic. Evaluating nasal obstruction related to the nasal valve must be done carefully and systematically. The goal is to identify exactly where the obstruction is and to distinguish a static narrowing from a dynamic collapse, as their respective treatments are inherently different. Examination of the nasal airway must be done with minimal distortion or artificial support to the nasal sidewalls, especially from the nasal speculum. Dynamic collapse of the nasal sidewall is generally repaired with cartilaginous batten grafts placed precisely along the epicenter of collapse with the intent to reinforce that area and resist the collapsing force during nasal inhalation. The static narrowing at the internal valve is usually thought of as a problem involving malpositioned upper lateral cartilages, typically remedied with spreader grafts, flaring sutures, or butterfly-type grafts. The dorsal septum is an important player in the anatomy of the internal nasal valve and can contribute significantly to the cause of valve obstruction. Clinical obstruction can occur on either the concave or the convex side of the septum, and it is difficult to predict without careful intranasal inspection. On the convex side of the nose, the dorsal septum deviates toward the airway and directly impinges on the internal valve from the medial side. Surgical correction is aimed at straightening the septum. When obstruction occurs on the concave side of the nose, the upper lateral cartilage is usually the culprit; it is usually medially displaced through either disarticulation off the septum or a buckling deformity. Correction involves lateralizing the upper lateral cartilage through spreader grafts. Similarly, a depressed nasal bone can cause both a cosmetic deformity to the dorsum and nasal obstruction at the level of the internal nasal valve. The displaced nasal bone brings with it the upper lateral cartilage and creates a secondary obstruction at the internal valve.

10.6 Surgical Correction

Once the precise anatomical cause of the external nasal deformity is understood, one can design an efficient surgical plan that is directed toward that specific aberrancy.

The surgical approach, i.e., endonasal or external, is primarily personal preference with some general considerations. The exposure must provide the surgeon with a level of comfort for consistent results. The columellar scar is not a significant deterrent, although more operative time and postoperative swelling are anticipated. One does not need to visualize the entire nasoskeleton for all techniques and, in fact, doing so may be detrimental to the outcome. While the cutaneous columellar

**Fig. 10.9** (a) Dorsal deformity involving the nasal tip. (b) Deviation of the caudal septum.

**Fig. 10.10** Intraoperative view of patient with tip deviation due to caudal septum deflection.
scar may not be a concern, total nasal scarring, including that which occurs beneath the normal nasal skin from undermining and exposure, can be significant. Some of the dissection from an external approach occurs in normal areas of the nose. The act of “opening” the nose introduces a variable that may be avoided with the endonasal approach; scarring and contracture that occurs beneath the soft-tissue envelope may not occur symmetrically between the two sides. On some occasions, the healing process from the nasal exposure alone may be the cause of external deformity. For this reason, subtle deformities of the middle nasal vault that are corrected with small camouflag grafts may be better accomplished through the endonasal route, thereby avoiding the unpredictable contracture associated with deglouging the nose. On the other hand, extensive and complex deformities may require more significant mobilization or reshaping of the cartilaginous framework. Releasing these structures from the overlying soft tissues may be advantageous; partial adherence to the soft tissues may hinder reshaping of the cartilages. As a general guideline, when the cartilage needs to be aggressively reshaped rather than just augmented or trimmed, the external approach has advantages.

### 10.6.1 Upper Third Deviations

#### Osteotomies

Deviations of the upper third are usually repaired via osteotomies in order to realign the nasal bony vault to the midline. Not all twisted dorsa are managed with the same type of osteotomies. The preoperative analysis must identify which side is deviated and the individual contour of each bone. When choosing an osteotome, the surgeon must balance the benefit of easier external palpation while guiding larger instruments against increased soft-tissue injury that can result in postoperative swelling and ecchymosis. Unguarded osteotomies are lower profile, preventing mucosal and lateral soft-tissue injury; however, the lack of a palpable guard makes the cut more difficult to direct. When both bones are relatively straight but deviated to the same side, bilateral lateral osteotomies may suffice, allowing the bony pyramid to realign as a single unit. Lateral osteotomies begin within the frontal process of the maxilla, usually around the head of the inferior turbinate, thus preserving a small ridge of bone (Webster’s triangle) in a lateralized position and avoiding collapse of the lateral nasal wall (and valve obstruction). The bone cut extends superiorly as the bone becomes thinner and easily fractured. The osteotome stops at the medial canthal area and is followed by a back fracture to the midline. One must avoid the tendency to carry the lateral cut too far superiorly, which could otherwise proceed into the frontal bone and create a “rocker deformity.”

More significant deviations may require medial osteotomies, either through an intercartilaginous incision (over the upper lateral cartilage) or transnasally by engaging the caudal border of the nasal bone, at its junction with the dorsal septum and upper lateral cartilage. Medial osteotomies can be performed as either “straight” (paramedian) or “fading” (oblique) cuts. The fading cut flares laterally at its cephalic border and stops at the level of the medial canthus. The straight osteotomy proceeds in a paramedian direction toward the frontal bone, again not extending into the frontal bone. Straight medial osteotomies are useful if specifically addressing excessively wide nasal bones. When a straight medial osteotomy is performed, one will require a transverse osteotomy, in order to connect the medial osteotomy cut with the lateral osteotomy. The transverse osteotomy should carry a horizontal path at the cephalic portion of the nasal bones. If one proceeds into dense bone, the osteotome should be redirected as this likely represents a cut carried into the frontal bone. The transverse osteotomy is also useful in the correction of a “rocker” deformity, by allowing the nasal bone to be manipulated independently from the frontal bone. The same vein, a transverse osteotomy is necessary in the patient with a deviated frontal beak, again allowing the nasal bones to be manipulated independently of the frontal bone. When only a single bone is displaced (usually medially), medial and lateral osteotomies performed unilaterally may be adequate to reduce the isolated segment. These situations are challenging because there is a tendency for the bone to collapse, especially if the periosteal attachments are disrupted. In these cases, intranasal packing may be needed, using either a resorbable material or a small finger cot. The packing may need to be secured with a percutaneous suture to retain a position high in the nasal vault. Systemic antibiotics are given in all cases of intranasal packing as prophylaxis against toxic shock syndrome. Ecchymosis following lateral osteotomies can be significantly reduced by digital pressure to the site for 3 minutes immediately after performing the cut. Most bleeding is from disrupted periosteum and can be controlled with digital pressure. This single intraoperative maneuver immediately following the osteotomy can have a dramatic postoperative benefit in terms of bruising, swelling, and patient comfort.

Bony dorsal hump reduction in the context of a deviated pyramidal hump is a common task, requiring an oblique hump reduction in order to create nasal bones of similar width. The wider nasal bone should have more resected from it with less bone resected from the narrower (toward the deviation) side, thus creating nasal bones of symmetrical width prior to realignment. Osteotomies are often necessary in bony dorsal hump reduction, even in a straight nose, to prevent the “open roof” deformity.

Older patients have a tendency toward more brittle bones, which often leads to comminution of the bony segments after osteotomy. This can be attenuated by performing an incomplete osteotomy, followed by digital manipulation to lateralize or medialize the segment.

#### Intermediate Osteotomy

The intermediate osteotomy is a third bone cut placed vertically between the medial and lateral ones. Examination of the nasal bones can reveal two circumstances where such an osteotomy is indicated. First, when the contour of the nasal bone is irregular, either concave or convex, simple realignment to the midline can leave a persistent deformity to the dorsal or sidewall. Second, when there is marked discrepancy to the width of the two nasal bones, the wider bone will hinder the equal reduction of both sides and an intermediate osteotomy to that side is indicated. The intermediate osteotomy is performed following the medial and prior to the lateral bone cuts. It is a vertical cut that runs through the apex of the concavity (or convexity), creating two segments of bone that reduce independently (Fig. 10.11).

#### Bony Septal Deviations

Most deviations of the upper third can be adequately reduced through osteotomies, but there are occasions where the posterior bony septum is sufficiently displaced as to hinder this realignment. The perpendicular plate of the ethmoid inserts to the undersurface of the nasal bones and may require direct attention. Most deviations of this portion of the septum can be gently fractured endonasally, allowing its reduction to the midline. It is imperative to recognize that its posterior/superior attachment is to the cribriform plate and aggressive manipulation in this area can risk a leakage of cerebral spinal fluid. For more significant deflections in this area, one can use a 2-mm percutaneous osteotome, inserted in the midline at the nason, to create a controlled fracture of the bony septum.
It is not uncommon for the repair of a significantly twisted bony dorsum to fail over the ensuing months as the bones slowly drift back toward their original position. While these late deviations are not as dramatic as the original deformity, they are problematic and may be the result of one of several factors. First, a septal deflection may have been overlooked and may be the source of asymmetrical tension on the nasal bones; severe deviations of the bony septum can influence the shape of the upper third of the nose. Second, overlying soft tissues, including the periosteum, can have some degree of memory that tends to pull the nasal bones back to the original position. Finally, deformities of the cartilaginous lower two-thirds can certainly influence the upper third and must be addressed independently.

The rhinoplasty surgeon must have a thoughtful approach to the progression of osteotomies when correcting deviations of the bony upper third of the nose. While there is no dogmatic approach to osteotomies, the surgeon must be mindful of the maneuvers taken, and their order. Dobratz et al propose proceeding in a stepwise fashion:

1. The medialized nasal bone should be mobilized first with a medial, intermediate (if necessary), and then lateral osteotomy.
2. The medialized nasal bone is then displaced laterally to allow space for the midline repositioning of the deviated septum.
3. A straight medial osteotomy is then performed on the opposite side into the nasal root, which is used as a fulcrum to reposition the septum in a midline position.
4. The intermediate (if necessary) and lateral osteotomies are then performed on the opposite side and the nasal bone is placed into an appropriate position.

**Camouflage Grafts**

Sometimes the simplest and most direct means of improving the twisted dorsum is to place a graft that fills the depression, including to the upper third. They are used more often in the setting of a unilateral depression where the contralateral side is normal in width. Great care must be taken with these grafts because of the thin skin in this area and the risk of visible edges or contour irregularities. Placing the graft under the periosteum has the advantage of better camouflage of the edges and improved security. Supraperiosteal grafts have a tendency to be mobile, but, in theory, viability may be enhanced due to vascularity from both sides of the graft.

A number of implant materials can be used for nasal camouflage, but autogenous grafts remain the gold standard. Lightly crushed septal cartilage can be inserted through an intercartilaginous incision, placed in a subperiosteal pocket, and can have dramatic effects on the dorsal asymmetry. Other autogenous materials can be used in a similar way, including conchal cartilage and soft tissue/scar. Homograft costal cartilage is controversial and rarely needed in this area. Homograft acellular dermis is widely used as a nasal implant material and can serve this purpose. There is some concern with long-term partial resorption of this material, although it may be replaced with sufficient scar so as to maintain its aesthetic effect. Alloplastic materials can also be used as camouflage grafts, but one should recognize that the overlying skin is characteristically thin and graft extrusion/infection is at risk.

**10.6.2 Middle Third Deviations**

Correcting the twisted middle vault can be one of the most unpredictable rhinoplasty challenges, often requiring a combination of techniques applied through an organized algorithm. Some surgical plans can be formulated preoperatively, but one must be prepared to progress to more aggressive techniques if others should fail. Techniques for correcting middle third deviations can be categorized into three approaches:

1. Camouflaging the deformity (spreader graft or crushed cartilage).
2. Direct straightening of the dorsal septum (splints, sutures, relaxing incisions).
3. Combination techniques.

Many dorsal deformities require combined techniques for accurate realignment of the cartilaginous framework and correction of the external deformity. Minor deflections can often be adequately addressed with either camouflage or suture techniques, depending on surgeon preference and familiarity.
Camouflage Grafts

Like the upper third, a middle vault concavity can often be improved with a small camouflage graft placed in a discrete pocket over the upper lateral cartilage and inserted endonasally through an intercartilaginous incision. A small disc of septal cartilage, lightly crushed to remove any intrinsic form, is an ideal graft for such purposes. The edges should be gently beveled in order to minimize the visibility of the graft borders. Creating the pocket is a critical step and should be done immediately superficial to the perichondrium and to precise dimensions in order to accommodate the graft without excessive mobility. Marking the skin should be done prior to infiltrating the local anesthetic. Suturing the graft in position is difficult endonasally but can be done with a small resorbable stitch through the center of the graft, and out percutaneously at the middle of the concavity. The suture can be taped to the adjacent skin and hold the graft in position for the first several days. Autogenous cartilage remains the standard implant for such purposes, but other alternatives such as acellular dermis and some alloplastic materials are being used with some success. Resorption, infection, and extrusion must all be considered prior to implanting a graft, particularly under relatively thin nasal skin.

A unilateral spreader graft is a form of camouflage but more directly influences the causative anatomical structures. Despite an intrinsic deviation of the dorsal septum, the spreader graft, positioned between the concave septum and upper lateral cartilage, will laterally displace the upper lateral cartilage and correct the cutaneous deformity, i.e., the twisted middle vault. It can be considered a camouflage technique because the septal deviation persists. Prior to utilizing this technique, one must diagnose the causative aberrancy and distinguish between a middle third concavity versus a contralateral fullness and convexity. Failure to recognize this and inserting a unilateral spreader graft may generate an unnatural width to the middle vault that is equally conspicuous. The unilateral spreader graft is placed in a small pocket between the upper lateral cartilage and dorsal septum, taking care not to violate the mucosa and enter the nasal cavity (Fig. 10.12). If this does occur, the perforation should be directly repaired prior to placing the grafts. Septal cartilage is ideally suited for such grafting, although conchal cartilage is an acceptable alternative. When using ear cartilage, one often needs two separate pieces, sutured to one another with their concavities facing each other. In this way, each cartilage serves as a splint to the other and a straight graft is created. Costal cartilage may be a second alternative but is rarely needed. Alloplastic materials are at risk of extrusion due to the thin mucosal barrier intranasally. Grafts are carefully carved to an adequate width, which is usually thicker than first impression. The length of the spreader graft should span the entire vertical length of the upper lateral cartilage, occasionally extending between the caudal borders of the nasal bones. The grafts are usually secured by suture in a mattress fashion. Care must be taken when placing these sutures in order to avoid pinching the upper lateral cartilages together, effectively narrowing the internal nasal valve (Fig. 10.13).

Suture Techniques

Similar to camouflage grafts, suture techniques can be used alone or in combination with other maneuvers to address many mild to moderate deviations of the middle vault. Simple mattress suture along with the knot on the deviated side, can straighten a mild concavity. It can also serve to secure a spreader graft and provide support to the middle third.

A sidewall spreading suture is placed as a horizontal mattress suture of 4-0 polydioxanone from the peristium of the nasal bone to the upper lateral cartilage. As the suture is tightened, the upper lateral cartilage will flare laterally and the nasal bone and cartilage will be in better alignment (Fig. 10.14). This technique can be augmented by subsequent placement of a triangular-shaped spreader graft (narrower at the cephalad end) between the septum and upper lateral cartilage. This is similar to a flaring suture used to widen the internal nasal valve; in this case, however, the nasal bone is used as the fixed fulcrum rather than the dorsal septum. The clocking suture is a technique for addressing a tilted cartilaginous septum. In this technique sequential horizontal mattress sutures are placed through both upper lateral cartilages and the cartilaginous septum. The sequential sutures are “stair stepped” caudally on the deviated side, such that the septum is pulled to

Fig. 10.12 Spreader graft pocket between septal cartilage and upper lateral cartilage.

Fig. 10.13 (a) Insertion of a right spreader graft. (b) Suture fixation.
the midline as the suture is tightened (Fig. 10.15). Placing multiple sutures allows for titrating the correction as one proceeds. The upper lateral cartilage must be separated from the dorsal septum prior to placement of these sutures.

Others have described the clocking sutures as separate, simple, interrupted sutures, placed caudocephally on the convex side and cephalocaudally on the concave side between the septum and each upper lateral cartilage. Upon tightening, the sutures bring and secure the septum toward midline.9

**Straightening the Dorsal Septum**

The most anatomical method of correcting the twisted dorsum is to directly manipulate the dorsal septum. This is often done through a sequence of steps: (1) beginning with a complete release from the extrinsic binding structures (bony septum, overlying soft tissues, septal perichondrium, upper lateral cartilage); (2) followed by a controlled release of intrinsic tension forces; and (3) finally, external splinting.

When this is not sufficient, the ultimate correction is through an extracorporeal maneuver with septal explantation, reorientation, and then reimplantation with careful fixation. Realigning the dorsal septum is best accomplished through the external approach, giving direct access to the area of need and allowing accurate trimming and suturing.

The deviated dorsum may be a linear deformity to one side. When the dorsal strut is straight but misaligned, it may need to be detached from the posterior bony septum and maxillary crest in order to allow it to swing back to the center (Fig. 10.16). The critical bony/cartilaginous junction ("keystone area") should be resecured with a permanent suture in order to avoid future loss of support and saddle deformity. To do this, one should leave a small knuckle of posterior cartilage through which one can pass a suture. Even when other complex deviations exist in the remaining dorsal septum, if the proximal area along the bony junction is off-center, it should be addressed first as one proceeds from a superior to inferior direction.

The first step in correcting the twisted dorsal septum is to detach it from the upper lateral cartilages bilaterally. The firm fibrous attachments may themselves be contributing to the warped configuration and a complete release is an essential prerequisite for straightening the alignment.

Second, the perichondrium on the concave side of the septum is then elevated, thus releasing a binding force to the septal deviation. These two maneuvers may be sufficient to correct...
a dorsal deformity of the cartilaginous septum, particularly one that involves the anterior septal angle. This dissection also allows an accurate intraoperative analysis of the remaining intrinsic deviations to the dorsal septum.

Third, following release of the extrinsic attachments, persistent deviations are then addressed with partial-thickness incisions on the concave side, which will further release the constricting forces and help to straighten the cartilage. Relying on the partial-thickness incisions alone for significant reshaping may not provide longevity since mild twisting tends to recur. One possible mechanism for the relapsing deformity may have to do with the many small, wedge-shaped spaces created as the cartilage bends open. Cartilage has a characteristically low metabolic rate and the healing of these tissue voids occurs with scar formation and wound contracture. The contracture represents numerous small forces that may deform the cartilage once again. Mattress sutures placed across the deviated dorsum can stabilize the correction. Permanent suture material is used and the longitudinal part of the suture should be on the convex surface. When placed this way, tightening the suture will bend the cartilage in a favorable direction and serve to reinforce the dorsal strut. Persistent deviations may require multiple, full-thickness, vertical, cartilaginous incisions that allow the twisted septum to realign in a straight configuration (Fig. 10.17). There is a moderate degree of structural destabilization from this maneuver and splinting is often indicated.

Fourth, the autogenous dorsal septal splint serves two functions: it can further straighten the bowed cartilage and also restore support to a weakened structure. The ideal material is thin but rigid enough to maintain cartilaginous alignment; posterior bony septum is readily accessible and functions well in this regard (Fig. 10.18). It should be directly sutured in a mattress fashion to the dorsal septum after small burr holes have been created in the bone. Wider splints, for example, double cartilaginous spreader grafts, can be used to splint and camouflage simultaneously. These grafts are secured in position with mattress sutures that resuspend the upper lateral cartilages as well.

Finally, there are occasions when extensive and complex deformities of the cartilaginous septum exist and the above measures prove inadequate. On these occasions, it may be...
necessary to excise the entire cartilaginous septum, reorient it such that the new dorsum is a straight strut, and suture it back into place (Fig. 10.19). This is an aggressive maneuver as it is difficult to control the dorsal projection in a precise manner. It is helpful to leave a small strip of cartilage along the posterior bony junction for suturing. The upper lateral cartilages must be carefully resuspended to the neodorsum, often with bilateral spreader grafts to ensure appropriate width to the middle third. If the caudal strut is equally distorted, it may also require resection and reimplantation.

The twisted dorsum can be due to a unilateral fullness of the middle vault, rather than a concavity on the other. These deformities are more amenable to a volume reduction of the involved side via shave excision of the convex dorsal septum. This maneuver is always followed by a resuspension of the upper lateral cartilage (Fig. 10.20). The resected cartilage can be transplanted to the contralateral side if indicated. Many dorsal deformities require combined techniques for accurate realignment of the cartilaginous framework and correction of the external deformity.

### 10.6.3 Tip Deviations

Tip displacement can be the sole deformity of a twisted dorsum. Surgical maneuvers of the lower lateral cartilages are covered elsewhere in this text and apply to correction of the deviated dorsum as well. While most tip deformities are the result of aberrancies of the lower lateral cartilages, the septum, particularly the anterior septal angle, can have a significant role in dorsal twisting. The anterior septal angle can be straightened by a number of methods. On occasion, simply elevating the perichondrium from the concave side will release the binding force and allow the cartilage to spring back to the midline. Partial-thickness incisions on that side will further break up the intrinsic tension forces and permit the cartilage to realign.

Alternatively, the deviation of the caudal septum may be due to an isolated fracture, rather than a broad area of concavity. In these circumstances, it is best to excise the fracture line, mobilize and reduce the displaced segment, and fixate with sutures (Fig. 10.21). Splinting with a small graft extended from...
the middle third down to the anterior septal angle, similar to methods described above, will usually be effective in reinforcing this area. One must create an adequate pocket between the two medial crura in order to accept the repositioned caudal border in the midline.

If the deviation is due to residual caudal septal bowing, septocolumellar sutures can be placed between the crooked caudal septum and a rigid columellar strut, to straighten the segment after it is scored. Leah et al. describe excision of a Burrow triangle of septal cartilage at the “elbow” of the dorsal strut as a means of correcting tip deviations with a redundancy of cartilage.9

Crushed cartilage can also be used to camouflage tip deviations in a similar manner as described previously.

**Functional Repair**

Correcting the twisted dorsum for functional purposes follows many of the same principles as cosmetic rhinoplasty, but the focus is on the intranasal anatomy, rather than the cutaneous form. A twisted upper third with collapse of a nasal bone may be the cause of nasal obstruction and correctable with osteotomies that lateralize the bone, and indirectly the upper lateral cartilage. The acute nasal fracture may create nasal obstruction
from the displacement of the caudal portion of the nasal bone along with the upper lateral cartilage. Conversely, nasal obstruction from acute nasal trauma may occur on the contralateral side, i.e., the convex side, due to displacement of the septum. Standard septoplasty techniques are employed with attention to the dorsal septum.

Long-standing deviations to the middle third of the nose can be associated with nasal obstruction on either the concave or the convex side. When clinical obstruction occurs on the convex side of the nose, it is usually due to the deformity of the dorsal septum and its direct impingement on the internal nasal valve. The surgical correction of the dorsal septum is often best achieved through the external route, giving direct access to this area of the septum. The intrinsic cartilaginous bow must be realigned and is done in a stepwise fashion, beginning with release of the binding forces (intrinsic and extrinsic), followed by splinting. Attention is also given to the more posterior bony septum since it is often deviated from traumatic nasal deformities.

When the obstruction is on the concave side, one must focus on lateralizing the nasal sidewall away from the septum. This is accomplished with osteotomies, batten grafts, spreader grafts, and flaring sutures.

The spreader graft is very effective in correcting a cutaneous concavity, but its contribution toward expanding the internal valve cross-sectional airway is less convincing. The technique for inserting a functional spreader graft is identical to a cosmetic one with greater emphasis on adequate graft width in order to shift the upper lateral sufficiently. The flaring stitch is placed across both upper lateral cartilages in a horizontal mattress fashion, using the dorsal septum as a fulcrum, and directly widening the internal valve.

Placing a batten graft is one of the more common surgical maneuvers used to support the nasal sidewall and improve function at the middle vault area. Autogenous grafts are used nearly exclusively and both septal and conchal cartilages work well. The natural curvature of the conchal graft lends itself particularly well to supporting the lower third of the nose. These grafts do not need to be particularly thick or wide, but it is critical that they have adequate length to rest on the bony pyriform aperture, thus pulling the sidewall tissues out laterally (Fig. 10.22). It is common for a combination of techniques addressing the twisted dorsal septum, collapsed upper lateral cartilage, and flaccid lateral wall soft tissues to be employed.
10.7 Principles of Postoperative Care

General principles of postrhinoplasty care are applicable to many types of facial plastic procedures. The initial few days can be associated with significant periorbital swelling, ecchymosis, epistaxis, and congestion. At times, the swelling can be the primary source of discomfort during the convalescent period. Tremendous benefit comes from diligent and prompt use of ice packs to the eyes and consistent head elevation during the first 2 to 3 days. Bags of ice cubes tend not to be as effective as either crushed ice or bags of frozen peas. Strenuous activities are generally avoided for 2 weeks and contact sports for 6 weeks. Following these principles, along with digital pressure after osteotomies, can significantly minimize the postoperative ecchymosis, and on occasion eliminate it altogether.

Dense intranasal packing following rhinoplasty was once the standard of care in an effort to maintain compression on septal flaps as well as minimizing epistaxis. Precise suture techniques for reapproximating septal flaps have obviated the need for this type of postoperative packing. Intranasal crusting can be minimized by maintaining a moist environment through humidifiers, saline nasal sprays, and ointments in both nasal vestibules. Topical nasal decongestants and steroid sprays may also be of some short-term benefit. The external rhinoplasty dressing serves to minimize postoperative swelling, obliterate the dead space beneath the soft-tissue envelope, and remind the patient to avoid trauma. This type of bandage is usually kept in place for 5 to 7 days. There is a role for long-term nasal taping with patients in whom a moderate amount of soft-tissue dissection was performed, especially when debulking of soft tissues occurred. In these circumstances, it is practical to have the patient reapply his/her rhinoplasty dressing themselves in the evening. Some degree of recurrent deviation of the bony and cartilaginous skeleton can occur postoperatively. This can present in the form of recurrent twisting as well as widening of the nasal bones. Instructing the patient to perform daily nasal exercises can help mold the nasal bones during the healing period, particularly by applying more pressure to a given side.

10.8 Complications

Acute complications are not common, but include such things as excessive epistaxis, infection, nasal obstruction and congestion, unexpected pain, or massive swelling and ecchymosis. In general, these types of complications are found in all nasal procedures and are best managed on an individual basis. Later complications can arise as healing progresses and include such items as intranasal synchia or progressive airway obstruction from either lateral nasal wall collapse or septal deformities.

The most troublesome and common long-term complication specific to the twisted nose is recurrent deformity. When significant dorsal twisting exists, it may be worthwhile to forewarn patients that recurrent deformity is a distinct possibility and that revision procedures may become necessary. In some patients with tremendous dorsal deformities and asymmetrical intrinsic forces, the potential for a degree of memory to the tissues and subsequent recurrent deformity. This can occur at both the bony and cartilaginous portions of the nasal skeleton. Another reason for recurrent deviations relates to the external surgical approach and normal wound contracture. The “shrink wrap” effect that occurs beneath the nasal skin is powerful, ongoing, and not necessarily symmetrical. Subtle variations in this process will lead to recurrent twisting. Additionally, when the dorsal strut is realigned via partial-thickness incisions, recurrent warping occurs unless properly buttressed with a graft. Although these partial-thickness incisions create a dramatic effect on the operating table, they leave triangular spaces that heal with second intention and wound contracture. These small contractile forces may be the source for recurrent deviations to this cartilaginous structure.

Small dorsal irregularities are another complication prevalent in twisted nose rhinoplasty. Cartilaginous grafts are used liberally as either splints or camouflage grafts during the correction of the twisted nose. The skin along the middle vault is characteristically thin and the continued contracture of the nasal envelope will allow these cartilaginous edges to become visible. In anticipation of this potential complication, it may be worthwhile inserting a soft-tissue filler to serve as a barrier between the skin and cartilage, thus buffering the edges of these grafts. Autogenous fascia, acellular dermis, and rarely alloplastic materials can be used for this purpose. Once the irregularities become evident, they can be selectively trimmed through an endonasal approach, but this remains technically challenging under the thin overlying skin.
10.10 Representative Cases

10.10.1 Case 1: Mild Dorsal Deviation

A 33-year-old woman complains of bilateral nasal obstruction and twisted appearance of her nose. On frontal view, her dorsum is slightly twisted with a concavity on her right. The nasal bones have a palpable ridge in the left paramedian area. The nasal tip is somewhat wide and bulbous. On lateral view, her dorsum is overprojected with a slight hump that is composed of both bony and cartilaginous structures. Her tip is slightly ptotic and has good projection. Intranasal examination shows both narrowing to nasal valves and a dynamic collapse to the nasal sidewall (Fig. 10.23).

Intraoperatively, there is a twisted contour to her dorsal septum and narrowing along the internal nasal valve (Fig. 10.24).

Surgical repair was done with selective mucosal elevation of the right mucoperichondrium, release of both upper lateral cartilages, and a right unilateral spreader graft. Additional maneuvers included rasping of her bony ridges and lateral osteotomies to maintain balance to the upper third of her nose. She had bilateral cartilaginous batten grafts to the sidewall to reinforce that region. A flaring suture was placed across the upper lateral cartilages to further support the internal nasal valve. She has a bilateral cephalic trim and placement of an interdomal suture to refine her nasal tip (Fig. 10.25).

Postoperatively, she was satisfied with the improved aesthetics and nasal function (Fig. 10.26).

10.10.2 Case 2: Severe Dorsal Deviation

A 38-year-old woman complains of twisted nose and asymmetrical nasal tip. She had a reduction rhinoplasty roughly 8 years ago. On frontal view, the nasal bones are seen to be deviated to her left with a significant twisted deformity to the middle third, with the concavity on her right. Her tip also has a twisted and asymmetrical appearance. She has thin skin, and sharp bossae are palpable with tip-defining points at uneven levels. On lateral view, the dorsum is underprojected with a
low radix. Tip projection is adequate although slightly rotated cephalically (Fig. 10.27).

Palpation of her dorsum reveals C-shaped configuration involving the upper and middle thirds (Fig. 10.28).

Intraoperatively, the upper lateral cartilages were disarticulated off the dorsal septum, which in turn showed a twisted configuration. There were tip bossae at uneven levels and a fracture through the left intermediate crus (Fig. 10.29).

Surgical repair to her dorsum was accomplished by dissection of the mucoperichondrium off both sides of the dorsal septum followed by full-thickness incisions in order to release the intrinsic deviation to this area of her septum. The superior bony–cartilaginous junction was separated to allow the quadrilateral cartilage to reduce to the midline. Bilateral spreader grafts were used as splints. A dorsal onlay graft with septal cartilage was also used. Additionally, lateral ostotomies were performed to realign the upper third of her nose. The tip was addressed with a vertical dome division and excision of the bossae. These areas were closed primarily. An interdomal suture was also placed to maintain support and symmetry (Fig. 10.30).

One year postoperatively, she is satisfied with nasal contour and tip. She denies problems with nasal obstruction (Fig. 10.31).
Fig. 10.26 Eighteen months postoperatively. 
(a) Frontal view. (b) Lateral view. (c) Oblique view. 
(d) Submental view.

Fig. 10.27 (a) Preoperative frontal view. 
(b) Lateral view. (Continued)
Fig. 10.28 Deviated dorsum with concavity on the right.

Fig. 10.29 Intraoperative finding of deviated dorsum and disarticulated upper lateral cartilages. Note bossae to lower lateral cartilages.

Fig. 10.27 (Continued) (c) Oblique view. (d) Submental view.
Fig. 10.30 Schema of operative procedure.

Fig. 10.31 One year postoperatively. (a) Frontal view. (b) Lateral view. (Continued)
Fig. 10.31 (Continued) One year postoperatively. (c) Oblique view. (d) Submental view.

Fig. 10.32 (a) Preoperative view. (b) Preoperative lateral. (c) Oblique view. (d) Submental view. (e) Close-up frontal view.
10.10.3 Case 3: Fractured Dorsum and Twisted Tip

A 45-year-old woman comes in with complaints of her nasal deformity, in particular the twisted appearance of her dorsum, as well as bilateral nasal obstruction. She had a resection rhinoplasty roughly 15 years previously. On frontal view, one can see and palpate her dorsal septum projecting through the nasal bones and the upper lateral cartilages. The nasal tip is deviated to her left and her dorsum appears to deviate to her right. On lateral view, her tip is somewhat ptotic, with loss of support. There is increased columellar show due to both the hanging columella and alar rim retraction. The upper two-thirds of her nose have adequate projection. The lower lateral cartilages show obvious asymmetry with tip-defining points at uneven levels. There is fullness to her left supratip area that can be palpated. On base view, the nasal tip appears to deviate to her left (Fig. 10.32).

Intraoperatively, one can see a disarticulation to her dorsal/caudal septum with a significant deviation of the superior portion to her right. The dorsal septum was projecting through the nasal bones and upper lateral cartilages. The lower lateral cartilages show an asymmetrical, over-resection of both lateral crura that failed to adequately address the intermediate crura and domes (a common error with endonasal cephalic trims). The two intermediate crura were overlapping one another, creating the asymmetrical tip (Fig. 10.33).

Her rhinoplasty plan included a resection of the redundant dorsal septum with open reduction of this fracture line. This was reapproximated primarily and fixated with suture. The tip was made more symmetric by equalizing the remaining lower lateral cartilages and creating a left vertical dome division with overlapping lateral crural segments. Interdomal sutures and a columella strut helped to stabilize the tip-defining points in the midline and at even levels. Lateral sidewall batten grafts were placed bilaterally to support that area. The septal cartilage was used as a dorsal onlay graft and sutured into position (Fig. 10.34–c).

One year postoperatively, she continues to show increased fullness on her right, but there is improvement in the dorsum as well as nasal function (Fig. 10.35).

10.10.4 Case 4: Functional Obstruction from Deviated Dorsum

A 30-year-old woman comes in complaining of a twisted nose and left-sided nasal obstruction. On frontal view, the left middle third of her nose is unusually wide and full. Her nasal tip is slightly bulbous and ptotic. On lateral view, her dorsum is somewhat overprojected and the tip slightly ptotic. The posterior septal angle was dislocated off the anterior nasal spine and rested in her left vestibule (Fig. 10.36).

Endonasally, the right airway was widely patent. The left lumen was obstructed at the level of the internal nasal valve. Palpation of her dorsum shows her nasal bones to be straight; however, there was a twisted deformity to her dorsal septum with the concavity to her right (Fig. 10.37).

Intraoperatively, one finds a complex deformity of the cartilaginous septum. The dorsal strut is twisted with a concavity on the right. The caudal strut is twisted with the posterior septal angle displaced to her left. The concavity to her dorsal septum was creating the obstruction to her left internal valve (Fig. 10.38).

The surgical plan included a complete release of the extrinsic binding forces to the cartilaginous septum. The left lateral aspect of her dorsal strut was thinned via sharp excision. A right unilateral spreader graft was then placed to serve as a dorsal splint. A flaring suture was subsequently used to further open the internal valve. The tip was refined with an interdomal suture and tip graft. The posterior septal angle was trimmed to allow it to swing to the midline and a columella strut was also placed for additional support (Fig. 10.39).

Eighteen months postoperatively, she reports a significant improvement in her nasal function and is satisfied with the improved dorsal alignment (Fig. 10.40).
Fig. 10.34 (a) Intraoperative maneuvers. (b) Symmetry to the lower lateral cartilages. (c) Dorsal onlay graft.

Fig. 10.35 One year postoperatively. (a) Frontal view. (b) Lateral view. (continued)
Fig. 10.35  One year postoperatively. (a) Frontal view. (b) Lateral view. (c) Oblique view. (d) Submental view.

Fig. 10.36  (a) Preoperative frontal view. (b) Lateral view. (c) Oblique view. (d) Submental view.
The Deviated Nose

Fig. 10.37 Palpation of the dorsum reveals a twisted deformity to the patient's dorsal strut.

Fig. 10.38 Intraoperative view of the complex deformity of the quadrilateral cartilage.

Fig. 10.39 (a) Surgical plan. (b) Intraoperative view of right unilateral spreader graft and flaring stitch. A shave excision of the left dorsal septum was also performed.
References

Chapter 11
The Functional Tension Nose, the Overprojected Nose

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11 The Functional Tension Nose, the Overprojected Nose

Hans Behrbohm

11.1 Introduction

11.1.1 Definition of Terms

The functional tension nose is characterized by an excess of anatomical components in the cartilaginous nose. The basic problem is excessive length of the septal cartilage in the basodorsal direction combined with hyperplasia of the upper lateral cartilages. Both septal and lateral cartilages develop embryologically from a common rudiment. It is common, therefore, to find combined hyperplasia that frequently affects the alar cartilages as well. This overgrowth leads to a general elevation of the nasal dorsum. The nasal pyramid is narrow and resembles a high, narrow, pointed gothic arch. Due to the firm attachments between the septum and upper lateral cartilages and the membranous attachment of the alar cartilages, the changes in the nasal dorsum are always accompanied by typical deformities of the nasal tip. This marks the difference between the functional tension nose and the humped nose, in which the dorsal hump is bony or cartilaginous in varying proportions. The shape of the nasal tip is usually unchanged. The hump in itself does not cause nasal airway problems, unless it is posttraumatic and associated with septal deviation.

A pseudohump exists when the distance from the nasal tip to the facial plane is too small, causing the dorsum to move above the level of the nasal tip.

The term tension nose always refers to a combined morphological and functional problem.

Due to the excess cartilage, the functional tension nose is often disharmonious in relation to the face. It is too large and too high, i.e., overprojected. The nasal tip alone may be overprojected, independently of the overall size of the nose (Figs. 11.1a, b and 11.2a–d).

Building on the tripod model of Anderson and its modification by McCollough and Mangat, Parell and Becker identified four key factors in the pathogenesis of the functional tension nose: excessive height of the septum, anteroinferior rotation of the tip, narrowing of the tip, and excessive length of the lateral crus of the alar cartilages.

The functional tension nose also tethers the upper lip, causing abnormal exposure of the maxillary gingiva.

Various surgical techniques have been described for relieving tension on the alar cartilages. These techniques focused mainly on the resection of the dome area, portions of the lateral crus, or the upper and lower alar cartilages. Bull stressed the importance of a hyperplastic anterior nasal spine in the overprojected nasal tip and recommended resecting the spine to retroposition the tip.

11.1.2 Measurement of Overprojection

Joseph used the profile angle as a measure of nasal projection. He defined it as the angle formed by the intersection of two straight lines: one line tangent to the glabella and chin, and a second line tangent to the nasal dorsum. He stated a normal range of 23 to 37 degrees. By measuring the angles in portraits painted by various famous artists (e.g., Holbein, da Vinci, Reynolds, Gainsborough), Joseph determined an average profile angle of 30 degrees (Fig. 11.3).

Goode recommended the ratio of nasal length, measured as the distance between the nasion and pronasale, and projection measured between the alar groove and the pronasale for evaluating underprojection or overprojection of the nose and nasal tip. He defined the normal range as a ratio of 0.55 to 0.60.

Baud described a method of profile analysis in which he drew a circle around the face with a radius from the external auditory canal to the pronasale (tip-defining point). He then checked the relationship between three key profile points (the pronasale, pogonium, and frontal hairline). Ideally, the three key points are located on the path of the circle (see Chapter 5). He used three sectors and sector angles to analyze the profile. Our own modification of this method is described in Chapter 5. In our experience, the facial circle should be centered on the lateral roof of the external auditory canal (the porion).

We have had good experiences with a simplified and modified form of this method in routine situations, as it permits a rapid assessment of nasal projection in relation to the chin and forehead. The following questions can be answered:

- Is the nose or tip overprojected?
- Does the patient have maxillary or mandibular prognathism?
- How does the forehead affect the profile (high or sloping forehead)?

Fig. 11.1 Dorsal hump. (a) Before and (b) 3 years after septorhinoplasty.
Digital image processing can be used, for example, to predict whether reducing the tip projection, causing a relative anterior displacement of the pogonion toward the circle, will provide sufficient improvement to the profile, or whether chin augmentation should be recommended\textsuperscript{12,13} \textbf{(Fig. 11.4).}

\section*{11.2 Indications}

The surgical treatment of the overprojected nose or functional tension nose has both functional and aesthetic indications. Both indications are based on the same morphological causes, and they are separated here purely for didactic reasons.

\subsection*{11.2.1 Functional Indications}

The nares display typical changes: they are narrow, have a slit-like rather than oval shape, and terminate in a high "gothic" vestibule. The alar lateral crura and upper lateral cartilages are medialized, causing stenosis of the nasal valve. The nasal valve is formed by the junction of the free caudal margin of the upper lateral cartilage with the septal cartilage. The normal nasal valve opens at an angle of approximately 15 degrees. This angle is decreased in the functional tension nose, which in itself leads to obstructed nasal breathing. Forced inspiration causes the nasal valve to narrow and collapse, causing further airway obstruction \textbf{(Fig. 11.5)}. Even a mild degree of high septal deviation in this situation will produce marked aerodynamic effects and exacerbate the nasal obstruction. Today, the term nasal valve (see Chapter 5) is distinguished from nasal valve area, which includes the membranous attachment to the free cranial margin of the alar cartilage and the functionally important head of the inferior turbinate.
11.2.2 Aesthetic Indications

The functional tension nose is characterized by hyperplasia of the septal cartilage. Typically, the septal cartilage is too long in its dorsobasal dimension, elevating the upper lateral cartilages and cartilaginous nasal dorsum. The cartilaginous dorsum is typically convex or may form a hump, which blends proximally with a bony hump at the rhinion. The nasofrontal angle is reduced, depending on the size of the hump. Not infrequently, hyperplasia of the individual cartilages is also combined with increased longitudinal growth, creating the impression of a long nose.

Functional tension nose is associated with typical changes in the supratip area, depending on the anatomical situation. The supratip point moves to the level of the tip-defining points, and tip definition is lost.

Elastic fibers in the nasal tip area pass from the corium layer of the skin to the corium of the nasal vestibule. The skin in this area is relatively immobile. If the hyperplasia of the caudal septum can no longer be compensated by the elastic and collagen fibers of the skin over the nasal tip and the connective tissue fibers between the septum, alar cartilages, lateral cartilages, and membranous septum, then the tip-defining points will drop below the level of the supratip point (at the level of the anterior septal angle). This drooping of the tip is called ptosis.

If we draw a straight line from the tip-defining point to the supratip point, we find that the angles of the nasal tip tangents are reversed when compared with the “ideal” nose. Although this discrepancy in the levels of the tip and supratip areas may be no more than 1 to 2 mm, it has a significant impact on nasal tip aesthetics (Figs. 11.5a–h and 11.6a–f).
11.2 Indications

Fig. 11.5  (e) Preoperative basal view. (f) Postoperative basal view after widening of the vestibule and nasal valve. (g) Preoperative right nasal valve during quiet respiration. (h) Preoperative right nasal valve during forced inspiration (0-degree endoscope, Karl Storz, Tuttlingen).

Fig. 11.6  Stages of tension nose. (a) Normal nose. (b) Compensated tension nose. (c) Decompensated tension nose with a ptotic tip. (d) Normal position of the alar cartilages. (e) Tension nose with elongated nares and incipient obstruction of the nasal valve. (f) Severe obstruction of the nasal valve, with a tendency toward valve collapse and a ptotic tip.
11.3 Contraindications

Contraindications for septorhinoplasty for a functional tension nose or an overprojected nose or tip are based on functional and aesthetic considerations. Other contraindications may be due to underlying conditions (e.g., coagulation disorders, hypertension) or systemic diseases (diabetes mellitus). The patient’s skin and connective-tissue type may prohibit the use of certain operative techniques. For example, very thin skin through which the contours of the alar cartilages can be seen preoperatively would contraindicate grafting procedures on the tip.

An overprojected nose with a convex dorsum may be an ethnic feature. It may be very desirable to preserve this convexity at operation. We have also seen cases in which the patient desired straightening of the nasal dorsum but her family did not. The operation should not be scheduled until an agreement has been reached.

11.3.1 Functional Contraindications

- Good nasal breathing in computer rhinomanometry.
- No stenosis or collapse of the nasal valve, no inspiratory alar collapse.
- Function should not be sacrificed for morphological change. If significant reduction of the dorsum is needed, the surgeon should use spreader grafts, for example, or alternative techniques to establish a functioning nasal airway.

11.3.2 Aesthetic Contraindications

- Adverse effects on the overall profile. For example, a high nasal dorsum “lightens” a heavy, massive chin, even in prognathism. Lowering the dorsum in this case would further accentuate the lower half of the face.
- The correction of an overprojected nose, possibly combined with a mentoplasty, can radically alter the facial appearance. If the patient does not want this, the surgery may be contraindicated.

11.4 Preoperative Preparations and Prerequisites

11.4.1 Inspection

As with every nose, facial proportions should be considered in the assessment of the functional tension nose, especially the position of the chin, forehead, maxilla, and mandible in the three standard views: frontal, lateral, and basal.

When the tension nose is viewed from the front, the bony and cartilaginous framework appears thin and the nasal base is narrow. The skin of the supratip and tip area is tight, pale (hypoeemic), and relatively immobile. The nasal dorsum and tip are usually narrow. The infratip triangle is usually too long.

In the basal view, the nares appear narrow and slit-like rather than elliptical, and they terminate in a high “gothic” vestibule. The alar lateral crura and upper lateral cartilages are medialized (see Fig. 11.6).

Typical associated profile changes are described in the section on Aesthetic Indications earlier in this chapter.

11.4.2 Palpation

Especially in patients with a functional tension nose, palpation of the external and internal nose yields information that is important for surgical planning. It is easier to palpate tension than to see it.

- External nose: size, shape, and resilience of the alar cartilages; palpation of the anterior septal angle; tip recoil and tip support.
- Internal nose: anterior septum, anterior nasal spine, membranous septum, medial crura, and footplates.

11.4.3 Function Studies

Active anterior rhinomanometry should be performed to objectify the subjective sensation of obstructed nasal breathing. This study is based on the synchronous recording of the nasooronasal pressure difference $\Delta P$ (in Pa) and of the nasal airflow $V$ (in cm$^3$/s).

If there are signs of nasal valve stenosis, Bachmann recommends the dilatation test. Spreading open the upper part of the valve with a small cotton ball can demonstrate the pathological significance of the morphological or functional valve stenosis. The dilatation curve in this case is better than the resting curve.

11.4.4 Informed Consent

The preoperative consultation with the patient is held at least 24 hours before the operation and is preferably conducted by the surgeon or a physician representing him or her, following the recommendations given in Chapter 5. The doctor and patient review the agreed surgical goals, preferably aided by clinical photographs or drawings, and the patient is informed about all possible complications. The points that have been reviewed are documented.

The patient signs a consent form stating that all necessary information has been presented (verbally and in writing), that the patient understands all of this information, and that he or she consents to the operation.

11.4.5 Photographic Documentation and Computer Simulation

Patients with an overprojected nose or nasal tip often want to have the desired surgical result simulated preoperatively on a computer screen so that they can see their “new” nose and appreciate the overall effect of the operation on the face. This wish is justified, given the radical effect that this type of surgery can have on the patient’s appearance. Opinions differ as to the value of graphics programs in preoperative planning. We offer our patients this option and have had positive experience with it.

One advantage is that the doctor and patient have 20 to 30 minutes in which they can thoroughly discuss and review the surgical goals. During this time, the doctor can learn a great deal about the patient’s wishes. Only those changes that can actually be effected in the nose should be simulated on the computer. The simulated image is not the blueprint for judging the success of the operation, but only a tool for comprehension and planning. Consequently, we do not save the simulated image but document the desired result in a diagram.
11.4.6 Laboratory Tests
Modern septorhinoplasty is a well-planned and atraumatic procedure with less bleeding.

If there are signs of bleeding, the routine workup includes a simple blood count (Hb, platelets, leukocytes). Coagulation parameters (quick prothrombin time [PT], partial thromboplastin time [PTT], and thrombin time) are also determined.

Patients are asked about the use of cardiovascular medications or “blood thinners.” If patients report the use of nonsteroidal anti-inflammatory agents (e.g., aspirin, acetylsalicylic acid), a platelet function test is indicated. If this test is delayed, the operation should be postponed. The workup should include an allergy test if there is evidence of perennial or seasonal allergy.

At least a plain radiograph of the paranasal sinuses should be obtained prior to any septorhinoplasty. If sinus disease is present, the sinuses should be evaluated by coronal computed tomography or digital volume tomography (DVT).

Function studies consist of active anterior computerized rhinometry with a decongestion test and olfactometry with a threshold and identification test by Sniffin’ Sticks. Patients with middle ear ventilation problems or otitis media should be assessed with tonal audiometry and tympanometry.

11.4.7 Postoperative Measures
Silicone foils or Doyle splints are used to stabilize the nasal septum. They are removed on the third to fifth postoperative day. Merocel packs can be left in the ethmoid for 2 to 3 days, but intranasal packs should be dispensed with whenever possible. Steri-Strips are affixed to the external nose, placing light traction or pressure on the nasal tip according to requirements.

The internal nose is treated with nasal oil (e.g., GeloSitin, Coldastop) and an isotonic saline spray (e.g., Emser Sole Spray, Rhinomer). Intranasal crusts are removed under endoscopic control. Further details on postoperative care are presented in Chapter 15.

11.5 Preoperative Analysis
Although the nose consists of only a few structural elements, the variations in their size, arrangement, and interrelationships lead to countless shapes and nuances. Ultimately, no two noses are alike. The preoperative morphological analysis of an overprojected nose or a functional tension nose is essential for a successful operation. Through inspection and palpation, the surgeon can determine which structural elements are the major causes of the overprojection or tension deformity of the nasal inlet. Hyperplasia is rarely confined to a single structure, but often only a few features are chiefly responsible for the overprojection.

Although the operation focuses on the main anatomical problem based on this morphological analysis, the surgical correction of an overprojected nose always requires more or less extensive changes in multiple structural components of the nose in order to achieve the most natural and harmonious result.

Because an overprojected nose is always a result of hyperplasia, surgical treatment consists mainly of a series of resections.

11.5.1 Principles of Surgery for the Overprojected Nose and Tension Nose
1. Reduction or resection of hyperplastic structural elements.
2. Selective weakening of tip support mechanisms as described by Tardy (Figs. 11.7 and 11.8a–f).

11.5.2 Principal Causes of Overprojection

Hyperplasia of the Anterior Nasal Spine
An overprojected tip may be caused by an overdeveloped anterior nasal spine, either alone or combined with other hyperplasias. The hyperplastic nasal spine pushes the anterior septum upward. The nasolabial angle is obtuse and obscured. The upper lip is tethered and appears shortened. There is concomitant downward rotation of the tip. Hyperplasias of the caudal septum and nasal spine can be differentiated by careful external and internal palpation (Figs. 11.9 and 11.10a, b).

Hyperplasia of the Alar Cartilages
Hyperplastic alar cartilages may be the sole cause of an overprojected and usually bulbous nasal tip. Usually the cartilage is...
Fig. 11.8 Woman with an overprojected nose and functional tension nose, before and 3 years after surgery. (a) Frontal view: washed-out contour between the nasal pyramid and facial plane. (b) Postoperative appearance. (c) Preoperative lateral view: overprojection, retrognathism. (d) Postoperative appearance after steps 1, 2, 3, 4, 6, and 7 in Fig. 11.7. (e,f) Preoperative and postoperative half profile.
very elastic and there is firm connective tissue. The nasolabial angle is not affected (Figs. 11.11–11.13a, b).

**Excessive Length of Medial Crura (Columellar Hyperplasia)**

Elongated medial crura that are wedged between the nasal tip and spine lead to typical changes in the alar–columellar region. Usually there is concomitant hyperplasia of the anterior nasal spine. It is typical to find increased lateral exposure of the nares with vestibular skin show. A harmonious double break is absent. The intermediate crus of the alar cartilages is lengthened, causing excessive length of the infratip triangle (Figs. 11.14 and 11.15a, b).

**Hyperplasia of Septal Cartilage in the Dorsobasal Direction, Hyperplastic Vomer, Pollybeak Deformity**

Hyperplasia of the septal cartilage in the dorsobasal direction leads to elevation of the cartilaginous nasal dorsum. A similar effect can result from an overdeveloped vomer. Due to the elevation of the supratip area, the tip loses definition and has an amorphous appearance. The anterior septal angle is above the tip-defining point.

A postoperative *pollybeak* can result from insufficient shortening of the dorsal septal cartilage. Postoperative scarring, especially in thick skin, can also lead to pollybeak deformity (Figs. 11.16–11.18a, b).

**Hyperplasia of Septal Cartilage in the Craniocaudal Direction**

Hyperplastic septal cartilage that shows marked caudal extension leads to a typical clinical picture. Usually the cartilage is also hyperplastic in the dorsobasal direction. The nasal tip is poorly defined. The anterior septal angle (supratip point) is above the level of the tip-defining points. The tip is caudally rotated and ptotic. The appearance is similar to that of columellar hyperplasia due to excessively long medial crura. The difference can be appreciated by palpating the firm caudal septal cartilage and distinguishing it from the membranous septum. As with columellar hyperplasia, there is marked vestibular skin show and a deficient double break (Figs. 11.19 and 11.20a, b).

**11.6 Operative Strategy**

Preoperative analysis of the morphological problems of the nose is the basis for an efficient operation. This analysis is essential for identifying the structural elements of the nose that require critical modification and reorientation and for planning the approach, which should be as invasive as necessary and as noninvasive as possible.
Fig. 11.11 Overprojected nasal tip due to hyperplasia of the alar cartilages. Red shading: possible operative steps for retroposition of the nasal tip.

Fig. 11.12 Patient with an overprojected nose due to alar cartilage hyperplasia. (a) Before and (b) 3 years after surgery.

Fig. 11.13 Patient with an overprojected tip due to alar cartilage hyperplasia. (a) Before and (b) 4 years after surgery.
The preferred approach for correcting the functional tension nose or overprojected nose is the delivery approach. This is a closed approach that provides excellent exposure for direct, symmetrical modification of the alar cartilages. Several techniques can be used in this approach for retroposition of the nasal tip:

- Cranial volume reduction with or without resection of the tip-defining points (complete strip). The cephalic portion of the lower lateral cartilage can fold down to form a cephalic underlay. It is an effective technique in patients with a tendency of alar collapsibility and vestibular aspiration.
- Wedge excision from the lateral alar cartilages, reapproximating the stumps with sutures, better than resections is the lateral sliding technique.
- Releasing, modifying, or reorienting cartilage tension by cross-hatching, morselizing, or incising.

Fig. 11.14 Overprojection of the nose due to columellar hyperplasia with elongated medial crura.

Fig. 11.15 Lateral and frontal views; (a,c) before and (b,d) 2 years after surgery.
In approximately 30% of our patients with an overprojected or tension nose, we use an open approach. The indications for this approach are as follows:
- Significant overprojection requiring a dome resection.
- Severe asymmetry of the nasal tip.
- Revision surgery.

### 11.6.1 Central Role of the Septum

The nasal septum is of key importance in the surgical correction of the functional tension nose. By reducing the septal height, changing the position of the anterior septal angle, shortening the caudal septal margin, or beveling the anterosuperior margin, the surgeon can selectively modify the shape, position, and aesthetics of the nasal tip.\(^\text{12,13}\)
The operation begins with exposure of the septal cartilage. The transfixion incision is better for this purpose than the traditional hemitransfixion. Tip support can be weakened and reduced in two ways through this approach:

- Dividing the membranous septum.
- Releasing the footplate attachments to the caudal septal margin.

The preferred three-tunnel technique of Cottle has the advantage of preserving the nutrient connections between the cartilage and mucoperichondrium. The risk of postoperative septal hematomas is reduced, and there is less scarring and less tendency toward redeviation.

If it is necessary to correct septal deviation in addition to shortening the septal cartilage in the dorsobasal or craniocaudal direction, it can be helpful to create two superior tunnels. In this way, the surgeon can fully expose the septal cartilage and assess its deformities and tensions. It is common to find dual sites of anterior and posterior stenosis. With two superior tunnels, these sites can be corrected under vision by scoring or cross-hatching both sides. It is our impression that this facilitates rotation of the septal cartilage between the alar cartilages and the actual “trimming” of the mobilized and basally shortened cartilage. The risk of perforation is thereby in principle increased, but this can be prevented by avoiding mucosal lesions at corresponding sites.

### 11.6.2 Intranasal Septal Resection

#### Basal Strip

A septum that is too long in the basodorsal direction can be relaxed by resecting a basal strip only 2 mm wide. The effect of this on the nasal tip and supratip area should be checked at each step in the operation. The effects vary considerably in different patients, ranging from no visible change to a marked decrease in projection or a saddle depression in the supratip area.

#### Anterior Septal Margin

Shortening the anterior septal margin by 2 to 4 mm may be necessary if the septum is too long (see Fig. 11.20). This can affect the tip rotation. Cranial rotation is produced by shortening the cranial or caudal septal margin between the medial and anterior septal angle. Another option is to shorten the entire anterior margin or, if the nasolabial angle is obscured, shorten the basal portion.

#### Swinging Door

The septal cartilage can be detached 2 mm in front of the perpendicular plate to expose and access the bony septum.
Experience has shown that approximately 30% of the causes of nasal obstruction are located in that region. Bone spurs and ridges also have indirect effects on the anterior septal cartilage. If they are left alone, nasal breathing will continue to be obstructed and there will be a danger of incomplete relaxation of the septal cartilage.

**Treating the Septal Cartilage**

The intrinsic tension of the basally and cranially mobilized septal cartilage can be altered by scoring, careful morselizing, cross-hatching, or incising. The cartilage should be scored on the concave side to lengthen and “open up” the shorter curvature on that side. This is supported by small wedge excisions on the opposite side. 19

**Reimplantation**

All cartilage that is removed from the nose should be treated externally and reimplanted to help stabilize the nasal dorsum and tip. The position of both structures should be permanently and predictably maintained after the operation. This can also prevent septal flutter during phonation and forced respiration. The removed fragments are compressed by applying careful, controlled pressure with a cartilage crusher. This alters the bending properties of the cartilage without seriously damaging it or compromising its mechanical strength. Fibrin glue can be used to reattach the cartilage fragments and seal the mucosal pouch (see Chapter 12).

**Extracorporeal Septoplasty**

The extracorporeal septoplasty or extracorporeal septal reconstruction, as described by Gubisch, provides an option for correction of serious septal deformities in difficult and previous operated cases. The external reconstruction of a straight septum requires removing of the whole cartilaginous and bony septum in one piece. After the external straigtening and stabilization, for instance, with spreader grafts, the neoseptum will be reimplanted and fixed at the anterior nasal spine and nasal pyramid in the K-stone area.20,21

### 11.6.3 Principles of Profile Correction and Hump Removal

We use a closed approach in approximately 70% of our patients with an overprojected nose or tip or functional tension nose. The delivery approach, unlike the cartilage-splitting approach, permits specific measures for reposition of the nasal tip. These include resections to reduce the alar cartilages themselves as well as incisions to weaken the tip support mechanisms. By delivery of the alar cartilages, the surgeon can modify the three most important factors that determine tip support and projection:

- The size, shape, and resilience of the medial and lateral crura of the alar cartilages.
- The attachment of the crural footplates to the caudal septum.
- The connective-tissue attachment between the upper lateral and alar cartilages.

The nasal tip is corrected first, followed by the dorsum. The advantage of the delivery approach is that it allows the surgeon to evaluate the effects of each step in the operation on the tense contours of the external nose. Also, it preserves the system of elastic and collagen fibers in the skin of the nasal tip for enhanced tip support.

It is logical to correct the nasal tip first, as this sequence allows the surgeon to evaluate fine changes in the nasal tip at each step of the operation.22,23 When the desired tip projection and rotation have been achieved, the height of the nasal dorsum can be adjusted. A large hump is the only situation in which it may be better to deviate from this sequence.

Resection of the cartilaginous and bony nasal dorsum should be done in the extramucous plane to avoid intraoperative and postoperative bleeding. Injuries to the nasal mucosa during lowering of the nasal dorsum or hump removal are a particularly common source of bleeding. The mucosa can be separated from the dorsum using an elevator.

An osseocartilaginous hump should be removed piecemeal. The bony component is usually smaller. With a piecemeal technique, the osteotome can be positioned at a more precise angle for shaping the nasal dorsum than with an en bloc resection (Fig. 11.21).

The larger, cartilaginous portion of the nasal dorsum has a more important effect on the supratip area, tip area, and dorsal region. After the cartilaginous dorsum has been lowered with a No. 15 blade, the Ruben’s osteotome can be used. Generally, less bony hump is removed due to the differences in skin thickness at the nasal root, rhinion, and tip. Fractionated, piecemeal hump removal is the best technique for achieving a straight dorsum or obtaining a slightly convex contour in the rhinion area.

It is a precondition to preserve the underlapping cartilage of the nasal vault under the nasal bones in the K-stone area.

**Lateral Osteotomies**

**Types of Osteotomy**

Osteotomies can be performed transnasally with micro-osteotomes 3 to 4 mm or percutaneously with 2 mm osteotomes (Figs. 11.22 and 11.23).

**Low-to-Low Osteotomy**

This osteotomy starts with a vertical, percutaneous transverse osteotomy with a 2 mm osteotome using postage-stamp technique, initiating the cut from the medial canthus. The next, caudal cut runs straight from the nasal process of the piriform aperture to the level of the medial canthus.

**Low-to-High Osteotomy**

This osteotomy starts at the maxillary nasal process of the piriform aperture and runs tangentially from there to the nasofrontal suture, cutting partially through the nasal bones. It
leaves a bony bridge that is then infractured by thumb pressure like a greenstick fracture.

**Low-High-Low Osteotomy**

The osteotomy line curves upward the piriform aperture. This is done to reduce the functional sequelae of medializing the inferior turbinate, the inferolateral fragment, and the soft tissue.

**New Osteotomes**

**Ship’s Bow Osteotomes**

To compensate for the problem of an uncontrolled osteotome position while avoiding injuries to the periosteal layers, we added a prominence over the cutting edge, which enables the surgeon to locate the cutting edge by palpation. The prominence is shaped like a “bulbous bow” of a ship, which forces water to flow up over the bulb, optimizing the flow along the hull. A similar effect occurs between the bone and the periosteum, as the bulb lifts the periosteum and projects it from injury. The bulbous bow glides beneath the intact periosteum (Fig. 11.24).

The removal of large humps or marked lowering of the nasal dorsum always carries a risk of postoperative valve stenosis. This can be avoided by the liberal use of spreader grafts placed in the extramucous plane.

### 11.7 Complications

Possible complications relate to the hazards of the selected approach and the various steps in the operation. A closed endonasal approach causes less tissue trauma than an open approach and is associated with less edema, swelling, and ecchymosis. The less trauma is inflicted, the more quickly postoperative swelling will subside. The most aggressive instruments are rasps. They should be used only sparingly to smooth irregularities.

Potential complications include infection, hemorrhage, and the displacement of mobilized cartilage and bone. Injury to the orbit from a minichisel is possible in theory, but the author is unaware of any cases reported to date.

#### 11.7.1 Infection

The larger the wound area and the longer the operation, the higher the risk of infection. Atraumatic technique reduces this risk, as small hematomas are associated with less danger of infection.

#### 11.7.2 Bleeding

Dissections should proceed strictly in the surgical plane (see Chapter 1). This can prevent bleeding and minimize swelling.

The nasal mucosa should be preserved as scrupulously as possible. Mucosal injuries are the most frequent cause of significant postoperative hemorrhage.

#### 11.7.3 Dislocations

The surgically modified cartilage and bone should be securely fixed in their new position and stabilized. Significant long-term scar traction (e.g., on onlay grafts) is a concern. Cartilage...
The Functional Tension Nose, the Overprojected Nose

should be fixed with sutures, and bone should be stabilized with splints or a nasal cast.

The complications of endonasal endoscopic microsurgery are reviewed in Chapter 1.

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Chapter 12

The Saddle Nose—Causes and Pathogenesis, Approaches and Operative Techniques, Principles of Tissue Replacement in the Nose

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12 The Saddle Nose—Causes and Pathogenesis, Approaches and Operative Techniques, Principles of Tissue Replacement in the Nose

Hans Behrbohm

12.1 Introduction

The term *saddle nose* denotes a polycausative condition that is associated with destabilization or destruction of the bony or cartilaginous structures of the nose. In old textbooks on otorhinolaryngology, saddle nose was most often described as a feature of congenital syphilis.¹

Today, osseous forms of saddle nose are rare and usually result from dysplasia of the nasal bones or from nasal or midfacial trauma. The cartilaginous saddle nose is a more frequent concern for rhinologists. The central problem in this condition is serious structural compromise caused by a loss of anterior septal cartilage between the rhinion (keystone area) and the “septal pedestal” at the level of the premaxilla and anterior nasal spine.²

Frontal trauma to the nose can lead to septal cartilage necrosis as a result of septal hematoma or septal abscess. Meanwhile, cartilage fragments may be displaced and weaken the mechanical properties of the septal cartilage or may produce a sharp, angular septal deviation or transverse deviation. Combined injuries to the bony and cartilaginous nose lead to lateralization of the nasal bones or portions of the maxillary frontal process. This creates an open roof, often with disruption of the osseocartilaginous junction at the rhinion (keystone) and the formation of a visible step-off (inverted V) between the cartilaginous and bony nasal segments. Cartilaginous saddle nose can also result from the over-resection of septal cartilage in a septoplasty—a common legacy from the age when the Killian’s resection was widely practiced.

Depending on their size and location, septal perforations cause a loss of cartilage substance, leading to concavity of the cartilaginous nasal dorsum and retraction of the lower columella (“hidden columella”). Other causes may be Wegener’s granulomatosis, cocaine abuse, trauma from nose picking, atrophic rhinitis sicca (often combined with an anterior septal deviation), or polychondritis.³

A change in the septal cartilage is almost never the sole cause of saddle nose, however. Saddling is a multifactorial process in which the destabilization of the septum incites changes such as separation or settling of the upper lateral cartilages, and cranial tip rotation or loss of tip projection and support. For this reason, stable reconstruction of the cartilaginous septum is the critical challenge in the operative treatment of saddle nose deformity. Saddle nose is a typical example of the inseparable link between morphological and functional abnormalities in the nose and the task that is faced by corrective nasal surgery.

The depression of the supratip area leads to widening of the nasal valve with a caudal drift of the upper lateral cartilages. The increased nasal valve angle is accompanied by hyperplasia of the inferior turbinates (ballooning phenomenon). The result of these changes is always an impairment of nasal breathing.

The surgical treatment of saddle nose has a reconstructive character. Many patients will bring in old photographs of themselves to demonstrate the original shape of their nose. In contrast to most other operations in aesthetic nasal surgery, where the object is to modify an existing form, the usual goal in saddle nose surgery is the restoration of a former state (Fig. 12.1).

The surgery of saddle nose requires expertise in the selection, procurement, and placement of suitable grafts or implants for tissue replacement in the nose (see the section on Guidelines for Tissue Replacement in the Nose later in this chapter).

Many different techniques have been described for the surgical correction of saddle nose. The state of the art is particularly well represented by the works of Tardy, Meyer, Rettinger, Nolst Trenité, Aiach, and others.⁴⁻⁵

12.2 Indications

The goal of a saddle nose correction is not just to reconstruct the nasal dorsum. A more important goal is to restore the supportive framework of the nose in order to improve nasal breathing and achieve stable long-term results.

Form and function are almost always equally compromised in saddle nose deformity, and both must be included in the plan of operation in order to achieve acceptable results.

Our discussion of functional and aesthetic indications in separate sections is done purely for didactic reasons.

12.2.1 Functional Indications

The indication for septrhinoplasty on functional grounds is based largely on the degree of nasal breathing impairment. Severe impairment often leads to pathological sequelae such as pharyngitis, laryngitis, and bronchitis. Septal deformities, usually following septal fractures, lead to paranasal sinus ventilation problems with recurrent or chronic sinusitis, which in turn may cause headaches and facial pain. Septal perforations can cause drying of the mucosa and olfactory compromise, depending on their size.

12.2.2 Aesthetic Indications

Saddling leads to typical external changes in the nose relating to depression of the cartilaginous dorsum, especially in the supratip area. Depending on the cause, there are typical pathogenic mechanisms that affect the face as a whole and especially the proportions of the profile. Fig. 12.2 illustrates these typical changes in a woman with posttraumatic saddle nose. The frontal view demonstrates a broadened nasal dorsum. The rhomboid of the nasal tip is broadened. We look in vain for the *supratip point* formed by the anterior septal angle. The result is a broad, poorly defined tip. A *hidden columella* is apparent in the frontal view. The infratip triangle is shortened. The result is a general coarsening of the facial features.

The lateral view shows saddling of the nasal dorsum in the supratip area. The tip is rotated upward and has lost projection. As a result, the chin appears to jut forward.

A *pseudosaddle nose* is caused by an overprojected tip combined with a concave nasal dorsum. The facial circle is useful for determining the position of the tip and helps in differentiating between a true and pseudosaddle nose (see Chapter 5).

A *pseudohump* occurs when the cartilaginous nasal dorsum is depressed below the rhinion. In contrast to a true hump, the nasofrontal angle is not increased.

The hidden columella is most apparent in the three-quarter profile view (Fig. 12.2a–f).
12.3 Contraindications

Contraindications for septorhinoplasty exist in patients with florid granulomatous inflammations that have caused cartilaginous destruction, as in Wegener’s granulomatosis or polychondritis. The top priority in these cases is to diagnose the underlying disease. It is often difficult to make a histological diagnosis in Wegener’s disease. The excisional biopsy should always be taken from the margin of the septal perforation and should include normal-appearing mucosa along with the granulations. If possible, reconstruction should be deferred until remission has been achieved with pharmacological therapy.

Pirsig et al reported on the successful reconstruction of saddle nose in cases of Wegener’s granulomatosis and ectodermal dysplasia using extranasal incisions and auricular cartilage.9

Saddle nose reconstruction following a prior septal operation is most successful when it is delayed for approximately 9 months after the initial surgery so that the new operation can be planned on the basis of definitive, scarred defects. Operating too early before wound healing is complete and stabilizing or destabilizing the revision outcome. Traumatic saddle nose in boxers should not be corrected until the patient has retired from the ring. Often, however, professional boxers will already have problems with obstructed nasal breathing at the start of their career. In these cases, a compromise may be struck between functional improvement and reasonable aesthetic improvement without extensive mobilization of the nasal skeleton.

12.4 Preoperative Preparations and Prerequisites

12.4.1 History

History taking in saddle nose patients should include any prior history of trauma. Besides the mechanism of a nasal injury, the timing of the injury provides important causative clues. If the trauma affects the cartilaginous growth zones of the pediatric nose, saddling may result from the inhibited growth of specific nasal cartilages. The traumatized adult nose is characterized by the displacement of initially normally developed cartilages.

The rhinological history should also probe for signs of cartilaginous diseases, previous nasal operations, and underlying diseases.

12.4.2 Inspection

Saddle noses present characteristic external features that vary with the underlying pathogenic mechanisms.

Frontal View

The following changes may be seen as isolated findings or in various combinations. The nose appears generally broadened. This may be most conspicuous in the supratip area or may
affect the entire nasal dorsum. If the nasal bones are displaced or lateralized, hypertelorism is noted. Often, this impression is strengthened by ruptured medial palpebral ligaments. Epicanthal folds result from a disproportion between the skin and the reduced nasal height. An open roof contributes to widening of the nasal dorsum. The “inverted V” is a sign that the connection between the cartilaginous and bony nose has been disrupted.

**Lateral View**

The nasal dorsum is depressed. The tip is usually rotated upward or occasionally downward, causing a loss of projection. If the cartilaginous anterior septal margin is absent, the columella is retracted cephalad (hidden columella) with deformation of the alar–columellar complex. The columella is shortened. The upper lip appears too long.
Saddle nose can result from a variety of causes. Three pathogenic mechanisms have been identified for the most common types of saddle nose.

**12.5.1 Type I Pathogenic Mechanism of Saddle Nose**

Loss of nasal dorsum support from the anterior septum leads to a loss of cartilaginous dorsal height. There may be lateralization, spreading, or separation of the upper lateral cartilages, depending on the depth of the saddling. With depression of the dorsal septal margin, an important tip support mechanism is compromised. This leads to depression of the supratip area and anterior septal angle. As this occurs, the rhomboid of the nasal tip loses its supratip point, and the tip becomes amorphous. Because tip support is deficient, the tip rotates upward. If residual cartilage is preserved in the caudal septum near the caudal margin, this remnant can still provide adequate tip support. The loss of projection in the nasal tip results from cranial rotation due to deficient support of the supratip area.

This cranial rotation leads to a loss of tip projection. The nasolabial angle is broadened (> 110 degrees). The loss of structural support from the septal cartilage causes the caudal portions of the lateral cartilages to sag, with broadening and deformation of the nasal valve angle (ballooning phenomenon). There is compensatory hyperplasia of the inferior turbinates. Viewed from the front, the central nasal dorsum appears broad and blends smoothly with a poorly defined tip (Fig. 12.3).

**12.5.2 Type II Pathogenic Mechanism of Saddle Nose**

This type is based on extensive cartilage defects in the septum or an absence of cartilage at the caudal septal margin. Absence of the anterior cartilaginous septum leads to a lack of support of the dorsal septal margin. There is no membranous septum to stabilize the medial crura of the alar cartilages, and the caudal septal margin is unable to secure the footplates of the medial crura. The columella is retracted upward (hidden columella). The tip loses projection due to the complete loss of tip support. The tip may rotate upward or downward, depending on whether the forces exerted by scar formation and tissue contraction act chiefly on the nasal dorsum and supratip area or the caudal sep-

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**Basal View**

The nasal base and nares are broadened. The nares assume a more horizontal alignment and have a round or transverse oval shape. The columella is shortened. The angle between the septum and lateral alar cartilages is obtuse.

**12.4.3 Nasal Endoscopy**

The nasal valve is broadened. The inferior turbinates are hyperplastic, and the upper lateral cartilages show caudal displacement (*ballooning phenomenon*).

The septum can be inspected for cartilaginous defects (*soft septum*) with the endoscope and a cotton applicator. Granulations and perforations can be evaluated and biopsy specimens taken. Precise information on how much cartilage is still present is just as important as the size of a septal perforation.

**12.4.4 Palpation**

Important information can be gained in saddle nose patients by external and internal palpation of the nose.

**External Palpation**

The nasal dorsum is palpated for irregularities, bony and cartilaginous defects, and an open roof. Trauma will often leave sharp-edged irregularities resulting from displaced fragments of nasal bones. Selection of the operative technique is guided by the palpation of tip support in connection with the anterior septal angle.

**Internal Palpation**

Internal palpation of the nose can furnish information on the anterior septum, its anterior margin, and the presence of cartilaginous fractures or defects in the anterior septum.

**12.4.5 Laboratory Tests**

Saddle nose patients should be assessed with a simple blood count and basic coagulation studies (quick prothrombin time [PT], partial thromboplastin time [PTT], platelets). The blood group is not routinely determined because hemorrhage requiring a transfusion is extremely rare. If the patient should require a transfusion because of heavy bleeding, the blood group can be quickly determined in a hospital setting.

In patients with septal perforations and granulomatous inflammations, *interleukin 6* is a more sensitive marker than *C-reactive protein* in assessing the acuteness of the inflammation.

If an autoimmune disease such as Wegener’s granulomatosis is suspected, the lungs should be investigated by plain radiography and computed tomography. Laboratory tests are done to check for signs of progressive renal failure (*creatinine*, *creatinine*). When Wegener’s granulomatosis is present, tests will reveal anticytoplasmic antibodies directed against plasma granules of neutrophilic polymorphonuclear leukocytes and monocytes (*ACPA/ANCA*).1011

Patients with elevated transaminases should undergo more precise coagulation testing (*platelet function test*) prior to surgery. Members of high-risk groups such as homosexuals, drug users, and prostitutes should be tested for HIV.
tal margin. Because the depression of the cartilaginous dorsum and dorsal septal margin and the basal movement of the upper lateral cartilages create a greater loss of static support, the tip usually rotates upward, compounding the loss of projection.

The broadened central portion of the nose in this situation is accompanied by a broadened tip. Because of the lax membranous attachment between the upper lateral and alar cartilages, the anterior margins of the upper lateral cartilages slip downward, while the alar cartilages are displaced laterally. The columella is shortened (Fig. 12.4).

12.5.3 Type III Pathogenic Mechanism of Saddle Nose

Displaced fractures of the nasal bones or maxillary frontal process combined with trauma to the cartilaginous nose can disrupt the attachments of the upper lateral cartilages to the nasal bones in the keystone area.

“Keystone” is an architectural term for the central stone that is wedged in place at the apex of an archway. If the keystone were removed, the archway would collapse.

Describing the osseocartilaginous attachment at the level of the rhinion as the keystone area underscores the essential load-bearing importance of this area. A traumatic avulsion of the cartilaginous nose from the nasal bones leads to an inverted V-shaped depression that is difficult to correct. In contrast to the type I and II mechanisms, the cranial portion of the upper lateral cartilage or the entire lateral cartilage is shifted downward.

Associated changes in the cartilaginous dorsum and nasal tip result from the mechanisms described earlier.

The bony nasal pyramid is depressed, and the dorsum already appears broadened at the bony level (Fig. 12.5).

12.6 Surgical Strategy

The surgical treatment of saddle nose is reconstructive in nature. While the patient with an overprojected nose, for example, wants to have something altered, most patients with saddle nose are interested in having their former appearance restored. Often the patient will bring in old photographs to give the surgeon an idea of the desired result.

The most important surgical goal in saddle nose is to reconstruct a stable septum. All other reconstructive measures are adjuncts. The main consideration, then, is how to carry out the reconstruction. The surgeon can determine the approximate extent of the cartilage defect by carefully probing the septum with a soft cotton applicator, guided by a 0-degree wide-angle endoscope. Besides identifying the missing cartilage areas, the surgeon can also gain information on the size and resilience of the remaining cartilage. Important points to note are the size of the cartilage defects and the cartilage remnants that are still present.

Only small defects can be reconstructed by the local transfer of residual cartilage.

12.6.1 Reconstruction for Minor Saddling of the Cartilaginous Dorsum with a Circumscribed Defect in the Cartilaginous Septum and Normal Tip Support

The options in this situation are reconstruction with posterior septal cartilage or with cartilage harvested from the conchal cavity.

Reconstruction of the anterior septum with material from the posterior septum is possible if there is residual cartilage of sufficient quantity and quality. The septal cartilage is fully exposed by making a hemitransfixion incision and developing two superior and inferior tunnels.

Using this technique, the “fontanelles” formed by duplications of the mucosa at cartilage defects can be visualized without tension and sharply divided with a No. 15 blade. The remaining posterior cartilage is divided basally and dorsally with a pair of Heymann nasal scissors and elevated with a Freer elevator at its junction with the perpendicular plate. It can be mobilized then and removed en bloc. Once removed, the piece of cartilage can be placed on a small carving bench for measuring and modification.

Mild deviations can be corrected by carefully morselizing the cartilage or scoring it on the concave side. While the anterior cartilage piece should not be morselized, the posterior cartilage can be enlarged by careful compression with a Rubin morselizer.

After external preparation of the cartilage pieces is completed, a mucoperiosteal flap is medialized by the insertion of a Doyle splint. Using fibrin glue, the surgeon replaces the cartilage pieces like mosaic tiles and glues them to the medial mucosa. A defect located at a very caudal level can be repaired with a large piece of cartilage fitted into a columellar pocket. The columellar pocket is developed by passing a pair of curved Cottle scissors from above in a downward direction between the medial crura of the alar cartilages and carefully spreading open the connective tissue in the vertical plane (Figs. 12.6 and 12.7a–f).

The cartilage piece is secured inferiorly with a 4-0 polydioxanone suture (PDS) on a straight needle. Since the tissue will undergo scarring and shrinkage, the cartilaginous dorsum should be augmented with a dorsal onlay graft, even with mild degrees of saddling. A hemitransfixion incision extending to the anterior septal angle can provide atraumatic access for graft placement. A supraperichondrial
recipient bed can be created on the depressed nasal dorsum with a pair of fine Joseph scissors, keeping strictly below the vascular plane of the superficial musculoaponeurotic system (SMAS).

The connective tissue should be carefully dissected using either a blunt spreading technique or sharp division when scars are present. The recipient bed should be scarcely larger than the actual graft size. While a tight pocket cannot prevent scar contractures, it will allow the dorsal graft to heal in an optimum position. Fibrin glue (Beriplast) can be used for graft fixation. Larger onlay grafts should be introduced through a bilateral intercartilaginous incision with a superior hemitransfixion.

**12.6.2 Reconstruction for Deep Saddling of the Cartilaginous Dorsum with Extensive Cartilage Losses or Septal Perforations and Adequate Tip Support**

Conchal cartilage makes a suitable graft material for reconstructing the cartilaginous nasal septum. This material is less stable than septal cartilage, however, and should be morcellized very carefully.

**12.6.3 Harvesting the Donor Cartilage**

Three ultrathin needles are placed below the margin of the conchal cavity, and the posterior sites of emergence are marked with methylene blue. A retroauricular skin incision is made, and a skin flap is raised. The cartilage is divided, and the conchal cartilage is carefully dissected from the anterior conchal skin. The skin on the anterior side of the conchal cavity is more adherent to the cartilage than on the posterior surface of the auricle. The conchal cartilage graft is circumscribed and removed.

The open approach can be used to reconstruct the nasal dorsum in patients with deep saddling. If the nasal dorsum appears broad or if an open roof is present, two paramedian and laterally curved osteotomies are performed with miniosteotomes. The upper lateral cartilages are detached from the superior margin of the septum. The apposed mucosal layers are sharply separated, dissecting onto the nasal floor at the level of the anterior nasal spine, premaxilla, and vomer. Cartilage islands that are encountered are removed and set aside. Then the harvested, straightened conchal cartilage is placed on the nasal floor and attached to the connective tissue of the nasal spine anteriorly with a PDS suture.

The two upper lateral cartilages are pulled upward with two-prong hooks and fixed with two fine needles. After checking the position of the upper lateral cartilages on the supporting neoseptum, the surgeon secures them with two prolene sutures. The conchal cartilage above the upper lateral cartilages is cut off with a pair of Fomon nasal scissors (Figs. 12.8 and 12.9a, b).

Circumscribed saddling of the supratip area can be corrected with a butterfly graft. The graft is composed of conchal cartilage with both perichondrial layers dissected off the graft but attached at one edge. The cartilage is placed in the supratip area with the perichondrial “wings” spread symmetrically over the upper lateral cartilages and secured with PDS sutures or fibrin glue. The graft is supported by the lateral cartilages, which anchor it to stabilize the supratip area (Figs. 12.10 and 12.11a–g).

**12.6.4 Reconstruction of the Nasal Dorsum with Severe Loss of Tip Support**

Cartilage harvested from the sixth or seventh rib is suitable for the reconstruction of saddle nose with severe loss of tip support. Good results have been achieved with autografts and allografts. Only central cartilage should be used ("balanced grafts") to prevent subsequent warping and displacement of the implants.

Two pieces are cut from the central portion of the cartilage, and the dorsal onlay graft and columellar strut are carved from these pieces. The dorsal graft is fashioned so that it extends from the tip area to the cranial part of the bony nasal pyramid. The sides are beveled to eliminate visible or palpable ridges. The columellar graft is placed against the nasal spine or, if nasal lengthening is desired, farther anteriorly on the upper alveolar crest.

The grafts are connected with tongue-and-groove joints. This provides a firm connection that is also flexible enough to yield to scar traction and provide some residual mobility of the tip (Figs. 12.12 and 12.13a–d).

**12.7 Guidelines for Tissue Replacement in the Nose**

The basic types of material available for cartilage replacement in saddle nose reconstruction are autografts, allografts, and synthetic implants.

**12.7.1 Graft Requirements**

Graft and implant materials must satisfy various requirements. They should have good biocompatibility or be biologically inert. They must cause no local or systemic toxicity. The graft should undergo minimal absorption in the body and should not alter its shape or position in the recipient bed. The material should be quickly and safely accessible, available in the necessary quantities, and economical. It is advantageous if the material is easy to shape and use, with mechanical properties (resilience, load-bearing ability) that closely approximate those of the original tissue.
With cartilage implants, “balanced cross-section” costal grafts should be used to allow for the special deformation properties of the cartilage. The tension in septal, conchal, or tragal cartilage grafts can be altered by cross-hatching, morselizing, or scoring on the concave side.

Allografts and synthetic implants must be autoclavable. The current consensus is that allografts should no longer be used in the facial region.

### 12.7.2 Synthetic Implants

New implant materials have constantly been developed and utilized for tissue replacement in reconstructive surgery. The history of nasal implants began in 1828 with gold and silver (Rouset). Paraffin was used in 1904 (Eckstein), ivory in 1925 (Maliniac), cork in 1931, marble in 1939 (Zeno), and acrylic in 1948 (Wolf).
Synthetic implants must meet rigorous criteria. These include chemical and thermal stability that permit autoclaving, dimensional stability, minimal foreign body reactions, and the absence of cytotoxic, antigenic, and carcinogenic properties. Polyvinylchloride (PVC), polyamide (Nylon), polyvinyl alcohol (Ivalon), and polyurethane (Perlon) are among the materials that do not meet these criteria due to inadequate chemical stability.

**PTFE (Teflon), ePTFE (Gore-Tex), and Porous Polyethylene (Porex)**

Some materials such as polytetrafluoroethylene (PTFE) (Teflon, Proplast), expanded polytetrafluoroethylene (ePTFE) (Gore-Tex), and porous polyethylene (Porex) are receptive to permeation by fibrous tissue ingrowth when used in the form of thin-walled implants.

This tissue ingrowth depends on the porosity of the plastic. Large pore sizes in the range of 100 to 150 mm are favorable. PTFE has proven unsatisfactory for reconstructive nasal surgery due to problems of stability and tissue compatibility. The FDA revoked its approval of Proplast implants in 1990. The material is easy to shape.

Gore-Tex (ePTFE) is used mainly for volume replacement and is less suitable for providing structural support. It has good biocompatibility, although a 10.6% incidence of infection with fistulation and extrusion has been reported.

See Fig. 12.14.
Porous polyethylene (Porex) is a porous plastic used to replace cartilage that provides mechanical support. When heated, it can be shaped, cut, and perforated. Its tissue compatibility is good. The material is receptive to tissue ingrowth and is becoming increasingly popular in rhinosurgery.19,20

**Silicone**

Silicone is sometimes used for augmentation of the nasal dorsum, particularly in Asia. There is a substantial risk of early or late extrusion. A fibrous tissue forms around the silicone implant, which does not establish a strong attachment to
surrounding tissue. Microtrauma, especially in the cartilagi-
nous nose, may lead to microhemorrhages, edema, and inflam-
matory reactions around the implant, with an associated risk of infection and extrusion. Silicone is unsuitable for use in the cartilaginous nose (Fig. 12.15a, b).

Cements

Cement material (biocement, ionomeric cement, e.g., aluminum oxide ceramic, hydroxyapatite cement) cannot be used in the flexible nose because of their brittleness. They have proven useful, however, for bone replacement in areas such as the forehead and glabella5,21 (Fig. 12.16a–d).

New synthetic materials for tissue replacement in the nose are usually greeted with initial enthusiasm. Later, there are reports of expulsions and complications, dampening the early expectations. In retrospect, no synthetic material has been able to fulfill all expectations, and so the rhinosurgeon should always regard new materials with a certain skepticism. This is the only way to safeguard patients from implants that will not yield positive intermediate- and long-term results.

It is certain that new synthetic implant materials will continue to be developed. Organ replacement with a biocompatible

Fig. 12.12 Reconstruction of saddle nose with costal cartilage.

Fig. 12.13 (a) Woman with cartilaginous saddle nose following severe nasal trauma. There is a complete loss of tip projection and support. (b) Appearance 3 years after nasal reconstruction with autologous costal cartilage. (c,d) Preoperative and postoperative three-quarter profile.
Fig. 12.14  Section through the wall of an ePTFE prosthesis, completely permeated by connective tissue, showing distinct capillary structures (from 16).

Fig. 12.15  (a) This patient presented with infection 6 years after the insertion of a silicone implant (in Thailand). (b) Silicone implant after removal.

Fig. 12.16  (a) Posttraumatic broad nose accompanied by absence of the outer table over both frontal sinuses. (b) Appearance 10 years after reconstruction of the frontal defect with bioceramic and septorhinoplasty with closure of the open roof deformity. (c,d) Preoperative and postoperative lateral views.
material that can be carved to any shape and is available in unlimited quantities is a fascinating concept. It may, however, be that advances in tissue engineering for nasal cartilage replacement will slow this trend. There have already been several case reports on the successful reconstruction of the nasal septum following a childhood abscess. Tissue engineering for cartilage generation is based on the use of biodegradable polymers as a temporary scaffold for differentiated chondrocytes or precursor cells. The cells are harvested, propagated in culture, seeded onto the scaffold in vitro, and then transplanted. While in the body, the differentiated cells should produce their tissue-specific matrix constituents, generating a tissue that has virtually the same morphological and functional properties as the original cartilage.

A compromise to avoid implantation hazards is to implant an incorporeal material (e-tetrafluoroethylene) at an inflexible site, such as the retroauricular area, and then use the incorporeal implant to augment the nasal dorsum approximately 6 weeks later.

In our experience, there is almost sufficient endogenous tissue available for reconstructing the nose, and consequently there is little reason to implant synthetic materials in the nose. Autologous tissue should be used whenever possible. Autologous cartilage continues to be the gold standard for plastic reconstructive surgery of the nose. The most popular graft types are discussed next.

12.7.3 Autologous Grafts

**Septal Cartilage (Autologous, Isotopic Draft of First Choice)**

Cartilage from the posterior septum should always be used when it is available in sufficient quantity. It should be harvested behind a line between the rhinion and anterior nasal spine, leaving intact the cartilage that is essential for dorsal support.

Septal cartilage has good stability and resilience. Tension can be removed by cross-hatching, incising, or gentle morselizing with an atraumatic Adson forceps or Rubin morselizer. Septal cartilage is easier to morselize than conchal cartilage, for example. It is more stable to pressure and will alter its bending properties under gentle pressure without fraying. Generally, however, the properties of the cartilage should be altered as little as possible.

Other advantages of septal cartilage are that its properties are identical to those of the tissue being replaced, and it can be quickly and safely harvested through one approach.

**Alar Cartilage**

Pieces of alar cartilage, usually from the upper lateral crura, can be used for augmentation of the nasal dorsum or tip. Because of their thinness, they are principally used as onlay grafts for superficial contour modification rather than as supporting grafts for the nasal dorsum.

**Conchal Cartilage (Autologous, Heterotopic Draft of Second Choice)**

Considerable amounts of conchal cartilage can be harvested from the conchal cavity and tragus.

**Conchal Cavity**

Conchal cartilage is excellent for cartilage replacement in the nose and is the material the author uses most frequently for that purpose. This is because septal cartilage is rarely available in sufficient amounts for the reconstruction of saddle nose deformity. Conchal cartilage is dimensionally stable, resilient, and provides good mechanical support for use in the nose. It can be harvested quickly and safely and is easy to carve.

Another advantage is that conchal cartilage has a variety of intrinsic convexities and concavities that are useful for reconstructing specific areas in the nose (see Fig. 12.10).

Conchal cartilage is suitable for the replacement of septal cartilage, upper lateral cartilage, and alar cartilage. It can be used in the form of a shield graft, tip graft, or columellar strut. The cartilage is exposed through a retroauricular approach. The skin on the posterior side of the auricle is loosely attached to the perichondrium by abundant connective tissue. The skin on the anterior side is tight and immobile. Often it is best to leave connective tissue on the cartilage when the graft is harvested, as this will help in the correction of larger defects.

As a general rule, conchal cartilage should be harvested and used without perichondrium. In children, however, a perichondrial layer can be left on the graft to exploit the chondroplastic potential of the cartilage.

Conchal cartilage is usually easy to carve with a scalpel. It is extremely difficult to morselize, however, as it will fray when the least pressure is applied. The cartilage heals without difficulty and undergoes very little resorption. During use, the surgeon should take advantage of the intrinsic shapes and curvatures of the cartilage.

**Tragus**

Tragal cartilage is harvested through an approximately 12-mm incision made with a No. 15 blade just behind the anterior border and directed toward the external meatus. The cartilage can be used along with two small perichondral flaps, which are quickly dissected, and has the same uses as cartilage from the conchal bowl. The perichondrium is thin but very tough. It can be used to camouflage an inverted V in the nasal dorsum, as in cases where the keystone area has been injured during the reconstruction of a traumatic saddle nose. The perichondrium undergoes less postoperative swelling than fascia.

The perichondrial layers can be mobilized on both sides and left on one end of the cartilage, where it can be fixed with PDS sutures. The tragus can be used in this way as a butterfly graft to reconstruct circumscribed cartilage defects in the supratip area.

**Costal Cartilage**

The use of costal cartilage is indicated in saddle nose reconstruction when there has been extensive loss of nasal supporting structures with a lack of tip support. Septal or conchal cartilage may lack sufficient strength in this type of situation.

The cartilage is harvested from the sixth or seventh rib through a 4- to 5-mm skin incision placed over the right rib or in the inframammary crease in women. The perichondrium is incised, and the costal cartilage is harvested within the perichondrium. The surgeon should be alert to possible pneumothorax by wetting the pleura with a few drops of sterile water and consulting with the anesthesiologist. The rib cartilage should be balanced, i.e., only the central portions of the cartilage should be used for grafting.
The disadvantage of the long, stiff rib graft is its unnaturally consistent in the nasal dorsum. The nose becomes rigid, and even a perfectly healed graft may cause a foreign body sensation.

**Diced Cartilage in Fascia and Turkish Delight**

“Turkish delight” is diced cartilage mixed with blood and antibi-otic and wrapped in methylcellulose (Surgicel). The graft remains moldable, even days or weeks after the operation. The Surgicel wrap is resorbed in 2 weeks. Fascia can be used as an alternative to Surgicel. A diced cartilage in facial transplant (DCF transplant) is recommended for repair of large defects of the nasal dorsum, for instance, in saddle noses or in cleft noses. (refer to Chapter 13).

**Fascia**

In principle, adequate amounts of autologous temporal fascia or fascia lata can be quickly harvested through an incision placed in the scalp or the lateral thigh.

**Temporal Fascia**

Temporal fascia is available in sufficient quantities. An incision made in the scalp above the auricle provides the best access. The fascia should be sharply divided inferiorly, elevated and separated from its muscle fibers with a Joseph elevator, and then harvested with a pair of small, preferably ball-tipped scissors. The less damage caused to muscle fibers, the more bloodless and atraumatic the graft removal.

The consistency of the fascia varies greatly in different individuals, depending on the connective-tissue type.

**Fascia Lata**

Fascia lata is the toughest fascia in the body. It consists of an approximately 5-cm-wide strip extending between the greater trochanter and lateral epicondyle of the femur. The course of the fascia lata must be considered in the harvesting of graft material. After the fascia is removed, the defect should always be repaired to prevent the herniation of muscle tissue.

**Bone**

Bone has probably been the most widely used material for augmentation of the nasal dorsum in saddle nose over the past 100 years. The harvesting of iliac bone is a painful procedure. Iliac bone transplanted to the bony nose requires a stable, well-vascularized bed; otherwise, it will be resorbed. The bone (especially its cancellous portion) does undergo resorption in the mobile cartilaginous nose.

**12.7.4 Allografts**

**Cartilage**

Cartilage tissue from the septum, concha, or rib can be stored by various methods (Mercihiolate, Cialit, alcohol, freeze-drying, dehydration, gamma irradiation). In principle, allograft cartilage, or “banked cartilage,” is comparable to autologous cartilage in its mechanical strength, its low degree of resorption, its susceptibility to infection, and its deformation properties.

Mercihiolate-preserved cartilage behaves like devitalized tissue. It is partially resorbed at the edges and is also replaced and ensheathed by connective tissue.

**12.7.5 Fibrin Glue**

Fibrin glue is a physiological two-component adhesive (Beriplast). In principle, it mimics the final stage of blood coagulation. Fibrinogen is polymerized by thrombin to produce fibrin. The latter is cross-linked by factor XIII to form a stable fibrin clot. The glue contains a small amount of aprotinin (fibrinogen solution) to protect the fibrin clot from premature degradation in vivo. The glue is excellent for attaching onlay grafts, fascia, perichondrium, and similar materials used for camouflage.

**12.8 Principles of Implantology in the Nose**

The successful transplantation of autograft or allograft cartilage is influenced by the following factors: the type of cartilage, its storage and preservation, the volume and surface area of the graft, the methods used to harvest and prepare the graft, the biological characteristics of the recipient bed (rigid or flexible part of the nose, deep or superficial), the condition of the operative field, the connective-tissue type, the surgical technique, and the postoperative mechanical stresses to which the graft is exposed.

The principal dangers of cartilage implantation in the nose are graft resorption, deformation (warping), and infection. The graft material of first choice is always viable autologous cartilage. If it is not available, allograft tissue should be used. We have experienced no problems with infection, intolerance, or inflammation associated with the use of autologous cartilage grafts.

**12.8.1 Harvesting Graft Material**

Atraumatic harvesting of the graft material is essential for the successful transplantation of autologous cartilage. Septal cartilage should be dissected in the subperichondrial plane, and conchal cartilage in the supraparichondrial plane. The tissue should not be injured or crushed during removal. Perichondrium does not protect the graft from resorption and should be dissected off the cartilage unless it is intended to have a chondroplastic function in children, in which case it should remain on the graft.

Following hemostasis with fine bipolar forceps, the donor site must be absolutely dry. This is necessary to prevent hematoma formation, which can become a major problem in postoperative care.
The conchal cavity should be packed with pledges after graft harvest to promote adhesion of the skin layers.

The nasal mucosa is kept moist by spraying it with an isotonic saline solution. Ultrasonic waves can generate a fine, relatively homogeneous mist that can deliver droplets smaller than 5 μm to the nasal and paranasal sinus mucosae.ிஊ

12.8.2 Preparing the Recipient Bed

The quality of the recipient bed is critical for the fate of the graft and thus for the long-term success of the operation.

The size of the recipient bed should closely match the graft size to prevent subsequent displacement. When cartilage is implanted to broaden and stabilize the nasal valve or to reinforce collapsing alar cartilage, it may even be wise to make the recipient pouch slightly too small to maintain a certain basic tension in the graft. We have found that a rhinoplasty template or other measuring device is an indispensable aid for matching the sizes of the graft and recipient bed.

Deep implants in the nasal dorsum have a supporting function and provide for the structural replacement of cartilage or bone substance. They should be placed between the perichondrium and the vascular SMAS layer, from which they will derive their vascular supply. Injuries to the SMAS lead to hemorrhage. Hematomas can result in graft infection as well as heavy scarring that can jeopardize graft healing. Superficial grafts are used for contouring the external nose, which requires a direct subcutaneous graft placement. The surgeon must decide case by case whether to attach the grafts with sutures or fibrin glue. We use absorbable suture material almost exclusively for graft fixation—usually polydioxanone and less commonly polypropylene (Prolene).

When revision surgery is performed, care should be taken to dissect the tissues in a way that will not subject the implant to scar traction (Fig. 12.17).

12.9 Postoperative Care

In patients who have undergone reconstructive nasal surgery with grafts, it is essential to rest the operative area for several days after the surgery. This is aided by starting the patient on a liquid diet, progressing later to semisolid foods. Ice goggles can be worn in the postoperative period to reduce soft-tissue swelling.

The nasal septum is stabilized with a flexible silicone stent (Doyle) for 5 to 7 days. The nasal dorsum is immobilized with a plaster cast, thermoplastic splint, or metal splint. The length and size of the nasal dressing are varied according to its desired effect.2

Draining secretions and clots are aspirated from the nose with semiflexible plastic suction probes with fingertip control (Micro-Flex probes).

If splints or packs are left in the nose for more than 3 days, an antibiotic (cephalosporin) should be administered for 6 days. Treatment with an herbal mucolytic agent (e.g., Gelo-myrtol forte) for 2 to 3 weeks has also proved beneficial. This product has deodorizing, bacteriostatic, mucolytic, and secretomotor properties.

12.10 Complications

The main complications associated with the use of grafts for saddle nose reconstruction are infection, expulsion, displacement, and resorption.

The best way to prevent infection is to avoid using allografts in the nose. Other critical factors are the use of autologous tissue and an atraumatic technique for harvesting the graft and preparing the recipient bed. Infected synthetic implants will eventually have to be removed. In Asia, silicone implants are still widely used in reshaping the broad, flat Asian nose.

Minimally displaced autologous grafts in the nasal dorsum or the slight warping of a graft can be managed with minor corrections of the nasal dorsum. For greater degrees of graft displacement, a revision procedure should be scheduled at 8 to 9 months.

Bleeding may occur from the richly vascularized nasal mucosa during the immediate postoperative period. The source of the bleeding should be identified endoscopically so that it can be selectively coagulated. If intranasal packs are needed to control the bleeding, they should be placed by the surgeon under endoscopic guidance.

A postoperative septal hematoma should be drained by opening a suture (e.g., in the hemitransfixion incision) without delay. A loose pack will support the fixation of the mucosa to the septal cartilage.

Postoperative infections are rare. Initially they can be treated with empirical antibiotics, followed later by specific antibiotic therapy. To date, we have not had to remove a cartilage graft because of postoperative infection.
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Chapter 13
Rhinoplasty after Cleft Lip Repair

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In all cleft lip and palate (CLP) patients, a nasal deformity is part of the malformation and affects patients functionally as well as aesthetically. This complex deformity is due to a congenital anomaly and may partly be the result of previous surgical procedures. The nasal deformity in a unilateral cleft lip patient is totally different from that in a bilateral cleft lip patient.

### 13.1 Correction of Unilateral Cleft Lip Nasal Deformity

The nasal floor and the nostril sill are usually reconstructed during primary lip repair, which should be focused specifically on the repair of the divided oral ring muscle. The ala on the cleft side is repositioned symmetrically with the healthy side and sometimes the lower lateral cartilages (LLCs) also are fixed in a more symmetric way. Only a few surgeons try to position the dislocated anterior septum in the midline, which always follows the dislocated anterior nasal spine (ANS) to the non-cleft side. New concepts attempt to reach early symmetry of the nostrils and the tip through subtle techniques without interfering with cartilage growth and avoiding the typical severe nose deformities that stigmatize these patients.1–3

### 13.2 Surgical Anatomy

According to Huffmann and Lierle,4 the classic cleft nose is characterized by 22 features, although not all of them are typically present in every patient.

The external examination reveals a deformed nose to the healthy side due to the characteristic sepal deformity. The anterior septum follows the dislocated ANS to the noncleft side. Therefore, the caudal border is always subluxated to the noncleft side. Very often, there is also an asymmetry of the nasal bones, so that not only the cartilaginous nose is deviated. Because of the malposition of the ANS, and thereby induced deformity of the caudal septum, there is always an oblique columella with asymmetric nostrils. In addition, the columella on the cleft side is shortened and the LLC (alar cartilage) on the cleft side presents an S-shaped distortion and is flattened and displaced laterally and/or cranially. Therefore, the nostril on the cleft side is horizontally orientated and presents as an oval shape in contrast to the physiological oblique orientation of the nostril on the noncleft side.

The endonasal examination reveals a bowed septal deformity toward the cleft side, and the septum is deviated in all three planes—a so-called difficult septum being the result. Compensating for this typical deformity, the inferior turbinate of the noncleft side quite often shows a hypertrophy. The most lateral part of the lateral crus on the cleft side slants into the vestibule and forms the vestibular plica. The sill is often missing, depending on the effect of the alveolar bone grafting that is mostly performed at the age of 10 years. There might be a bony deficiency with a depression.

### 13.3 Indication

In many patients with a unilateral CLP deformity, the correction of the nasal deformity has a high priority because it produces characteristic stigmata in the middle of the face. Upon meeting another person, usually you look into their eyes, but with a conspicuous nose like a cleft nose, your gaze will be drawn to it. This is realized and noticed by these patients, and it affects them. However, what worries them is not only the typical distortion of the nose, but also the functional impairment. Typically, there is a blockage in the cleft side and quite often breathing is blocked on both sides.

The nose correction is, therefore, an essential part in the rehabilitation of CLP patients.

### 13.4 Surgical Principles

The goal of surgery is straightening the deviated internal and external nose, creating symmetry of the nostrils, and giving a good contour to the tip. By correcting the anatomical deformities, good function can be achieved.

In our concept, most of these severely deformed septums need an extracorporeal septal reconstruction, which means a temporary explantation of the whole septum.5 Because this dramatically affects the growing zones, we only perform this kind of surgery 1 year after menarche in girls and 1 year after a change of voice in boys.

### 13.5 Operative Technique

Because of the complexity of surgery, we perform all cleft nose corrections under general anesthesia.

There are five complex problems that need to be addressed:
1. **The deformed septum.** To straighten the nose, we need a straight septum. Because the septum presents mostly a three-dimensional deformity, in most cases we perform an extracorporeal septal reconstruction.
2. **The displaced anterior nasal spine.** Not only must the septum stay in the midline, but the malpositioned ANS also has to be fixed in its normal anatomical position. Therefore, in all major ANS displacements, we osteotomize the ANS, transfer it into the midline, and fix it there by microscrews and microplates.
3. **The deformed nose.** Because in most cases an asymmetric nasal pyramid is seen, we straighten the bony pyramid via parasagittal medial osteotomies as well as percutaneous lateral and transverse osteotomies.6
4. **The distorted ala and deformed nasal tip.** To reach symmetry of the nostrils, we generally perform a lateral crural steal technique on the cleft side and then replace the missing lateral crus with a cartilage graft.
5. **The malposition of the alar base.** Correction of the ala base is optional because this deformity depends a great deal on the previous surgery. There is a wide variety of typical ala base asymmetries, but in most cases the ala on the cleft side is too far lateral and too caudal.

### 13.6 Septal Correction, Part 1

Using an open approach, we dissect the anterior septal angle, expose the caudal border, perform an extramucous dissection,
and cut the upper lateral cartilage (ULC) from the septum. Then the upper and the lower tunnel of both sides are dissected. To remove the whole septum—if possible, take it out in one piece—a parasagittal medial osteotomy is performed. The author prefers a Lindemann fraise (Medicon Company, Tuttlingen) for that maneuver because an exact, straight bone cut can be achieved with this tool, while simultaneously removing some bone that otherwise might block the bone fragments during repositioning. To avoid any bad fractures, which might extend into the cribriform area, we make a bone cut downward from the bony dorsum with an angle of about 60 degrees. After dissecting out the base of the septum from the maxillary crest, we fracture the bony septum by pressing with a 5-mm chisel. It is important that the whole mucosal wall be freed from the septum before this step so that the mucosa will not tear during its removal.

To achieve a straight neoseptum, or at least a straight L-shaped frame with the adequate dimensions, the length of the original dorsum and of the original caudal border have to be measured. Very often the explanted septum can be rotated 90 degrees so that the bony–cartilaginous junction becomes the new dorsum and the original dorsum gets the caudal septal border. Bent or weak parts are best splitted with thinned ethmoid bone. For reconstruction of the internal nasal valves and for keeping the neoseptum straight, we always apply spreader grafts. The use of spreader flaps is possible, but in these cases it is technically difficult. Thicken parts of the septum are always flattened with a cylindrical drill.

### 13.6.1 Correction of the ANS

Before replantation of the neoseptum, the ANS must be positioned in the midline. A side-to-side fixation of the replanted septum is only possible in cases of minor dislocation. Then the ANS is perforated with a drill to allow a transossous fixation of the neoseptum placed next to the dislocated spine.

In most cases, we cut the displaced ANS with a Lindemann fraise, put it in the midline, and fix it there by an angulated four-hole microplate that is secured by microscrews. The septum itself is sutured after replantation (see below) directly to the microplate.

### 13.6.2 Correction of the Bony Pyramid

Before the septum is put back, the deviated and asymmetric bony pyramid has to be straightened.

Parasagittal medial osteotomies are necessary for explanting the septum. The lateral as well as the transverse osteotomies are performed percutaneously. We do not respect Webster’s triangle, because in more than 10,000 rhinoplasties we have not seen problems with medialization of the lower turbinates’ head. After marking the low-to-low lateral osteotomy line, we make a stab incision, push away the vessels by scratching on the bone, and make a continuous transsection of the maxillary process with a 3-mm osteotome. The transverse osteotomy is performed analogously in the intercanthal line.

### 13.7 Septal Correction, Part 2

After bringing the fragments in the right position, replantation of the neoseptum starts. Safe fixation of the replant is essential for success.

After smoothing the dorsal line by trimming the nasal bones with a drill and the ULC with a scissor, the neoseptum is put back. To avoid the need of a columella strut, the neoseptum is put in a more caudal position to allow a tongue-and-groove maneuver because an exact, straight bone cut can be achieved with this tool, while simultaneously removing some bone that otherwise might block the bone fragments during repositioning. To avoid any bad fractures, which might extend into the cribriform area, we make a bone cut downward from the bony dorsum with an angle of about 60 degrees. After dissecting out the base of the septum from the maxillary crest, we fracture the bony septum by pressing with a 5-mm chisel. It is important that the whole mucosal wall be freed from the septum before this step so that the mucosa will not tear during its removal.

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### 13.7.1 Tip Correction

A strong and straight caudal border of the septum is also essential for tip correction. The goal is a symmetric cartilaginous framework of the LLCs. If trimming of the cephalic portion on the noncleft side seems appropriate, we do not resect this part, but dissect off the vestibular skin from the alar cartilage and turn the excess under it so that it gets stronger. Furthermore, this procedure helps to flatten the lateral crus. On the cleft side, we prefer to dissect out the lateral crus completely and form symmetric domes by a lateral crusal steal technique. The complete dissection of the lateral crus enables us to give it a symmetric orientation to the noncleft side. By transferring the cartilage medially, a lateral deficiency may result, which can be corrected by a lateral crusal strut graft or a batten graft taken from residual septum parts, straight parts from the concha, or from rib cartilage.

For stabilizing the nasolabial angle and preventing postoperative drooping, we like a tongue-and-groove technique and fix the medial crura to the caudal border of the replanted septum. If it is not possible to follow this principle, we use a septal extension graft for the same purpose. If this does not work, a columella strut from a double-layered conchal graft is our favorite technique.

The tip itself is contoured as usual with transdomal (interdomal) sutures and sometimes with additional intradomal sutures. The strong lateral crus can be molded by ala spanning sutures, which are combined with a tip suspension suture, fixing the tip complex to the dorsal septum (tip suspension with posterior sling technique). In case stronger lateral crus are needed to apply spanning sutures without any risk of creating an iatrogenic deformity, we prefer to use horizontal mattress sutures as suggested by Gruber for flattening and strengthening the alar cartilages.

The soft tissue does not always follow the changes of the framework, and an asymmetry may persist. In such cases, we perform a triple-flap repair. The principle of this technique is to lengthen the short columella on the cleft side by a flap, based on the columella, and swing it inward 90 degrees after incising the vestibular skin for lengthening. The typically hanging ala on the cleft side is elevated into normal position by raising a second flap, based on the ala, and swinging inward accordingly. By transposing these two flaps, a gap results at the apex of the nostril. To achieve roundness, a third flap is created from the excessive vestibular skin, which remains after transposing the skin flaps.
13.7.2 Correction of the Alar Base

The position and the shape of the alar base on the cleft side depend a lot on the primary cleft closure and the effect of bone grafting. If there is a maxillary deficiency, we compensate it with diced cartilage fascia (DCF), made from allogenic fascia lata and autogenous diced ear or rib cartilage. We prefer rib cartilage because of its unlimited quantity. In minor asymmetries, we use fine-diced cartilage as free graft.

In most cases, the ala on the cleft side is displaced laterally and/or superolaterally. If the alae are positioned at the same horizontal level, a lateral displacement can be corrected by an island flap from inside to outside, based on the small nasal muscles. This technique works inversely too and has the great advantage that, by the pull of the muscle pedicle, the effect of narrowing or widening is increased. Additionally, this lineament creates a nice crease and therefore gives a more natural appearance.

If there is simultaneously a vertical asymmetry, we use transposition flaps for correction. If the ala base is positioned too cranially, we harvest a flap based on the upper lip medio-caudally to the ala. The lower incision has to be placed at the same level as the ala position on the healthy side. The vestibular skin is incised, the gap is filled with this transposition flap, and by closing the donor side, the ala is brought into a symmetric position. In case the ala base is placed too caudally, the same principle is used vice versa.

13.8 Case Examples

13.8.1 Case 1

An 18-year-old woman with left-sided CLP deformity presented for revision surgery after previous cleft nose correction (operation by Wolfgang Gubisch).

The axis was deflected typically to the noncleft side, and the cleft septum was oblique with consecutive asymmetric nostrils. The ANS was dislocated to the noncleft side and the caudal border of the septum was subluxated to the same side. The central septum was bowed to the left; on the right side, the lower turbinate was hypertrophic. The ala on the cleft side was pinched—the ala base was displaced superolaterally. In the profile, the maxilla was hypoplastic (the nasal tip was hanging) because the support to it was insufficient (Fig. 13.1a–f).

After exposing the typical deformity using an external approach via an inverted-V transsection, we found the ANS dislocated 9 mm from the midline (Fig. 13.1g, h) to the noncleft side. The caudal border of the septum was displaced in the same way.

If the deflected anterior septum (Fig. 13.1i) from the dislocated ANS, we cut the spine with the Lindemann fraise (Fig. 13.1j), put it in the midline, and fixed it there with an angulated four-hole microplate and micro screws (Fig. 13.1k, l). Before fixing the ANS, we augmented the hypoplastic maxilla with a DCF (Fig. 13.1m) from autogenous rib graft and allogenic fascia lata (Tutoplast; Tutogen Medical Gmbh). On top of the DCF, we placed a septal extension graft (Fig. 13.1n), harvested from the central septum. We fixed it to the anterior septum and then directly to the microplate (Fig. 13.1o), which secured the ANS in the midline. This septal extension graft kept the deformed septum straight.

The hypertrophic turbinate bone on the right side was removed by a submucous resection.

Tip asymmetry was balanced by suturing the medial crura to the septal extension graft using a tongue-and-groove technique (Fig. 13.1p) combined with a lateral crural steal technique (Fig. 13.1q). After trimming the asymmetric cephalic portions (Fig. 13.1r), the domes were contoured by intradomal sutures and then the tip was shaped by a transdomal suture (Fig. 13.1s). A very thin, extended shield graft was fabricated from the rib sutured in position and turned backward to cover the whole tip (Fig. 13.1t) to increase the projection. To avoid any irregularities, this construction was covered with a single layer of allogenic fascia lata (Tutoplast) (Fig. 13.1u). Before putting the skin flap back, an underbatten graft was placed to the right ala (Fig. 13.1v), fixed with transcutaneous sutures (Fig. 13.1w), and a rim graft was placed to the right side. After closing the columella, before closing the infracartilaginous incision, the final contouring was performed with a finely diced, paste-like cartilage (Fig. 13.1x), using it as a free graft injected through a tuberculin syringe (Fig. 13.1y).

Fig. 13.1 An 18-year-old woman with left-sided cleft lip and palate deformity presented for revision surgery after previous cleft nose correction. (continued)
Fig. 13.1  An 18-year-old woman with left-sided cleft lip and palate deformity presented for revision surgery after previous cleft nose correction. (continued)
13.8.2 Case 2
Hans Behrbohm

Introduction
The patient presented for an aesthetic rhinoplasty at 55 years of age. She had undergone six previous operations for CLP repair. She now sought an improvement of middle-third and alar symmetry and improved nasal tip projection.

Findings
Fig. 13.2a–c shows the patient as she appeared at presentation after six previous operations both to repair her CLP and to improve the function and appearance of her nose.

Surgical Procedures
A total of three revision rhinoplasties were performed by Hans Behrbohm:
1. In 2006, tragal cartilage was harvested, and the nasal septum was medialized through a hemitransfixion incision.
2. In 2007, the nose was refined by re-augmenting the same region with retroauricular connective tissue.
3. In 2009, very firm, stable tragal cartilage was harvested from the opposite side to make a columellar strut, which was inserted through an open approach and fixed with 5–0 Prolene sutures (Ethicon). The left nasal sidewall was again camouflaged with conchal cartilage (Fig. 13.2g).

13.9 Psychology, Motivation, Personal Background
CLP is not just a surgical problem; it affects the whole individual. Rehabilitation of the deformity proceeds in a series of steps that culminate in rhinosurgery. A successful operation can help to heal a psychological wound that has existed for years.
13.10 Discussion

Rhinoplasty is the last step in the reconstructive rehabilitation of patients with cleft lip deformities. It is important to establish a closed nasal sill, as it will create a foundation for constructing symmetrical columellar and alar anatomy. Previous cleft repairs leave scars that will direct the rhinosurgical procedure. In the case described, the patient’s desire for further improvements developed gradually, starting with a very minor improvement in symmetry and proceeding to increased nasal tip projection. Cleft lip produces typical anatomic changes depending on whether the deformity is unilateral or bilateral. Cleft lip repairs leave behind firm scars that tend to contract and distort the surrounding tissues. These factors must be taken into account when planning the placement of stable, tension-free implants in cleft lip rhinoplasties.

The term “cleft lip and palate” is somewhat incomplete, as it fails to express the significant functional and aesthetic nasal problems that always coexist with a cleft lip. The primary treatment goals are centered on the cleft repair, while secondary treatment options are directed toward optimizing the form and function of the nose. The goals of a secondary rhinoplasty are determined by the congenital anomaly itself and by the results of the primary repairs. Unilateral and bilateral cleft deformities present different starting conditions for septrhinoplasty. Patients with a bilateral cleft have a short columella. The nasal tip is broad and flat, and the

Fig. 13.2 (a) Frontal view shows asymmetric brow-tip aesthetic lines due to hypoplasia of the left upper lateral cartilage, depression of the left nasal sidewall, and upward retraction and medialization of the left ala due to scarring. (b) Profile view shows an underprojected nasal tip with an acute nasofrontal angle and typical flat profile associated with a cleft lip and palate. (c) Basal view shows severe vestibular stenosis and medial alar retraction due to scarring. (d–f) Findings 2 years after the revisions. (continued)
Fig. 13.2  (continued) g) intraoperative details: blue = cartilage implants (dorsal onlay grafts, columellar strut); red = resections. 1–3, conchal cartilage onlay grafts; 4, columellar strut; 5, tragus cartilage removal; 6, reconstruction of the cartilaginous and bony septum; 7, fixation of the straightened septal cartilage; 8, new positioning of the alar wing.

nostrils have a transverse oval shape. The nasal sill is frequently absent, and the alar base is displaced laterally and cephalad. The alar cartilages show an S-shaped deformity.

Unilateral clefts are usually associated with nasal deviation to the opposite side and significant septal deviation. Typically the anterior septum is dislocated toward the affected side, with the anterior septum deviated to the noncleft side and the posterior septum deviated to the cleft side. The nasal spine is displaced to the noncleft side.3,5

Given this initial situation, septrhinoplasty is a highly complex operation that has a different scope and time frame than other rhinoplasties. Complete symmetry often cannot be achieved, and many cases require a staged approach to surgical treatment. Optimum symmetry of the nasal tip and nostrils can be achieved only by repositioning the cartilages and reshaping the soft-tissue envelope.1,2

The following specific issues need to be addressed: the septal deformity, turbinated hyperplasia, the deformed bony nasal pyramid, the deformed nasal tip, the alar displacement on the cleft side, and the short columella.

1. It is important to approximate the septum to the palatal shelves. The septum is the central structural element. Good exposure is obtained with an inverted-V incision at the most narrow place of the columella, extending into the columella rim incision and the infracartilaginous incision on both sides. An extracorporeal septrinoplasty is often advised.13
2. It is often essential to perform a moderate, structure-conserving reduction of a hyperplastic inferior turbinate on the side opposite to the deviation.
3. The axial deviation usually affects both the cartilaginous and bony portions of the nose. Tailored osteotomies are often required. The authors prefer to perform the osteotomies percutaneously.
4. Contrary to the usual sequence of steps, the nasal tip should be addressed after correction of the septum and bony nasal pyramid.
5. The alar base, which is usually displaced laterally or laterally upward on the cleft side, is repositioned best by some kind of an island flap to avoid any tension to the new positioned ala base.
6. Columella lengthening may become necessary in a bilateral cleft deformity. A V-Y advancement should not be performed from columella skin, because this destroys the columella contour, but from both sides of the nasal floor. Then the alar base is transposed medially.

References

Chapter 14
Nasal Trauma

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14 Nasal Trauma

Oliver Kaschke

14.1 Introduction

The nose is the most prominent facial element. The fracture of the nasal pyramid is one of the most frequent bone fractures of the human body. The energy required to cause a fracture is lower than for other facial bone fractures. More than 50% of all facial fractures are injuries to the nose. In the course of increasing incidents of injuries to the facial area, the resulting mostly complex consequences pose great challenges for the trauma specialist, who, with his assessment and treatment, is responsible for the reconstruction of form and function.1–3

For nasal injuries, one can differentiate based on the type, direction, and energy volume of the impinging trauma between superficial soft-tissue injuries with lacerations of the skin and soft tissue, burns and frostbite, and fractures of the cartilage and bony framework and structure. High levels of energy striking the face often result in extensive and combined injuries. Not infrequently, injuries and especially fractures of the nose are considered minor injuries in an average clinical day and often treated with insufficient diagnostics as well as inadequate care. The incidence of posttraumatic deformities that have not only unaesthetic but also functionally unacceptable consequences is high. In many cases, the necessary revision septorhinoplasty has proved to be difficult. Therefore, practicable guidelines for the optimal medical care of acute nasal trauma are necessary. Currently, there are still discrepancies with regard to the timing and methodology involved in posttraumatic management. Posttraumatic repositioning of nasal bone fractures implemented early are generally carried out as simple, contained manipulations, resulting in cases requiring the corrective medical care of either rhinoplasty or septorhinoplasty. The data for frequency vary between 14 and 50%.4,5

14.2 Trauma-Relevant Anatomy of the Nose

A detailed anamnesis, in particular of the trauma event, as well as an exact clinical examination are especially important for the assessment of the injury. In doing so, precise knowledge of the fundamental anatomy is virtually essential for the surgeon. The osseous architecture of this compact region includes the twin nasal bones, front process of the maxilla, the maxillary process of the frontal bone, the lacrimal bone, the lamina papyracea of the ethmoid bone, the sphenoid bone, and the vomer. Fitted into this structure are the cartilage elements of the quadrangular cartilage of the septum and the upper and lower lateral cartilages of the external nose. The midfacial bony structures are reinforced by vertical and horizontal buttresses. The upper horizontal buttress is formed by the lower anterior rim of the sinus and the upper orbital rim, while the lower orbital rim functions together with the zygomatic bone as the lower horizontal buttress (Fig. 14.1). The twin naso-ethmoidal complex functions as a “central element” and forms the vertical buttress together with the frontal process of the maxillary bones and the lateral interior angle of the frontal bone. Only the thickened posterior edges of the nasal bones are components of the buttresses, but they protect the further dorsally located thin bones of the medial orbital wall. The central element is also the fixation point for the medial canthal tendon, which guarantees support for the bulb and the eyelids (Fig. 14.2). Tears to this support signify a traumatic telecanthus and a rounding of the medial canthus. However, the function of the musculus orbicularis oculi is not influenced by a mobile canthal tendon. In contrast,
impairment of the lacrimal sac drainage can result, because this is surrounded by portions of the canthal tendon.

The nose as a central and prominent facial element can function as an energy absorber and thus as protective buffer of the viscerocranium. The cartilage portions have a high level of flexibility, and traumata with a low amount of energy can be partially absorbed without permanent damage. The variously thick bone structures determine the predilection sites of fractures, but the different bone thickness also has an influence on the extent of the fracture. Thus, older people with osteoporotic bones have comminuted fractures more frequently, whereas in children dislocative fractures are rare, but here greenstick fractures predominantly occur.

The anatomical relations are significantly different in children in comparison to adults. The bones are shorter and the cartilage portion is larger. Additional protection is given because the bones are embedded in thicker soft tissue. Also, the nose is less prominent than in adults, which reduces the trauma consequences as the striking energy is distributed across a larger surface. On the other hand, various anatomical growth zones in the child’s nasal skeleton are strongly influenced. Consequently, the potential for growth impairment and problems with the development of the nasal framework and septum exist following trauma.

14.3 Classification of Nasal Trauma

The embedding of the nose in the midface requires that nasal fractures must be considered in the classification of midfacial fractures. In the classification according to Le Fort, bony injuries of the nose exist in types II and III (Fig. 14.3). The classification according to Becker and Austermann is divided into central, lateral, and centrolateral midfacial fractures (Table 14.1). Isolated nasal bone fractures are included in the midfacial fractures, whereas the fractures of the naso-orbito-ethmoid complex are synonymous with the centrolateral fractures. For isolated central nasal fractures, the categorization according to Simmen has been well established, divided into types I to IV. This categorization takes the direction of the trauma into consideration and specifies the trauma consequences on the osseous and cartilaginous system. In the classification according to Becker and Austermann, these fracture types are included in the category of central midfacial fractures of nasomaxillary and naso-ethmoidal types. A classification of the viscerocranium fractures with regard to the supporting structure mechanism seems sensible from a functional perspective but has generally not yet been accepted.

14.3.1 Isolated Central Nasal Fractures

Type I corresponds to the unilateral depression of the nasal bone (Fig. 14.4). Fractures of this type are caused by the effect of a lateral impact with only low or moderate energy. An untreated fracture is apparent by an asymmetrical nasal pyramid, a damaged aesthetic eyebrow line, and the potential presence of a low level of protuberance formation on the rhinion (Fig. 14.5). The lamina perpendicularis and the septum cartilage remain intact in this type of fracture. The osseous-cartilaginous connections of the nasal bone and the upper lateral cartilages remain intact as well. Type II is the multiple fracture of the nasal pyramid as a consequence of a frontolateral blunt trauma. The nasal bones and the lamina perpendicularis are fractured and the external fragments dislocate laterally. This fracture type results in a
destruction of the central buttress with fracture and dislocation of the septum, whereby the osseous-cartilage connections are predominantly separated. The dislocation of the septum structures can occur along the entire length of the nose (Fig. 14.6).

The long-term consequences are osseous-cartilaginous slanted noses with an occasional severely deviated and frequently also subluxated septum cartilage (Fig. 14.7). Intranasal avulsions of the mucosa and dislocation of cartilage fragments are very frequently observed. In the late phase, pronounced deformations and deviations are visible.

Type III is the consequence of direct frontal traumas, in which bilateral fractures and depressions or dislocations of the nasal bone occur. The lamina perpendicularis and the septum cartilage also frequently fracture as a result of the usually severe depressions. A separation of the connection between the nasal bones and the cephalic rim of the upper lateral cartilages often results as well. For this degree of injury, a relatively high level of energy is necessary (Fig. 14.8). The long-term consequences of an untreated fracture is expressed by a lowering and widening of the nasal pyramid, usually with a palpable protuberance formation on the bridge of the nose but also a saddle formation due to the lack of anchoring of the septum in the K-region (Fig. 14.9). Often a concha head avulsion at the height of the piriform aperture and mucous membrane avulsions with exposure of the cartilage is apparent endonasally. In addition, a deviation of the septum usually forms in the dorsal section. In the case of low trauma energy, only a marginal depression or an isolated avulsion of the nasal bones from the frontal bone may result. In this case, small step formations form on the nasal dorsum or on the nasion.

Fracture type IV is the result of a trauma striking in the direction of either caudal to cranial or dorsal to the tip of the nose. This causes a compression of the septum cartilage and the surrounding soft-tissue structures. The septum cartilage thus fractures and the osseous-cartilaginous connection to the lamina perpendicularis tears and results in a concomitant septum hematoma. The caudal fixation of the septum cartilage and the connection of the cranial septum rim to the cephalic rim of the lower lateral cartilages separate so that a complete or fragmented dislocation of the septum results (Fig. 14.10). An indirect sign for this fracture type is a hematoma in the upper lip at the height of the anterior nasal spine. This can be recognized by a cartilaginous saddle formation and rotation of the tip area with a reduction of projection (Fig. 14.11).

14.3.2 Naso-orbito-ethmoid Fractures

Classifications for the fractures of the naso-orbito-ethmoid complex were suggested by Markowitz et al. and Jackson. Fracture type I consists of a one-sided noncomminuted...
fracture of the central segment. Two subtypes can be differentiated: (1) avulsion of the medial canthus ligament together with a piece of the lacrimal bone and (2) complete separation of the medial canthus ligament from the medial orbital wall. The consequences are a telecanthus with elapse of the medial palpebral commissure, narrowing of the palpebral fissure, limppness of the lids, and epiphora. The injuries of type II show one-sided comminutions and dislocations of the medial orbital wall, which, with more severe trauma, can also extend to the orbital roof or floor. The nasomaxillary columns and the maxilla are often affected, but the central segment remains. The clinical signs are similar to those of type I.

In type III, there is such extreme comminution that the central element can no longer be identified and the septum, the nasal bones, and the frontal sinus are affected by the fracture and dislocation. Pronounced flattening and widening of the nasal dorsum and orbital displacement occur (Fig. 14.12).

14.4 Diagnostics

The clinical examination for nasal trauma with a suspicion of a nasal fracture should be conducted systematically. Because a nasal trauma can also be accompanied by craniofacial and cerebral injuries, the examination must also focus on cranial nerves, the cerebrum, and the eyes. The anamnesis for manifestations of allergic dispositions and chronically infected sinus illnesses is significant.

Fig. 14.8 Nasal fracture type III. Impression of the nasal pyramid with broadening and concurrent septum fracture resulting from a frontal impact.

Fig. 14.9 Saddle nose following frontal trauma. The dissolution of the supporting function of the osseous pyramid and the septum has caused the entire nasal bridge to sink in, resulting in broadening of the nose and deformation of the nose tip. The lateral crus of the lower lateral cartilage are sunk in and the projection of the tip is reduced significantly and at the same time the nostrils clearly appear broadened.

Fig. 14.10 Nasal fracture type IV. Compression and fracture of the septum resulting from a caudal-cranial impact.

Fig. 14.11 Substantial septum deviation and cartilaginous slanted nose as a late effect following a septum fracture caused by caudal–cranial trauma.
14.4.1 Inspection and Palpation

The external examination includes the inspection of the soft-tissue injuries, swellings, and deviations, as well as palpation of the nasal skeleton for abnormal movement, crepitation, depressions, a shortening of the nose, and also a possible widening of the nasal base (Fig. 14.13). In doing so, in particular, the intercanthal distance should be assessed. If the thumb and forefinger are each placed directly on the fixation point of the medial canthal tendon, the instability of the central fragment can be determined based on the extent of movement. A more sensitive estimation can be made according to the recommendations of Paskert and Manson by means of bimanual examination. An instrument inserted in the nose moves the mobile bone fragment against the externally palpating finger. In addition, the “traction test” can be executed by laterally pulling on the external edge of the lower lid. Asymmetries or abnormal movements indicate an avulsion of the medial canthal tendon.

The integrity of the nasal framework can be checked through palpation of the nasal dorsum. A lack of resistance indicates a loss of osseous or cartilaginous buttresses in the central element. In cases of combined fractures of the nose and midface, the orbital rims should be palpated carefully. Steps and dehiscences in the bony edges of the orbital rims are suspect to fractures of the maxilla and orbit. An enophthalmus can immediately occur when the orbital floor developed large gaps after injury and content of the orbit moves downward into the maxillary sinus cavity. This clinical sign can be masked in the acute posttraumatic situation because of soft-tissue edema, hematoma, and ecchymosis.

14.4.2 Intranasal Diagnostics

Particular attention should be paid to the intranasal examination, for which an endoscope should always be used. It is the most important examination that can ensure a certain determination of the functional and aesthetic consequences of the nasal fracture. Verwoerd describes the pathogenesis of septum fractures of three septum zones with thicker cartilage as dorsoposterior, basal, and caudal. In contrast, the central section of the septum cartilage is thin. The thick posterior section of the septum cartilage supports the nasal dorsum. Therefore, trauma in the nasal dorsum area can cause caudal–basal to cephalo–dorsal lesions and horizontal fractures of the thin central regions. Fry presents the clear displacement of fractured septum cartilage fragments based on the separation of internal osseous cartilaginous connections (Fig. 14.14). Gunter and Rohrich show that the septum has a key function in the optimal care of nasal trauma and of the minimization of secondary deformities. All deformities and obstructions can be estimated with a rigid endoscope with a 4-mm optic (0 or 30 degrees). In doing so, one must pay particular attention in the cases of types II and III nasal bone fractures and naso-orbito-ethmoid fractures to the posterior osseous septum sections and to the vomer. A topical local anesthetic with 4% pantocaine and an additional reduction of the swelling with naphazoline is necessary in order to carry out a nasal endoscopy on conscious patients. It has been found that the endoscope should first be led along the nasal floor along the lower nasal concha to the posterior end of the septum. In addition to assessing the septum anomalies, the mucous membranes can be investigated for injuries and hematomas. These can occur on one or both sides. The disturbance of circulation to the septum cartilage resulting from the hematoma, which is provided by the perichondrium, can lead to irreversible damage after only 3 to 4 days (Fig. 14.15). Early recognition of these problems prevents the development of fibroses with ensuing septum displacement, abscess formations, and successive complete necrosis with nasal saddle formations. Pulling back the septum can allow for the recognition of possible injuries to the nasal concha and anything conspicuous, in particular bleeding, in the middle nasal passage.

Fig. 14.12 (a–c) Condition following a naso-orbito-ethmoidal fracture. The distinct broadening of the nasal pyramid and the significant flattening of the nasal bridge with cartilaginous and osseous substance deficit are apparent.
An epistaxis occurs almost routinely with nasal trauma and is an indication of an injury to the mucous membranes. The intensity of bleeding and the localization of bleeding can indicate the extent of injury. With severe persistent bleeding indicating a capillary rupture, a tamponade must be inserted before the planned repositioning procedure and must be treated accordingly.

An overview shows typical and possible additional and intranasal findings and associated symptoms of nasal traumas (Table 14.2).

### Table 14.2 Clinical symptoms of nasal fractures

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<th>Extranasal</th>
<th>Intranasal</th>
<th>Concomitant symptom</th>
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<td>Lacerations, edema, ecchymosis</td>
<td>Lacerations of septal mucosa</td>
<td>Rhinoliquorrhoe</td>
</tr>
<tr>
<td>Decrease of projection</td>
<td>Septal dislocation</td>
<td>Pneumocephalus</td>
</tr>
<tr>
<td>Impression of the nasal dorsum</td>
<td>Fracture and comminution of bony parts of the septum</td>
<td>Anosmia</td>
</tr>
<tr>
<td>Widening of the nasal dorsum</td>
<td>Septal hematoma</td>
<td>Vertical dystopia</td>
</tr>
<tr>
<td>Telecanthus</td>
<td></td>
<td>Enophthalmos</td>
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<tr>
<td>Rounding of medial canthus</td>
<td></td>
<td>Diplopia</td>
</tr>
<tr>
<td>Mobility of the central element</td>
<td></td>
<td>Epiphora</td>
</tr>
</tbody>
</table>

### 14.4.3 Imaging Diagnostics

The radiological diagnostics consists of a planar radiograph of the nose laterally (Fig. 14.16) and the occipital–mental radiograph (Fig. 14.17). These radiograph images show pronounced osseous dislocations or chipping. The images are not absolutely necessary for the diagnosis of an isolated nasal bone fracture; the diagnosis should be ascertained by the clinical symptoms. Studies by Logan et al have shown that radiograph examinations are not cost-effective and...
that a broad misuse of radiological examination techniques exists in the diagnostics for management of nasal trauma.\(^{19}\) In contrast, a coronal and axial computed tomography (CT) is necessary for the exact diagnostic of naso-orbito-ethmoidal injuries.\(^{20,21}\) A cross section of between 1.5 and 2 mm provides an adequate, detailed image. In doing so, particular attention should be paid to the assessment of the central element (Fig. 14.18). In the case of an existing fracture, the extent of comminution and the position of the fracture must be taken into consideration in order to determine the exact classification.\(^{22}\) The CT provides information on the integrity of the osseous and cartilaginous septum. In addition, injuries to the sinuses, the nasofrontal duct, and the orbits can be analyzed.

B-scan sonography can be used as a primary diagnostic technique for evaluating nasal fractures. Beside the advantage that it inflicts no radiation, it provides various imaging planes without positional change, and it can be used to evaluate the cartilaginous septum. Especially in children, the investigation can be performed fast and safe. Potential pitfalls are the appearance of false-positive signs like nasofrontal suture, the junction between the nasal bone and the pyriform aperture of the maxilla, the vascular groove, and the presence of an old fracture. In cases of suspected complex facial bone trauma CT scan can be used in addition to sonography.\(^{23,24}\)

### 14.5 Management of Nasal Traumas

#### 14.5.1 Chronological Procedure

In trauma management, the question is always raised as to what the optimal time is for treatment. Only a minority of fractures are treated promptly (within a few hours) following the trauma. At this point in time, the soft-tissue swelling is still minimal and in the case of simple fractures, repositioning can be carried out immediately. Acute naso-orbital-ethmoidal fractures can result in naso-orbital deformities. Understanding the acute injury is the first step in reconstructing the established late deformity. The best management strategy for reconstruction of severe deformity of the nasal pyramid and orbital hypertelorism is to avoid late complications by repairing these deformities early near the time of the original fractures.\(^{25}\)
More frequently, injuries are first treated after a longer time interval or after other primary or life-threatening injuries have been treated. With adults, the possibility for primary treatment is limited after a time span of 2 to 3 weeks and with children, 5 to 7 days. After that, the improper fixation of fracture fragments must be expected. In the majority of cases, patients come for treatment after a time interval of more than 6 hours. By then, the palpable fracture findings are masked by the associated edema, and an assessment and reliable repositioning procedures are no longer possible. It is recommended that one wait approximately 3 to 5 days after the trauma before carrying out any repositioning measures. However, a septum hematoma that occurs in the meantime must on no account be overlooked26 (Fig. 14.19).

14.5.2 Anesthesia

The type of anesthesia required for the treatment of nasal trauma is often discussed. Numerous studies have compared the use of local or general anesthetic for closed repositioning.27–29 It has been concluded that in most cases, local anesthesia is sufficiently effective as well as more cost-effective. The choice of anesthetic is also dependent on the seriousness of the nasal trauma and the patient’s compliance and pain tolerance. In principle, local anesthetic with or without intravenous sedation can be utilized for central nose bone fractures types I–III. Regardless of the cost and risks associated with general anesthesia, it provides better patient satisfaction with anesthesia, appearance and function of the nose, and preference of treatment for a refracture of the nose.27 A decreased number of subsequent corrective surgeries (septoplasty, septrhinoplasty, and rhinoplasty) is required when general anesthesia is used during fracture correction measures. In the case of naso-orbito-ethmoid fractures and in situations in which no adequate repositioning is possible, a general anesthetic should be used. For children and teenagers, a general anesthetic is also recommended, because only in rare cases or with minor dislocation is it possible to successfully manipulate under local anesthetic.27,28

Independent of the choice of the anesthesia procedure, the nose should be topically and locally prepared. To do so, following careful cleaning of the main nasal cavity, gauze or cotton soaked with pantocaine and naphazoline is inserted into the middle and lower nasal passageway and left there for at least 10 minutes. A local anesthetic can be administered by means of an injection of 1 or 2% Xylocaine with added epinephrine (1:200,000) intranasally in the nasal dorsum region to block the anterior ethmoidal branches of the trigeminal nerve, and additionally near the maxilla process to block the nasopalatine nerve and the upper dental nerves.

14.5.3 Management of Isolated Central Nose Fractures

A general decision to be made in the treatment of nasal bone fractures is whether open or closed repositioning is to be performed. The closed technique is in principle gentler, but the extent and the overview of the repositioning procedure is more limited. However, in the case of insufficient results following the closed technique, there is still the possibility of open repositioning either in an early phase or after a longer time interval has passed since the trauma. It must be noted that estimates of the success rate of the closed repositioning technique vary.2,5,10,15,26,30–32 The decisive advantage of open access is the better view of the fractured segments and the possibility of an exact repositioning and fixation. In addition, septum fractures can be precisely analyzed and treated. Studies have shown that these partially incomplete cartilage fractures lead to an imbalance in the pressure and traction fibers in the external cartilage layers, which then lead to deviations. In addition to the treatment of these recent cartilage injuries, there is the option of removing preexisting bony ridge and spur formations during an open procedure. Clinical reports of good results following open repositioning have been made that support a more generous indication stance on open repositioning.16,20,15,34 However, it is of decisive importance that an exact clinical analysis and assessment based on the force impact corresponding to the stated classification be carried out.
14.5.4 Closed Repositioning Techniques

The treatment, i.e., the repositioning of an osseous fracture should always, if the soft-tissue swelling allows for an appropriate assessment, first be attempted by means of a careful forming the natural nose shape with the fingers. This manipulation is only possible in the case of laterally displaced fragments. Displaced fragments must be lifted and repositioned. The instruments recommended for this—the Walsham pliers (Karl Storz GmbH & Co KG) and the Boies elevator (ReSource Surgical Equipment LLC)—are used for bone repositioning, and the Asch pliers (Becton, Dickinson & Co.) for septum repositioning. The disadvantage of the above-mentioned pliers is the danger of damaging the septum mucous membranes. The elevator as described by Behrbohm and Kaschke has been shown to be a universal elevator that is suited to the repositioning of bone fragments and septum portions as well as to fractures of the midface (Figs. 14.20 and 14.21). It unites the advantages that various sizes of the elevator tip are available with the fact that there is also a round side for the elevation of the bone and a flat side for repositioning the septum. In addition, the design of the handle allows for a subtle movement of bone fragments, on the one hand, although a powerful elevation of wedged fragments is also possible, on the other.\footnote{35} The repositioning of the septum should aim to place the fractured septum in the centerline of the nasal base.\footnote{36} An endoscopic check is essential in order to check the posterior sections. Following this maneuver, stabilization and fixation is required using a splint (e.g., Doyle Splints [bess Medizintechnik GmbH]) for 4 to 6 days and additional stabilization with a soft tamponade (e.g., Gelatin [Chauvin Ankerpharm GmbH], Rhinotamps [Spiggle & Theis Medizintechnik GmbH], etc.). The nasal pyramid should be covered with a dressing of Steri-Strips (3M) or bandages. The pressure of the dressing prevents additional hematoma formation. In addition, external splinting by means of a nose cast or a thermoplastic dressing is necessary, which should remain in place for at least 1 week. Closed reduction of nasal fractures appears to be an effective method of treatment as long as careful attention is paid to the key regions in the nasal complex, including the septum at the initial time of treatment. Ideal results are obtained when surgery is performed within 2 weeks of initial injury. Factors such as timing of surgery, the status of the nasal septum, delay in treatment, and other associated injuries may influence the overall result.\footnote{37}

Septum hematomas must always be relieved. A hemitransfixion incision on the side of the hematoma, careful under-tunneling of the mucous membrane, suction of the hematoma, and the placing of a silicon foil strip for drainage is sufficient. In the case of extensive hematoma findings, the mucous membranes should be compressed using a splint or tamponade positioned on the septum cartilage. Transseptal mattress sutures are also very effective.

14.5.5 Open Repositioning Techniques

Dislocations and injuries of the anterior or posterior septum sections, as seen in central nose bone fractures types II–IV and in naso-orbito-ethmoid fractures, are indications for an acute open septum correction.\footnote{38} Even when, due to trauma, severe bleeding into the mucosa and small avulsions exist, open reconstruction of the septum should not be avoided in these cases. The high rate of posttraumatic deformities and the associated scarring in the mucosa also make a septum correction at a later point in time more difficult. Access by means of the classical hemitransfixion incision and the under-tunneling of the mucous membranes on both sides of the cartilage has been proved for acute septum corrections. The fragments can thus be replaced with more certainty and bleeding around the nasal base or the posterior sections can be better checked and treated. The danger of new hematoma formation is thereby distinctly reduced. Further recommended measures are mattress sutures with resorbable Vicryl sutures (Johnson & Johnson Medical GmbH) and the placement of Doyle splints for 5 to 6 days. Nonetheless, conservative manipulation should principally be preferred in the case of exaggerated cartilage resectioning because of the danger of loss of the support function with saddle nose formations and columella retractions. In the case of mucosa injuries, there is the danger of septum perforation.

Fig. 14.20 A powerful repositioning of wedged and depressed fragments can be attained with the solidly built elevator. The rounded outer surface of the tip of the elevator supports the shaping of the repositioned pyramid, while the smooth inner surface prevents the mucosa of the septum from being damaged.

Fig. 14.21 (a) The elevator enables a specific and controlled repositioning by means of a specially formed tip and a long lever arm. (b) Use of elevator in a closed repositioning maneuver.
The open techniques for repositioning in the acute phase following the trauma are also indicated when repositioning by means of the closed technique are unsuccessful or if such serious comminution exists that adequate repositioning with sufficient stabilization cannot be carried out. Generally, immediate open treatment is also done in the case of an open tissue wound with simultaneous bone injuries, naso-orbital injuries, or injuries according to Le Fort II. All unsatisfactory functional and aesthetic later consequences following trauma with or without attempted closed repositioning should principally be remedied by means of rhinoplastic corrections.

The isolated osseous or osseous-cartilaginous slanted noses can be corrected in most cases using standardized transcortical or intercartilaginous access. In doing so, it is essential that the incision is made sufficiently wide in the lateralalar of the nostril cartilage extending to the transfixion incision so that broad mobilization of the skin of the nasal dorsum is possible. This is required in order for all fragments to be optimally mobilized and repositioned. Special care must be taken with the elevation of the skin of the nasal dorsum, because submucous layers of the skin can be drawn in and fixed in the fracture gap. While conducting the mobilization maneuver, perforation of the skin or injury to the submucous aponeurotic system can occur as a result of proceeding too abruptly, which in turn can cause acute bleeding and long-term tissue swelling. Therefore, the soft tissue around the fracture gap should be separated very minimally only with direct visual control, and only enough to provide for sufficient fragment mobilization. Overly extensive mobilization reduces the stability that is ensured by the fixation of the soft tissue to the periosteum. The correction of deviations in the late phase requires moving the bony pyramid. In addition, paramedian oblique as well as complete lateral osteotomies are generally necessary, which are also possible with open transcolumellar access for rhinoplasty.

The method of osteotomy chosen is dependent on the structure of the bony deformity. In the case of an extensively wide nasal base, often in connection with a palpable open roof, a lateral osteotomy must be conducted very wide laterobasally and extending far into the nasion (low-to-high osteotomy). Should the broadening of the nasal base extend to the nasion region, then a paramedian-oblique osteotomy would be necessary as well. If there is a distinct concavity in the midsection of the pyramid although the nasal base is of normal width, then lateral osteotomies are necessary in the midsection of the nasal bone. This allows for narrow open-roof findings, which often result from frontal traumas, to close anatomically correctly. The most difficult problem arising in the osteotomy of posttraumatic deviations of the nasal pyramid is the exact symmetrical reconstruction. It is often not possible to straighten the pyramid only with a parallel conducted lateral osteotomy. It is often necessary to vary the height of the lateral osteotomy for each side. The osteotomy conducted into the nasion region, and the combination with the paramedian-slanted osteotomy must be coordinated based on the findings. A double lateral osteotomy is required in the case of broad concavities of the pyramid in conjunction with a broadening of the nasal base. In doing so, a complete osteotomy of the midsection should always be carried out prior to the osteotomy of the nasal base. This allows one to take advantage of the stability of the base in the maxilla region. All asymmetries of the cartilage framework can be corrected by means of open transcolumellar access. Traumatically induced deformities of the septum upper rim and its connections to the upper lateral cartilages are easily viewed and can be adequately corrected. The straightening of cartilaginous slanted noses can be made in the case of a traumatically altered and frequently missing or only fragmented septal cartilage by inserting spreader grafts (Fig. 14.22). These cartilage strips form a stable connection between the upper lateral cartilages and thus prevent a lateral collapse of the nose as well as the caving in of the nasal dorsum. Through appropriate suture techniques, the paired grafts can be positioned so that a straight alignment of the septum upper rim results and the cartilaginous deviation is counterbalanced. The first choice for a donor region is sufficiently available septal cartilage. However, often septal cartilage is seriously deformed or lacking as a result of the trauma and thus concha cartilage should alternatively be gained. In cases of extensive substance defects of the supporting frame, in particular in the nasal dorsum with saddle formations or also at the tip of the nose with projection loss, the reconstruction can often only be accomplished through the use of rib cartilage. In comparison to ear cartilage, it has the disadvantage of giving a somewhat unnatural firmness to the nasal frame and has a higher resorption than ear cartilage.

Despite intensive repositioning and reconstruction, palpable step formations of the nasal skeleton or around the tip of the nose remain following pronounced combined traumas of the cartilage and bone. This problem can be particularly serious with very thin skin. Cartilage transplants inserted for augmentation of a displaced nasal dorsum can be especially intensively highlighted in the skin, having a negative effect on the overall aesthetic impression. A camouflage of the nasal skeleton through autologous fascia (musculus temporalis) or through nonvital implants (Tutoplast Fascia lata [Tutogen Medical GmbH], AlloDerm [biohorizons]) are possible solutions for this. Soft contours and thus harmony of the profile can be achieved once temporary swelling of the soft-tissue structures has subsided. This technique should be considered in particular when major dislocations of the fragments exist and extensive mobilization was necessary during reconstruction. The danger of undesirable fragment mobility is high in these cases and can be reduced by using inserted transplants.

### 14.5.6 Management of Nasal Traumas in Children

The consequences of nasal trauma in children require differentiated consideration. Although the current extent of the trauma may seem proportionally minor, significant functional and aesthetic consequential damage is possible as a result of the trauma. These are caused by the traumatic influences to the growth zones of the nasal septum. Also, intensive manipulation in repositioning following a trauma can influence the integrity of these zones. Therefore, the decisions regarding posttrauma treatment should be considered very carefully. Conservative measures should always be preferred, especially because the cartilage is highly flexibility and bone injuries...
almost always involve greenstick fractures. Dislocations occur very rarely and should be repositioned very carefully using a closed technique and under general anesthesia. Nasal trauma to children almost always results in significant hematoma formation in the nasal dorsum area. The nose should be externally splinted for a sufficiently long period (ca. 1 wk) so that the traumatized cartilage and osseous elements are not dislocated by the hematoma and edema. Secondary rhinoplasty that is necessary in children should be postponed until the end of puberty at the earliest, optimally until around age 18.

14.5.7 Management of Naso-orbito-ethmoid Fractures

Successful management of naso-orbital-ethmoid fractures is a complex and challenging task. Both the bony and soft-tissue components must be addressed and the extent of the injury must be adequately diagnosed to avoid omission of critical steps in the reconstruction. Inadequate treatment of naso-orbital-ethmoid fractures can produce a severe cosmetic deformity that is very difficult to correct secondarily.

Naso-orbito-ethmoid fractures can be viewed through existing open skin injuries. However, it is usually necessary and recommended to use standardized craniofacial incisions and accesses. The fractures can be widely exposed by means of broad coronal incisions of the scalp with the formation of a galea-periosteum lobe. The supraorbital rim, the supratrochlear column, and the neurovascular column can be carefully identified and treated with care. After removing the column, the nasal bones and the central segment can be completely viewed. A broad subperiosteal separation above the orbital wall and the orbital roof is necessary in order to be able to analyze and reposition the fractures of the nasal pyramid.

The coronal access also provides neurosurgical access to the frontal craniotomy or the repair of an accompanying fracture in the frontal sinus region, in particular repair to the supply of cerebrospinal fluid in fractures of the frontal sinus posterior wall (Fig. 14.23). Central–lateral midfacial fractures with injuries to the orbital floor are performed by means of a skin incision above the infraorbital rim of the maxilla or transconjunctivally. The caudal section of the central segment can also be viewed and repaired through this access. Direct skin incisions near the glabella or the nasal dorsum are possible, but should be avoided due to visible scarring; a bitemporal incision can also be used, because the attachment of the medial canthal tendon usually disrupts together with a bone fragment. The preferred donor region for the bone transplantation is the parietal bone of the skull. Transnasal wire cerclages are one possibility for securing the bone transplant in

Type I Fracture

Type I fractures can be displayed by means of an incision above the medial canthal tendon extending to the lateral eyebrow line. With this opening, the lacrimal sac in the lacrimal cavity can be checked. A mobile fragment in type I fractures cannot be easily fixated with microplates to the stable osseous processes of the frontal bone and the maxilla. In the case of an isolated separation of the canthal ligament, this can be attached with a secure, nonabsorbable thread to the posterior rim of the lacrimal bone.

Type II Fracture

In type II fractures, it is necessary to fixate the singular fragments with wire cerclage, because the attachment of the medial canthal tendon usually disrupts together with a bone fragment. The area of the trochlea must then be stabilized with a microplate. In addition, transnasal wiring, which begins at the lacrimal cavity and extends across the lamina perpendicularis to the medial upper orbital rim and fixated, has been proved for stabilization. This provides for an optimal adjustment of the intercanthal distance. Care should be taken that the wire does not lie too far ventrally in order to prevent a divergence of the dorsally located fragments. A fracture of the orbital lamina can result in constrictions of the medial rectus muscles and superior oblique muscles, which then causes double vision.

Type III Fracture

Type III of naso-orbito-ethmoid fractures is characterized by osseous comminution and defects, and can require primary bone transplantation. This is necessary for the restoration of a central element on which the majority of detached medial canthal tendons can be fixated. The preferred donor region for the bone transplant is the parietal bone of the skull. Transnasal wire cerclages are one possibility for securing the bone transplant in
the midline. If at all possible, miniplates and screws should be the goal in order to increase stability of the nasal pyramid and, finally, to reduce the bone resorption.46

In many naso-orbito-ethmoid fracture cases, a distinct comminution of the bony nose occurs, resulting in a loss of projection and support of the nasal dorsum. In these cases, the nasal dorsum and also the stability of the septum should be aspired to by means of primary bone transplants. The insertion of bony transplants is the last step of bony repair and follows the repositioning and fixation of all other fragments of the nose and midface.47

14.5.8 Management of Soft-Tissue Injuries to the Nose

Open injuries to the nose usually are accompanied by more or less serious contamination of the dermis, which must be eliminated as best as possible before bony repositioning takes place. Brushing out dirt particles with mild soap or saline solution or iodine-containing solutions is suitable. Intensive rinsing is also often helpful. One should abstain from using hydrogen peroxide because a tissue-toxic exothermal reaction can occur that would compromise the wound healing.

Following the repair of the bony segments, the subtle repair of all lacerations and soft-tissue injuries is carried out. Excisions should only be made to the extent that the wound edges can be precisely adapted. Extensive debridement is not usually necessary because the very good blood circulation of the face generally guarantees good healing and too much debridement produces aesthetically unfavorable scarring. If the lesions are highly contaminated and can only be insufficiently cleaned or are contaminated with animal or human saliva, a secondary wound closure should be considered. Primary closure is sufficient for most lesions, even with minor bacterial contamination, because in contrast to the other body regions, infectious inclusion is well tolerated in the facial region due to better blood circulation. The maximum time interval for primary wound closure after an injury to the facial and neck area should be limited to 6 to 8 hours. Beyond that, secondary wound closure should be considered.

The technical implementation of the wound closure is always connected to the precise, tension-free closure of the subcutaneous and epidermal layers. However, generally the loose wound edges must first be undermined, which in turn removes the tension from the skin suture and allows for a better placement of the subcutaneous sutures. Penetrating injuries to the nose are always accompanied by injuries to the mucosa of the main nasal cavity. In order to avoid functionally effective synchia or scar formation in the interior of the nose, a subtle suture of the mucosa is necessary. If the mucosa structures can be adapted free of tension, a quickly absorbable suture material (Vicryl rapid [Johnson & Johnson Medical GmbH]) can be used. If more tension on the suture is expected, then a slowly absorbed, monofil material (PDS II) is used, which guarantees trouble-free healing. An accurate subcutaneous suture reduces the dead space that can form under the skin suture as a result of hematomata and seroma formations. In addition, the tension of the skin suture is reduced and undermined incision edges can be better everted. A precise convergence of the skin edges with minimal tension reduces scarring of the skin. By using monofil, nonabsorbable sutures, bacterial contamination of the skin and introduction of epidermal structures are reduced. Smooth, clean skin lesions can also be adapted well with Steri-Strips or similar microporous bandages. However, the skin must first be carefully cleaned and dried. They are also suited to wound treatment in small children for whom suture removal is difficult.

Contusions are soft-tissue injuries that are always accompanied by hematoma formation. These usually accumulate above the osseous nasal pyramid but can also spread out under the entire nasal dorsum skin. Usually, these are spontaneously reabsorbed and only in rare cases does encapsulation occur, requiring expeditious drainage. Abrasions of the upper dermis layer are cleaned with sterile saline, mild soap, or antiseptic solutions and then covered with an antibiotic ointment. Spontaneous healing usually begins quickly.

14.6 Long-Term Complications following Nasal Traumas

Potential long-term complications of naso-orbit-ethmoid fractures are telecanthus, obstructions of the tear passage system with the danger of a pusy dacryocystitis, obstructions of the recess and frontal ostium with formation of purulent sinustis, and chronic headache syndromes. The possibility of rhinoliquorrhea must also be eliminated by means of endoscopic diagnostics and testing of the nasal secretion for Beta-2 transferrin. Further long-term consequences of untreated types II and III injuries are fixed defective positions and callus formations on the medial orbital wall, the herniation of soft tissue by fracture lines, scarring, and fixations around the orbita, which can lead to cosmetic inconspicuousness. Corrections at a later date mean that the tissue elasticity is reduced significantly and also that more expansive and sometimes multiple osteotomies are necessary because the callus formation must be overcome. Often a chronic epiphora begins weeks after the trauma, caused by increasing scarring obstruction of the tear passages. A dacryocystorhinostomy, either endoscopically or by means of a medial canthal opening, can establish a drainage path from the lachrymal duct into the nose.48

References

15 Postoperative Care and Management

Oliver Kaschke

15.1 Introduction

The common practices used in the perioperative care of patients undergoing septorhinoplasty are diverse and controversial. A consensus statement on the preferred clinical pathway in the perioperative treatment of patients undergoing septorhinoplasty has yet to be approached formally. It is obvious that perioperative care and practices after nasal surgery vary among the most highly trained and leading rhinoplasty surgeons.1

The following guidelines are recommendations that should be coincided with own practiced course of treatment after septorhinoplasty.

Postoperative treatment usually begins with the application of intranasal packs and the application of an external dressing. Removal of the packs and dressing does not mark the end of postoperative care.2 On the contrary, it is essential to maintain diligent surveillance of intranasal and extranasal wound healing dynamics. In the early postoperative period, the nasal surgeon should observe and support wound healing with specific manipulations. He should instruct the patient in how to protect the result with proper conduct and self-care.

Endonasal care is particularly important after surgical procedures involving the combined treatment of chronic inflammatory sinus diseases, septal deformities, turbinate hyperplasias, and osseocartilaginous morphological variants.3,4 With minimally invasive operative techniques, it is possible to combine functional endoscopic sinus surgery procedures with rhinoplastic procedures, thereby achieving different treatment goals in one operation. This requires a postoperative regimen that is geared toward preventing early and late complications and, if they occur, can ensure the rapid institution of appropriate treatment.

15.2 Intraoperative Management

15.2.1 Internal Dressing

Packs

The function of intranasal packs is to provide appropriate tissue compression to approximate the wound surfaces and prevent swelling, bleeding, and hematoma formation. The physiological wound healing should be supported by establishing a moisty milieu that can help to accelerate epithelialization and to reduce granulation and scar formations.2 These goals are particularly important when there are large, open wounds in the mucosa, like those resulting from endoscopic sinus surgery or a strip turbinectomy. Basically, a pack after sinus surgery can be avoided by minimal mucosa traumatization and meticulous bleeding control.5–10 Because there is only a limited evidence of beneficial effect by packs, many nasal surgeons never use nasal packing after septrhinoplasty.1,11

Packing materials for sinus or turbinate wound surfaces are placed temporarily and some kind of them are generally removed after a period of 1 to 3 days.12 These include Silastic-coated foam packs (Rhinotamp; Fig. 15.1), self-expanding polyvinyl acetate packs (Merocel; Fig. 15.2), and hydrogel-coated packs (Rapid Rhino; Fig. 15.3).

One of the main selection criteria should be minimal adhesion to the mucosa with a good hemostatic action. Pack removal should be painless and should not damage the mucosa. Packs with slick or gel-like surface provide a measurably better comfort to patients and less pain and bleeding during removal.13–17 Another option is to use hemostytic packing materials as biodegradable materials that liquefy as wound healing progresses.18 Remnants can be removed by means of suction during postoperative care. This eliminates the pack-removal procedure that patients dread. These materials include gelatin sponge (Gelfoam, Gelaspon; Fig. 15.4), hyaluronic acid (Merogel), carboxymethylcellulose (Tabotamp), and chitosan-dextran gel (PosiSep; Fig. 15.5). Side effects like increased rates of granulations, scar formations, and new bone formations had been shown after the use of these materials.19–21 An advantage was reported that after the use of carboxymethylcelluloses,22 hyaluronic acid,23 and chitosan-dextran gel,24 a lower rate of synchias had been demonstrated, but no advantages in terms of wound healing parameters or postoperative bleeding rates.25–27

Splints

Internal splints are designed to keep reconstructed portions of the septum from dislodging and prevent hematoma formation about the septum. They are also used to prevent synchiae formation between wound surfaces.28–30 The most commonly used splints are Doyle nasal airway splints (Fig. 15.6) and Reuter Silastic (Fig. 15.7) or Teflon splints. Specially molded stents

Fig. 15.1 Silastic-coated foam strips with attached threads (Rhinotamp), used in packing the ethmoid or inferior nasal meatus.

Fig. 15.2 Polyvinyl acetate pack with attached thread (Merocel). The material expands on contact with blood, exerting a compressive effect on the mucosa.

Fig. 15.3 Hydrogel-coated pack with attached thread (Rapid Rhino). The pack can be placed in the ethmoid or inferior meatus. When the pack is moistened, it exudes a gel that promotes platelet aggregation for hemostasis.
can be used to maintain the patency of enlarged passages in functional endoscopic sinus surgery (Fig. 15.8a, b).

It is wrong to expect internal packing to salvage a poor postoperative result in the septum, sinus ostia, or external nasal shape. Also, a pack that fits too tightly or is too long will interrupt venous and lymphatic drainage, resulting in unnecessary swelling.

The duration of septal splinting and the danger of submucous hematoma formation can be reduced by placing multiple transseptal mattress sutures (Fig. 15.9). Good results can be achieved with double-armed 4–0 Vicryl sutures (Johnson & Johnson Medical GmbH) on a straight needle.30,31

15.2.2 External Dressing

The function of the external dressing is to secure the mobilized skin on the cartilaginous and bony nasal framework. It should reduce potential spaces that may fill with blood or serum, leading to hematomas and swelling. The external dressing should also protect the mobilized nasal segments from displacement due to external trauma or intranasal swelling.

Like the internal dressing, the external dressing cannot salvage a technically poor result due, for example, to inadequate osteotomies or resections. Before the external dressing is applied, postoperative edema and blood residues should be massaged from the nasal dorsum so that the result can be assessed. The principle of “what you see is what you get” applies.32,33

The external dressing should consist of at least two layers: a skin-friendly adhesive dressing and a firm nasal splint.

The adhesive dressing for the skin consists of several, slightly overlapping adhesive strips that are placed across the nasal dorsum from the root of the nose to the supratip area.2,32–36 They are applied over a Gelfoam strip about 0.5 cm wide that is first placed along the full length of the nasal dorsum. This will facilitate dressing changes. One or two longer adhesive strips are slung over the nasal tip without obstructing the nares (Fig. 15.10).

Various materials can be used for the nasal splint. Plaster cast materials are widely used and are easily shaped to fit the individual nose. One disadvantage of casts is that they adhere poorly to the adhesive dressing, and the dressing will tend to loosen as swelling subsides, often requiring additional fixation. Malleable aluminum splints are also available. The Denver splint (Summit Medical, Inc.) (Fig. 15.11) is supplied in three pieces—an adhesive tape to which an aluminum splint is attached with Velcro, padded by a foam strip. Thermoplastics57 can be trimmed to match the nasal size and can be accurately molded to the postoperative shape. Preshaped thermoplastic splints are supplied with an adhesive surface and adhere well to the adhesive dressing. Special preshaped thermoplastics (bess|rhino Thermo-Splint) consisting of malleable small plate for the front and a small bridge to cover the nasion had shown good results in reduction of postop swellings especially after bony reduction in the nasofrontal angle. An adherent foil with markings helps to shape the optimal size of the external splint (Fig. 15.12a, b). The splint covers the nasal dorsum, the nasal tip, and two-thirds of the caudal margin of the alar cartilage (Fig. 15.12c). A splint that fits too tightly can cause ischemia...
in the dorsal nasal skin. If pain is reported, therefore, the splint should be changed without delay. Normally the external dressings are removed at 1 week. The dressing may be extended an additional week, depending on the degree of swelling and the extent of the corrections.

15.3 Postoperative Management

15.3.1 First Postoperative Day

All solid packings should be removed from the nasal cavity and, if placed, also from the ethmoid after sinus surgery or from the inferior turbinate after a turbinectomy on the first postoperative day. Pack removal must be done carefully, and spraying pantocaine and naphazoline into the nose will facilitate the procedure.38,39 Slight postoperative bleeding causes blood to collect in the nasal cavity. This blood coagulates and dries, forming blackish crusts. Sinus operations are followed by mucous drainage from the opened sinus, which also dries to form crusts (Fig. 15.13).

Serous and mucous wound secretions collect on the floor of the nasal cavity and in the sinuses. Patchy fibrin deposits form on surgical mucosal defects, especially on the turbinates, and dry to form crusts (Figs. 15.14 and 15.15).

15.3.2 Early Postoperative Period

Most patients are unfamiliar with the typical changes that occur after their operation. They should be given strict instructions that will help to reduce complications during the postoperative period. These instructions are outlined below:

- The face should be rested for up to 8 days after the operation.

Excessive facial movements (e.g., prolonged talking, chewing hard foods, vigorous laughter) should be avoided.
For the first 5 days after the operation, the patient should sleep with the head and upper body slightly elevated. Cooling compresses should be regularly applied to the eyes and cheek for the first few days. Medications should be taken only as directed. In particular, medications that contain acetylsalicylic acid should be avoided. The nose should not be blown, and the mouth should be opened during sneezing. Any physical exertion should be avoided for 2 weeks. Sports and other strenuous physical activities should be avoided for 6 weeks. Glasses should not be worn for at least 6 weeks after the operation. Excessive heat and sun exposure to the nose (including solarium treatment) should be avoided for 3 months after the operation. Smoking and drinking alcoholic beverages should be avoided during the initial weeks after surgery.

The patient should also be informed about necessary measures during postoperative management and the typical changes that may occur. This should include information on follow-up appointments and the schedules for dressing changes and suture removal. Other important points are information on postoperative complaints such as dry mouth, obstructed nasal breathing due to reactive mucosal swelling, transient subfebrile temperatures, and other possible complications. The latter may be classified as typical early postoperative complications or late complications.1,40–43

### 15.3.3 Typical Reactions and Clinical Signs in the Early Postoperative Period

The following are external clinical reactions and signs that most commonly occur during the early postoperative period. In case of overexpression of these symptoms, complications should be considered.

- **Extensive edema and swelling** can result from traumatizing osteotomies, especially those involving the lateral portions of the nasal pyramid. Vigorous rasping of the nasal bones can evoke similar reactions. The use of narrow chisels 2 or 3 mm wide for micro-osteotomies and the gentle use of rasps and files can significantly reduce the severity of these reactions.

- **Hematomas** are quite common, but if severe, they result from improper dissection outside the standard planes, resulting in excessive tissue traumatization. Unfavorable anesthesia parameters (high ventilatory pressure, high pCO2 values) or poorly regulated circulatory parameters (high blood pressure) during the operation can hamper intraoperative exposure and cause heavy bleeding into the tissues. Hematomas are best treated by intraoperative compression with ice water gauze pads and by applying a sufficiently large external pressure dressing combined with antibiotic coverage. Possible septal hematomas are detected by diligent postoperative surveillance. They are treated by drainage and subsequent splinting. Transseptal mattress sutures and the insertion of septal splints (Doyle or Reuter type) will significantly reduce the risk of hematoma formation.

- **Infections** of the skin surface occasionally develop below the external dressing, but most are punctate and resolve quickly in response to local ointment therapy. Subcutaneous abscesses and septal abscesses, on the other hand, are serious complications that result in tissue defects. Abscesses should be drained, and any prosthetic implants must be removed from the affected site.
Skin necrosis is a serious complication. It is often due to too much pressure from external and internal dressings, causing circulatory impairment. This problem can be significantly reduced by the use of loose packing materials and suitable external dressings. Skin ischemia can also result from excessive thinning of the dorsal nasal skin or the overtightening of implant fixation sutures. Regular dressing checks will disclose the clinical signs of ischemia or skin necrosis. In this case, the dressing should be removed. Local treatment of the skin and watchful waiting of skin healing is the preferred treatment.

Common endonasal changes are reactive swelling of the mucosa on the septum and turbinates. Pads of edematous tissue, sometimes of considerable size, can form in the parietal sinus mucosa as a result of obstructed lymphatic drainage. They usually persist for 4 to 6 weeks after the operation and also depend on the original sinus pathology. Sites of edematous mucosal swelling are particularly common at the margins of supraturbinate antral windows and in the frontal recess. Often the entire ethmoid region is affected. The reactive swelling can sometimes mimic small polyps. \[38,44\] It is common for infection to spread on the edematous mucosa, presenting clinically as a putrid nasal discharge.

Headaches are a common side effect of septorhinoplasties combined with endonasal procedures. A frequent endonasal cause is the obstruction of a frontal sinus ostium by reactive mucosal swelling, which usually clears spontaneously within a few days.

15.3.4 Measures during the First Postoperative Week

Secretions and clots should be carefully suctioned from the nasal vestibule for the first few days after the operation. This is easily done with thin suction tips introduced through the breathing tubes of the Doyle splint. Hard blood clots can be loosened with hydrogen peroxide and then removed with forceps.

After removal of septal splints on the third to fifth postoperative day, the nasal vestibule and floor can be cleaned using a rigid suction probe with fingertip suction control. Great care should be taken to avoid damaging the mucosa by overvigor-ous probe movements or by aspirating spongy mucosal tissue.

15.3.5 Measures after the First Postoperative Week

Starting on the second postoperative week, wound coatings and crusts may form, obstructing the nasal cavity and sinus ostia. They can be selectively removed with a suction tip, a small
hook, or suitable forceps to improve nasal airflow. These measures should be performed under endoscopic guidance to avoid injury to the regenerating mucosa. The epithelium still has little regenerative capacity before the end of the first postoperative week, however. It is best to avoid instrument manipulations in the excavated ethmoid, frontal recess, or supraturbinate windows at this stage following sinus operations.

The external dressing is changed 1 week after the operation. The tape sling on the nasal tip is divided, and the adhesive strips are carefully lifted from the nasal sidewall to free the dressing. The skin of the nasal dorsum is thoroughly cleaned, and fresh adhesive strips are placed across the nasal dorsum in an overlapping fashion. A firm splint is molded over the adhesive dressing and remains in place for an additional week. If there is still much swelling of the dorsal nasal skin after the cast or thermoplastic is removed, adhesive strips should be worn on the nose at night for the next 2 to 4 weeks. The strips are again placed across the nasal dorsum in an overlapping pattern, using skin-friendly adhesive tape.

Intranasal adhesions between opposing, deepithelialized wound surfaces may be encountered in the nose during postoperative care (Fig. 15.16). They commonly form between the lateral aspect of the middle turbinate and the lateral nasal wall and also between the septum and the inferior turbinates. The fibrous organization of these fibrin-containing adhesions leads to synechiae formation within 10 to 14 days. These fibrin bridges can be carefully removed with suitable suction instruments under endoscopic guidance, avoiding injury to the regenerating mucosa.

15.3.6 Pharmacological Therapy
Antibiotic prophylaxis for septorhinoplasty procedures is a common practice among nasal surgeons. If antibiotics (e.g., cephalosporins) are administered, they should be given intraoperatively and for additional 5 days after surgery. Different studies have shown that septal surgery with early removal of nasal packing is a clean-contaminated procedure and does not require routine antibiotic prophylaxis because of the low infection risk. Preventive systemic antibiotics are only indicated in complicated revision rhinoplasties, prolonged placement of nasal packs, and for patients who are susceptible to infections. Patients undergoing complex septorhinoplasty should be treated by prophylactic antibiotics rather than empirical postoperative antibiotics.

The intraoperative administration of 250-mg prednisone plus 150 mg on the first and second postoperative days will help to reduce postoperative soft-tissue edema and accompanying ecchymosis.

After intranasal crusts have been selectively removed and secretions aspirated, the epithelial regeneration process can be positively influenced by the application of low-viscosity ointments containing panthenol. Drops of physiological saline solution or, preferably, an isotonic saline spray will reduce the drying of secretions. Adhesions between mucosal surfaces are cleared.

15.3.7 Late Postoperative Period
The postoperative result after the removal of all dressings is not the final result. When major corrections have been made in the bony and cartilaginous framework of the nose, it is difficult to evaluate the definitive result. Unsatisfactory results and complications relating to faulty surgical techniques may not become apparent until the late postoperative period. Scheduling long-term follow-ups with regular photographic documentation is helpful in monitoring the changes. By critically evaluating the results of the operation, the surgeon can gain experience that is useful in refining his or her operating technique. Endoscopic follow-up is particularly important in the late postoperative period following procedures on the turbinates and paranasal sinuses. Reactive mucosal hyperplasia (Fig. 15.17) will regress gradually over a period of several weeks or months.

After the initial 6-week follow-up period, additional follow-ups should be scheduled every 3 months until the end of the first postoperative year. After that, the patient should be present for follow-ups once a year. It is important that the patient be informed about possible late complications.

Late Complications
Late complications result from scar formation or specific healing dynamics. They can occur despite a correct operating technique.

The following are typical late complications that may involve the external nose:

Irregularities and deviations of the nasal dorsum usually result from excessive surgical trauma with fragmentation of the bony pyramid and subsequent scar traction. Persistent deviations of the pyramid and nasal dorsum can result from...
inadequate mobilization of the bony structures, insufficient correction of the deviated septum, or existing asymmetries of the upper lateral cartilages. Patients may exhibit bony ridges or persistent bony and cartilaginous humps, especially when the skin is thin. Subcutaneous bone grafts may be clearly visible beneath the skin if they were not precisely matched to the recipient defect.

A *paranasal callus* may form as the result of a paranasal hematoma or a bony gap left between fracture fragments. The great majority of these calluses will resolve without treatment.

**Pollybeak deformity** is a frequent problem after rhinoplasties. A soft-tissue pollybeak is usually based on a lesion of the muscle and connective-tissue layers in the nasal dorsum, with corresponding scar formation. A cartilaginous pollybeak is the result of an inadequate resection of the superior septal margin and a significant loss of tip support. Both deformities are treated by touch-up surgery (Fig. 15.18).

Heavy scarring, discontinuities, and asymmetrical resections or sutures in the alar cartilages lead to *nasal tip deformities*. For this reason, the indications for all resections and techniques involving the division of cartilage should be weighed very carefully.

If the mechanisms of nasal tip stability are disregarded and too much tissue is resected, there is a danger of progressive *drooping of the nasal tip*. It is normal for nasal tip drooping to occur with aging, however.

The problem of the “hidden columella” represents a severe *columellar retraction*, which can result from excessive resection of the caudal septal margin. Over-resection of the caudal and dorsal cartilaginous septal margin and inadequate fixation of the cartilage also lead to dorsal rotation and retraction of the columella (Fig. 15.19).

The following are typical endonasal complications:

**Scar adhesions between the middle turbinate and lateral nasal wall.** These result from the inadequate widening of narrow sites, with opposing wound surfaces. The fibrin bridges that initially form between these wound surfaces become organized through the ingrowth of fibrocytes, which form compact scars. These scars, in turn, create an obstacle to ventilation and drainage, predisposing to a recurrence of inflammatory sinus pathology. Endoscopic examination shows a corresponding retention of secretions or inflammatory mucosal changes (Fig. 15.20).

**Scar obliteration of the enlarged sinus ostia.** The frontal sinus ostia in particular show a tendency toward restenosis following surgical enlargement. Recurrent frontal headaches are a classic symptom. Persistent mucous secretions in the nose and postnasal drainage are a sign of deficient drainage through the maxillary and sphenoid sinus ostia.

Exuberant *granulations* and *edematous tissue proliferation* ranging to *recurrent polyposis*. These usually result from persistent mucosal infections or may be a manifestation of an eosinophil-dominant mucosal disease (Figs. 15.21 and 15.22).

### 15.3.8 Treatment Strategy during the Late Postoperative Period

Follow-ups should be scheduled at appropriate intervals in the late postoperative period to assess the endonasal status and confirm the regression of postoperative swelling.

The most obvious regression of swelling is noted during the first 4 weeks after removal of the external dressing. The amount of swelling is variable, depending on the operating technique that was used and the degree of postoperative reactions or complications that have occurred. Aggressive hump removal and multiple osteotomies in the pyramid will cause greater swelling about the nasal bones. An open approach or alar cartilage-splitting approach leads to greater swelling in the nasal tip area. Postoperative swelling will generally subside over a period of 6 to 12 months, first in the pyramid region, then over the cartilaginous dorsum, and finally in the tip area. A good rule of thumb is that it takes approximately 3 months for swelling about the nasal pyramid to subside completely. It takes about another 3 months for swelling to clear over the upper lateral cartilages and 9 to 12 months over the alar cartilages, depending on the operative technique. These time frames should be kept strictly in mind if follow-ups show that the outcome of the correction is not proceeding as expected and complications are developing. Bony deformities of the pyramid appear relatively early, and so they can be corrected at a relatively early stage. If small asymmetries due to the depression of osteotomized sites or even irregularities in the nasal dorsum can be corrected under local anesthesia.

Asymmetries or pollybeak deformities of the nasal dorsum are often masked by soft-tissue swelling. Generally, they are noted only during later follow-ups. Their extent cannot be accurately assessed until all swelling has cleared, however.
and a soft-tissue pollybeak will frequently resolve. For this reason, the decision to reoperate should not be made until at least 1 year after the surgery. On the other hand, cartilaginous pollybeak deformities or asymmetries are clearly detectable by palpation after approximately 4 to 6 months, and so these cases can be revised at an earlier time. When patients subjectively appraise the outcome of their surgery, they give particular attention to the nasal tip. The surgeon should keep the timetable for nasal tip healing firmly in mind and should not be pressed into making a premature correction. Overprojection of the tip is usually still present in the early postoperative period, and the tip-defining points cannot yet be recognized because of tip swelling. The supratip break is also obscured because its contours have not yet been defined by postoperative scarring at the upper margin of the alar cartilages. Increasing asymmetries and retraction of the columnella may be a sign of developing complications. However, the dynamics of wound healing in the tip area require that any revision surgery on the tip be deferred for at least 1 year.

Local pharmacological treatment is beneficial in the late postoperative period and is even necessary in many cases. Irrigation of the nose with isotonic saline solution produces a mechanical cleansing effect. The ion concentrations present in various saline solutions also appear to have a supportive effect in boosting ciliary activity, thereby improving mucociliary clearance.

In the case of a surgically treated chronic rhinosinusitis, an additional spraying of the nasal mucosa regularly with topical corticosteroids (e.g., Mometasone, Fluticasone) has a favorable effect on the regression of reactive mucosal swelling. The use of sprays is particularly beneficial for inflammatory mucosal diseases. The healing process can be supported with topical and systemic antihistamines in patients who suffer from ascertained allergic rhinitis.

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