ENDOSCOPIC SURGICAL ANATOMY
OF THE LAMB’S HEAD

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As the main author, I have the honour to dedicate this book to my teacher

Prof. Radovan Subotić, MD, PhD

without whose initiative and comprehensive support I would not have started the development of the endonasal endoscopic sinus surgery in Croatia in the year 1989.

The author and his collaborators are grateful to Drago Prgomet, MD, PhD, Professor of Otorhinolaryngology, Head of ENT Department, University Hospital Rebro, Zagreb, Croatia, for his generous support in every respect throughout the entire editing process.

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Our gratitude also goes to the radiological team of the private radiological office “Dijagnostika 2000” in Zagreb for the excellent CT-scans of the lamb’s head prepared for scientific purposes.

All of our dissections were performed in the late afternoons, which required additional efforts from our nurses and technicians in the operating rooms, headed by Mrs. Katica Gugić, chief-nurse. We very much appreciated all the support given to us during all working sessions of this project.

All of the excellent and brilliantly clear endoscopic pictures were taken by Dr. Katarina Vuković, MD using a KARL STORZ AIDA System for this purpose. Macroscopic pictures were taken by the author, who performed all dissections in joint collaboration with Dr. Vuković.

Finally, as the main author of this monograph, I would like to take the opportunity to extend my special gratitude to those, who have not been mentioned explicitly herein, for the considerable support and assistance in the realisation of this important reading.

The personnel of our department and I are very proud to the fact that this monograph has been published at the dawn of the year 2011, the year in which our department is celebrating its 90th anniversary!

Ranko Mladina
Zagreb, July 2010.
Introduction

Endonasal endoscopic sinus surgery is a very challenging surgical discipline. This is mainly due to the fact, that it is performed within very narrow spaces, all surrounded by anatomical structures of vital importance, like large vessels (carotid artery, basilar artery) and involves structures that, during surgery, are susceptible to potentially adverse effects of iatrogenic injury, most commonly associated with lesions that do not immediately lead to a fatal end, but still can produce awkward consequences, whether during surgery itself, or in the early or late postoperative period (ophthalmic artery, sphenopalatine artery, frontopolar artery and ethmoid arteries). Apart from the presence of vital blood vessels, this region is in close proximity to a number of extremely important nerve structures, such as the optic nerve canal in the lateral sphenoid sinus wall, the infraorbital nerve canal in the roof of the maxillary sinus, and the pituitary gland within the sella turcica, at the sphenoid sinus roof, to mention but a few of the most important ones.

Proper surgical orientation in this area is another key factor in mastering the challenges of this relatively demanding type of surgery. Since in most cases endoscopic sinus surgery is performed using 30° or 45° telescopes, a high level of proficiency is required in order to appropriately interpret the endoscopic image of the surgical field. Proper anatomical knowledge and good orientation are prerequisites that must be met before considering to perform a surgical procedure at all. To plan surgery without having a good orientation about the anatomical landmarks and their locations in the operating field, can lead the unwary surgeon astray, into the wrong direction, which is fraught with the risk of iatrogenic injury instead of benefit to the patient.

Moreover, the inherent nature of endonasal endoscopic procedures involves that they are performed while watching the operative field on the video screen. This means, that the surgeon should be able to concurrently watch the image on the screen while performing surgical maneuvers, with the hands pointing in a completely different direction. At first sight, this type of eye-hand coordination seems to be relatively easy to do, but it is not at all. The best proof for this phenomenon comes from beginners in endoscopic surgery: they are usually “lost in space” – confused, they can not trace the tip of the instrument in the operative field, the picture is not properly oriented etc. Therefore, the factor of bimanual working on one location while simultaneously following the process at another site makes this otherwise extremely useful technique very difficult to learn.

This is why, for instance, the initial orientation of the surgical field is based on appropriate theoretical knowledge and tenacious exercising. In terms of theoretical knowledge, the trainee is required to acquire a high level of proficiency in both descriptive and surgical anatomy, including its numerous variations. Meticulous exercises of dissection constitute a good basis for developing and improving surgical skills spontaneously, by time. One should also take into account that nobody in this world is talented for all jobs, which hence applies to endonasal endoscopic sinus surgery. This does not involve, that someone who is not that good in endoscopic sinus surgery is not, at the same time, an excellent otorhinolaryngologist. On the contrary!

But all those, who want to develop their endonasal endoscopic skills should continuously strive to improve the technique. A positive outcome will be achieved rapidly by those who are gifted for this kind of surgery. In the course of time, the less talented colleagues will become aware of this point, and will spontaneously accept it as a fact.

However, the question is how to make the distinction between gifted and non-gifted persons? The most practical solution is to exercise on an animal model, particularly because dissections on human cadavers are becoming increasingly expensive, not to mention ethical issues or juridical regulations restricting or inhibiting their use in many countries in the world.

Besides, the main objective of dissection training is not to learn how to treat a disease, but to acquire a satisfactory level of basic surgical skills by hands-on training with suitable surgical instruments. Our dissection course is aimed at trainees who want to familiarize themselves with the use of endoscopes (in one hand) and various instruments which are inserted into very narrow spaces of the nasal cavities and sinuses (in the other hand). This is the point!

Once the trainee has gained adequate skills and experience in dissecting on the model, it will be much easier to begin surgical procedures on humans, under the supervision of a senior surgeon.

Because of that, we have developed a detailed training program for dissection on a lamb’s head which has been employed in most of our annual traditional courses, known as CIRAS (Croatian International Rhinosurgical Advanced School). The participants have been very satisfied all the time, regardless of whether the course was dedicated to septal surgery and rhinoplasties, or to endonasal endoscopic sinus surgery.

In conclusion, this booklet is intended to serve as a practical guide to a pleasant, comprehensive and thorough learning experience with training on a lamb specimen. Both descriptive and surgical anatomy are explained in detail, just following the usual course of the dissection training session on a step-by-step basis.

The booklet has been designed to allow trainees to follow each step of the dissection exercises. We cordially wish a sharp eye, placid hand and a lot of patience, competencies which all are indispensable for those who consider to go through this exciting experience.

Prof. Dr. Ranko Mladina and collaborators
Preparation of the Lamb’s Head for Dissection

Provided we have ample supplies of lamb heads, we keep them in the freezer and use them according to our needs. Still, we must take care about the time planned for dissection since the head should be melted exactly to the level that is most convenient for surgical training. This means, that the head which has been frozen at an average temperature of -15 °C to -20 °C takes eight hours to defrost until thawed at an average room temperature of 22 °C, or some 12 to 16 hours when it is left to melt slowly, for instance in a standard refrigerator at an average temperature of +5 °C to +6 °C.

Once the melting process is complete, we recommend that the head be washed and rinsed carefully under hot tap water, first. Then, the head is cleansed by use of paper towels, and finally placed on a lump of fresh sculptor’s clay (Fig. 1a), or more effectively (particularly for the needs of neuronavigation), fixed with the aid of a special head holder (Figs. 1b, c, d and e).

However, our recommendation is to soak the lamb’s head in water for 24 hours. The most important thing is to immerse the head in such a way that the parietal part shows toward the bottom of the receptacle (Fig. 2). Furthermore, we usually add some spirit vinegar, approximately 3 tablespoons per two liters of water in order to dissolve all slimy, mucilaginous secretions, which otherwise are found to accumulate in the nasal...
Endoscopic Surgical Anatomy of the Lamb’s Head

cavities of the lamb’s head. If left inside, such secretions can substantially impede dissection by smudging the lens of the scope each time the surgeon enters the nasal cavity. After 24 hours, the head can be taken out from the solution, dried and used for prompt dissection or stored in the freezer.

If dissection is not planned to be initiated in the short term, the head can be dried in the same way as described above, i.e., the specimens are just rinsed under tap water, put in a plastic bag, and stored in the freezer. We found the heads prepared in this way to be more suitable for successful dissection.

At the very beginning of dissection, it is recommended to remove the main part of the muzzle including the related portion of the nasal septum (Figs. 3a–o), because, from the author’s point of view, they have no relevance at all for endoscopic sinus surgery. Moreover, considering that the entrance to the lamb’s nasal cavity is relatively narrow (more narrow than in humans) introduction of instruments into the nasal cavity is practically impossible, if the scope has already been inserted.

We cut the muzzle by using a surgical blade No. 10, which we find most appropriate because it is wide, long and sturdy enough to be safely used for this purpose. Following removal of the muzzle and the anterior part of the nasal septum, the entrance site is wide enough to allow for a comfortable approach to the nasal cavities and a smooth proceeding of dissection.
The incision is continued at the opposite side of the piriform aperture until ...

... it joins the incision already made on the other side.

A transverse incision is made from above.

The nasal septum still obscures vision of the nasal cavities ...

... which is why we remove practically most of the anterior part of the nasal septum.

The specimen is now ready for endoscopy.
The plica recta is a very interesting anatomical structure which is readily noticeable once the scope has been inserted into the nasal cavities (Figs. 3m and 3o). Essentially, the plica recta represents a mucosal fold located in the anterior-most part of the nasal cavity. Proceeding dorsally, the plica recta shows an increasing degree of pneumatization and finally transforms into the superior turbinate. The inferior-most part of this anatomical configuration stays superior to the ethmoid labyrinth, ends blindly and stays very close to the frontal sinus while approaching its most antero-inferior portions. This is clearly demonstrated on coronal anatomical sections (Figs. 21 and 25), and on coronal CT scans (Figs. 20 and 28).

As described above, the plica recta, or, more posteriorly, the superior turbinate, is nothing else but the counterpart of the ethmoid bulla in humans. In order to preserve integrity of the ethmoid bulla during human endonasal endoscopic surgery, it is of paramount importance that the surgeon always keeps to the safe side while being fully aware of the risks involved when searching for the nasofrontal recess and the frontal sinus ostium itself. Accordingly, the same applies to the plica recta and superior turbinate in the lamb.

**Preparation of the Endoscope**

Most of the dissections are performed using 30°-telescopes. In rare cases, and just for the purpose of training we may also use a 0°-scope. The 70°-scope is used for the most part in advanced levels of dissections, which involves that the trainee has already reached a certain degree of surgical skills and experience and is able to cope with intrinsic challenges related to spacial orientation, an issue that has shown to be difficult even for the experienced senior surgeon.

At the very beginning of dissection, one has to check the scope’s depth of field and image quality, which practically means that the image, regardless of whether it is observed directly through the eyepiece or via screen, must be crystal clear. This also includes cleaning of the distal lens by gently sliding it over a special, wet sponge, or an alcohol-sparked gauze pad. The lens should not be cleaned just by rubbing it against a cleaning sponge or wet gauze, but rather by performing semicircular movements with the scope’s tip which is gently slid from back to forth against the gauze or sponge, as demonstrated on Fig. 4, with a 30°-scope.
Generally speaking, the problem with fogging up of the scope’s distal lens occurs both in real endonasal endoscopic surgery and in all kinds of cadaver dissections. In contrast to the situation in the living patient, where moisture condensation occurs owing to difference in temperature between the internal parts of the nose and the outside air, fogging during cadaver dissection is the consequence of near contact between the optic lens and the extremely mucilaginous, greasy mucus found in all nasal and paranasal cavities of the lamb. It is therefore prudent to have available a bundle of gauze soaked in physiologic solution which allows to clean the lens from time to time before protecting it against fogging up by wiping it against a pad of gauze soaked in alcohol or moving it over the surface of a special, prefabricated sponge used for this purpose. Once the lens has been cleaned properly, the focus should be assessed first. The test is very simple: just look through the eyepiece of the scope which is directed toward the light source. The image should be perfectly clear (Fig. 5).

The second test, intended to assess the quality of the screen image, requires that the scope be first coupled to the video camera (Fig. 6). The highest level of clarity and sharpness can be achieved by adjusting the rotatable outer ring on the camera head, which is a constant component in all KARL STORZ cameras that we have been using for decades (Fig. 7).

Once the required quality of the screen image has been confirmed, the position of the image usually needs to be adjusted, i.e., the proper position of the screen image of the

A first test is performed to evaluate the image quality of the scope. The eyepiece of the telescope is coupled to the video camera.

shows the outer ring of the endo-camera which can be turned to right or left to control sharpness and clarity of the screen image. The surgeon is seated next to the table, but viewing the image on the screen creates the impression as if positioned in front of the columella.
operating field. An adequately positioned screen image of the operating field enables the surgeon to remain comfortably seated and relaxed while watching the screen and getting an impression of “sitting on the patient’s thorax”, in the midline, introducing the scope exactly in the medio-sagittal plane (Figs. 8 and 9). If the surgeon’s preferred (dominant) hand is the right, he or she usually assumes a sitting or standing position at the right side of the patient, and vice versa. Anyhow, while sitting or standing next to the operating table and viewing straight ahead, the surgeon will see the wall or the door or some other part of the operating room, not the patient’s nose. Accordingly, there is a very simple solution for this situation: the screen should be placed almost opposite to the surgeon so that it can be observed very easily.

While defining the position of the image on the video screen, the scope stays 7–8 centimeters away from the object. The body of the endo-camera is gently rotated to the left or right using the right hand, while the left hand assists in holding the scope in the same position, which means that the longitudinal axis of the scope is aligned symmetrically towards the columella (Figs. 10 and 11). In this way, it is possible to obtain an overall view ranging from $0^\circ$ to $360^\circ$ (Fig. 12).

Once we have managed to position the screen image of the surgical field, it is time to introduce the scope in the nose. Prior to doing so, we usually rinse both nasal cavities using several 20 mL-syringes of alcohol or 2% hydrogen peroxide solution. At the end, we just irrigate both cavities with saline solution and aspirate all liquids from the nose with a suction cannula.
Endoscopy

Endoscopy is initiated by carefully advancing the scope along the floor of the nasal cavity.

The first distinctive feature that arises when entering the nose of the lamb, is the similarity with the human nasal cavity: nasal septum, then a structure that resembles very much the inferior turbinate in humans, and another one amazingly resembling the human middle turbinate (Fig. 13).

This could be most confusing because the structure – resembling very much the middle turbinate in man – in veterinary medical terminology is named concha ventralis, meaning inferior turbinate. On coronal anatomical section, it looks like a 4-month old embryo, with its back directed towards the nasal septum (Fig. 14). According to the veterinary anatomical nomenclature, the term “middle turbinate” (concha nasalis media) in the lamb is used to denominate a structure that is located much deeper in the lamb's nose, and can be clearly seen only if almost all of the inferior turbinate has been removed. The lamb's inferior turbinate has two main portions: the superior pars dorsalis and the inferior pars ventralis.

The nasal septum is straight as in all other quadrupeds. There is only one structure which very rarely can be found in humans: the vomero-nasal prominence at the most anterior and basal parts of the septum, formed by vomero-nasal cartilage (on Fig. 3n and on Fig. 13). This cartilage covers the vomero-nasal canal bilaterally.
There are at least two good reasons that can explain why such structure is only exceptionally seen in man. The first reason is the fact that rhinologists generally do not think about the existence of a vomeronasal (Jacobson’s) organ hence they do not look for it while inspecting the nose. The second reason is simple ignorance: very few rhinologists have an idea how the rudimentary vomero-nasal Jacobson’s organ in man looks like. Therefore, they can not trace it, even in its presence because they can not identify it properly. Furthermore, during endoscopy of this part of the nasal cavity, we can clearly see a structure resembling very much the inferior turbinate in humans. But in the lamb, this “inferior turbinate” still does not exactly look like the human inferior turbinate. This is because in reality it does not refer to any kind of turbinate, but to the cavernous plexus located within the nasal mucosa, exactly in the region where one would expect to see the inferior turbinate in humans. The name of this anatomical detail is *plexus cavernosus nasalis* (on Fig. 3 n, Fig. 14 No. 17, on Figs. 15 and 16).

The space between the vomeronasal prominence and the cavernous plexus has been named *meatus nasi ventralis*, while the space between the nasal septum and inferior turbinate (concha ventralis) has been named *meatus nasi communis* (common nasal meatus). All these details are clearly demonstrated on coronal CT scans of the lamb’s head on Fig. 17.
The next amazing anatomical detail that comes into view when the scope is advanced more deeply into the nose for just another centimeter, is the absence of almost half of the nasal septum. At very first sight, it resembles a defect of the nasal septum in man (otherwise wrongly named as septal perforation). However, this is not a defect of the nasal septum, this is a typical structure in the lamb’s nose called *meatus naso-pharyngicus*. The superior margin of this “defect” is formed by so-called *septum pharyngis*, consisting of septal cartilage and vomer. The inferior margin is constituted by the *lamina horizontalis ossis palatini* (a horizontal plate of the palatine bone). These two parts are in close proximity and merge anteriorly, exactly at the opening of the vomeronasal canal, which is the site where Jacobson’s nerve arises and terminates with a small branch, the so-called terminal nerve (*nervus terminalis*). Pronounced manifestations of *adenoid vegetations* are usually found in the choanal region (Figs. 18 a–g, and Figs. 22, 23 and 23 b).
Endoscopic Surgical Anatomy of the Lamb’s Head

The anatomical forceps has been inserted into the Eustachian tube without any problem. The tip of the instrument has emerged at the anticipated level of the middle ear (see Fig. 25, No. 66).

Medio-saggital anatomic section through the lamb’s head. The tip of the anatomical forceps points to the meatus nasopharyngicus, the bottom of which is occupied by the palatine tonsil. The black line indicates the vomero-nasal organ (canal).

Pay attention to the black line demonstrating the straight course of the lamb’s skull base, i.e., there is no angulation (Huxley’s angle) between the anterior and posterior skull base. There is no sphenoid sinus in lambs and other quadrupeds, most probably for the same reason.
The “septal defect” can be clearly seen also on coronal anatomical sections and coronal CT-scans (Figs. 20 and 21). Advancing deeper into the nose, the next anatomical detail that presents itself, is the choanal region. Unlike the one found in man, this region is not oval-shaped, dark and spacious, and there is not a clear junction of pathways leading to the nasopharynx. Approaching the lateral wall of the nasopharynx, the torus tubarius comes into view (Figs. 18 and 22). Occasionally, the Eustachian tube orifice can also be visualized (Figs. 18 e-g). The curved suction cannula, – frequently used in human medicine during endoscopic surgery of the maxillary sinus, – has been inserted transorally, and appears in the nasopharynx (Figs. 22 and 23). Performing the same maneuver in the lamb always takes some effort because its soft palate is very long. If carried out bilaterally, one might be led to believe that the lamb has two separate nasopharyngeal cavities. Even more, this false hypothesis is confirmed by findings demonstrated on coronal and sagittal anatomic sections (Figs. 24 and 25). The coronal CT scans support this idea as well (Fig. 26). Still, in case we remove the posterior septal portion, we shall find the unique nasopharyngeal cavity, adenoids at the typical place and the torus tubarius, that serves as a landmark indicating the area of the Eustachian tube orifice (Fig. 23 d and e).
Endoscopic Surgical Anatomy of the Lamb’s Head

The suction tip is in the left choana. The septum pharyngis is indicated by on both Figs. 22 and 23. The refers to the body of the levator veli palatini muscle. The indicates the mucosal fold anteriorly to the Eustachian tube orifice, i.e. the torus tubarius itself, whereas the refers to adenoids.

22

23

The suction tip is in the right choana.

Removal of the posterior portion of the nasal septum.

23a

23b

23c

The adenoids can be seen after the removal. The adenoids have been removed as well. The pointers refer to the torus tubarius, see Figs. 18 c–g.

23d

The inferior aspect of the lamb’s head. The occiput is located on the left, and the muzzle, on the right. The refers to adenoids, the points to the nasopharynx; the indicates the very elongated soft palate that extends most deeply into the oropharynx, the shows the oropharynx itself, the indicates the section plane through the lingual muscle, and the refer to the section plane through both greater cornua of the hyoid bones.

23e

The inferior aspect of the lamb’s head. Now, the occiput is superior, and the muzzle, inferior. The refers to the adenoids, to the soft palate (uvula, in fact), while the indicates to the oropharynx.
Coronal anatomic section through the related region. It seems to be quite obvious that the *septum pharyngis* (No. 30) divides the nasopharynx into halves. It closely communicates with the body of *levator veli palatini muscle* (No. 36).
Parasagittal anatomic section through the lamb’s head. The blue arrow marks the lateral part of the oro-pharyngeal space. The red arrow shows the frontal sinus, whereas the purple arrow points to the pneumatized posterior part of the plica recta, which has already transformed into the superior turbinate that approaches the frontal sinus from below.
Conversely, coronal CT scans of deeper located planes confirm unobstructed patency of the communication between the hypothetic right and left halves of the nasopharynx. Moreover, it can be assumed that the nasopharynx in lambs is quite spacious and voluminous (Figs. 27–30).

It seems as if the septum pharyngis extends posteromesally as far as the psephenoid and basisphenoid bones, in this way dividing the nasopharynx into halves.

Coronal CT scan taken at the level of the structures presented in Figs. 22–24. In deeper aspects, there is still a wide communication between both sides. It seems to be closed in virtual sense only because of the mass of the levator veli palatini muscle (>). This muscle has been changed post mortem, i.e. it is relaxed and flaccid leading to the impression of a closed space.

Left image: coronal CT scan; middle and right images: axial CT scans. All of them clearly show that the nasopharynx, oropharynx and hypopharynx form one and the same cavity. The on Fig. 28 refers to the concha nasalis superior as continuation of the plica recta. It literally fuses with the ethmoid labyrinth and approaches the frontal sinus from below.
Special Section

- Maxillary Sinus
- Ethmoid Sinus
- CSF Leak Repair
- Orbital Decompression
- Frontal Sinus
- Frontal Sinus Operations according to Draf
- Dacryocystorhinostomy (DCR)
Maxillary Sinus

The maxillary sinus in lambs is not a cavity that represents an integral entity, as in humans. The point here is that even three sinuses can be found at the same place: maxillary sinus proper, lacrimal sinus and palatinal sinus (Figs. 52, 54 and 56). The position of these sinuses at coronal anatomic sections and CT scans, reminds one of an elevated ground floor of a house. The attic of this house accommodates the lacrimal sinus, whereas in the ground floor there are two rooms, incompletely divided by a high partition (maxillary sinus proper, located laterally, and palatinal sinus, located medially. Amazingly, it seems as if the main entrance to this “house”, instead of being located on the ground floor, as front doors usually are, is found on the roof, i.e., the only, natural entrance to these three sinuses passes through the “skylight”, the natural ostium of the lacrimal sinus. The other two sinuses, that can be found below the first one, ventilate and drain themselves through this orifice, because all of these three sinuses are mutually connected in the anterior part of the complex. If a few drops of dye are administered into the maxillary sinus from outside through the artificial opening in this region, the dye will immediately appear in the second out of five niches.

![Image 31](Right recessus ostiarum. The niche designated as (1) ends blindly, the second one (2) conceals the entrance to the lacrimal sinus, (3) represents the outlet towards the frontal sinus. The indicates another niche, apparently ending blindly, but it is also possible that there is a connection to the ethmoid sinuses. This is quite obvious on Fig. 32. The indicates the level at which the degree of pneumatization of the middle turbinate noticeably increases. This is exactly the point that corresponds to the basal lamella in human anatomy. Traversing this point and proceeding superiorly at an angle of approximately 45°, one can directly reach the ethmoid labyrinth. )

![Image 32](Close-up view of the recessus ostiarum. blind niche (1), the posterior part; lacrimal sinus niche (2), niches of frontal sinus drainage (3 and 4) (see Fig. 34); most posterior niche (E), probably fusing with the ethmoid sinuses, only visible after advancing the scope until it is very close to the recess. )

![Image 33](Right recessus ostiarum. The dye, administered into the maxillary sinus from outside, emanates from the lacrimal sinus, and thus confirms that the three sinuses are mutually connected and maintain drainage through the same opening. )

![Image 34](The scope has been inserted into the left frontal sinus to get an impression about the bone thickness. An opening is made at a site where bone thickness is expected to be minimal, which is determined by transillumination from the other side. Following administration of just a few drops of dye through the opening, the dye is supposed to appear somewhere in the recessus ostiarum region. ⬨ – lacrimal sinus. )
in the area of the recessus ostiarum (recess of the sinus openings). This can be seen on Figs. 31–35.

The lacrimal sinus is partly separated from the palatinal and maxillary sinus by an almost horizontal bony plate that never extends as far as the anterior wall of these sinuses, thus providing a passageway in between them (Figs. 42–46, 76 and 98).

Removal of the inferior turbinate is essential for proper identification of the maxillary sinus because the inferior turbinate obscures vision of the middle turbinate, an indispensable landmark for localizing the natural ostium of the maxillary sinus, be it in man or lamb. The lamb’s inferior turbinate, as anatomical structure per se, is not that interesting to the endoscopic surgeon. This step of dissection is a good exercise for beginners regarding bimanual maneuvering and is useful in developing the right feel for the force required during its removal. In this way, trainees are offered the opportunity to build their skills in cutting, punching and crunching without putting at risk the integrity of critical anatomical and surgical landmarks.

The inferior turbinate should be transected with scissors along its insertion to the lateral nasal wall (Figs. 37–40).

35 The dye appears in the niches 3 and 4 simultaneously, immediately after administration from outside, through the artificially created opening in the frontal bone.

36 Coronal CT scan of a plane immediately behind the level of the basal lamella. The \( \text{refers to the left tuberculum Mladinae, which is orientated laterally and anteriorly, in this way coming into close proximity to the natural ostium of the lacrimal sinus. This detail can not be seen on the right side, most probably because of the oblique projection during CT imaging. The lower portion of the ethmoid labyrinth, therefore, lies at the same level as the roof of the maxillary sinus} \). The \( \) indicates the superior turbinate (well-pneumatized). In deeper regions, pneumatization of the superior turbinate gradually decreases, and finally ends blindly anteroinferior to the frontal sinus (see Fig. 68).

37 The inferior turbinate is transected along its lateral insertion.

38 The cut is carried deeper (\( \)).

39 The blade of the scissors partly masks the head of the middle turbinate (\( \)), The \( \) refers to the posterior part of the plica recta.

40 Right inferior turbinate (resembling an embryo). The left inferior turbinate has been already removed, therefore the complete plica recta is visible (\( \)). The pointers \( \) indicate two out of three tubercula of the head of the middle turbinate.
It is advisable to remove most part of the *plica recta* because in this way an unobstructed view of the head of the middle turbinate is provided. At first sight, the middle turbinate seems to have a bifid appearance, so the medial prominence is called *tuberculum septalis conchae nasalis mediae Proversae*, whereas the lateral one is named *tuberculum conchae nasalis mediae Petradae* (Figs. 41–43).

Bifid head of the right middle turbinate. ▸ ▶ refers to the prominence, called *tuberculum Petradae*, obstructing the view of the recessus ostiarum (see Fig. 33). Opposite to it, more medially, there is another prominence, close to the nasal septum, called *tuberculum Proversae* (P).

The outer bony wall of the maxilla has been partly removed, so the natural ostium of the lacrimal (and both palatinal and maxillary) sinuses can be clearly identified. The third prominence of the head of the middle turbinate, *tuberculum Mladinae*, has almost penetrated this opening (▷). The ▼ indicates the infraorbital nerve. The ▽ shows part of the almost horizontal bony plate which divides the lacrimal sinus above from the maxillary and palatinal sinuses below it. Noticeably, these two sinuses have a good communication between them, and owing to the absence of the horizontal partition in most anterior aspects, they also communicate with the lacrimal sinus, located just above them.

The main part of the outer bony wall of the right maxilla has been removed, revealing the course of the infraorbital nerve (▷), the middle turbinate with the *tuberculum Mladinae* (■), and most part of the lateral surface of the inferior turbinate (■). The ▼ indicates the lateral prominence of the head of the middle turbinate (*tuberculum Petradae*), which obscures vision of the sinus ostia. The ▾ refers to the lacrimal sinus, a cavity located above the maxillary and palatinal sinuses. The ▸ indicates the remnant of the bony partition which divides the lacrimal sinus from the other two cavities located inferiorly.

The main part of the outer bony wall of the maxilla has been removed. ▼ indicate the remnants of the horizontal bony partition, the ▽ indicates the natural ostium, whereas the ▾ refers to the joint space of those three sinuses located directly superior to the area traversed by the infraorbital nerve and infraorbital rim. Neither of the two structures mentioned above can be visualized yet, because the lower portion of the outer wall of the maxillary sinus, so far, has not been removed.
The diaphanoscopic effect of the 30° telescope light. The tip of the telescope has been inserted in the region of the recessus ostiarum, or more precisely, in front of the niche No. 2 (see Figs. 31 and 32). Based on this diaphanoscopic finding, it seems that we are dealing with specific types of fontanelles at the medial wall of the palatinal and lacrimal sinuses. The main difference between fontanelles in the lamb and those in humans is the fact that human fontanelles are formed by two layers of mucosa with no additional bony support. Yet, this finding suggests that the bone at this site is very thin and can be easily perforated by curved instruments, as is the case in endonasal surgery.

At the level of the head of the middle turbinate, the plica recta passing above, a considerable degree of pneumatization is demonstrated (Figs. 47 and 48).
In the next step, the middle turbinate is medialized using a blunt instrument (elevator, for instance). In this way, the recessus ostiarum comes into view (Figs. 49 and 50).

To clearly demonstrate that the cavity to which the white pointer indicates in Fig. 49, is actually the lacrimal sinus ostium, it is enough to administer a few drops of dye into the maxillary sinus from outside. Just a couple of seconds thereafter, the dye becomes visible in the niche (Fig. 50). It is strongly advised, that the area be inspected endoscopically prior to applying the dye, in order to be prepared as to see where exactly it will flow out. A close-up view of this area allows the tuberculum Mladinae to be nicely demonstrated (Fig. 51), which otherwise, in most cases, may be missed.

Once we have placed the scope at the proper place, the diaphanoscopy effect becomes noticeable when the light emitted from the tip of the endoscope is directed toward the bony outer wall of the maxillary sinus (Fig. 52). Next, a back-biting forceps can be used to remove adjacent tissue and to begin creating a large middle antrostomy window (Fig. 53).

The complete head of the middle turbinate and particularly the tuberculum Mladinae (red) have been medialized. The yellow arrow points to the ostium of the lacrimal sinus. Black arrow to tuberculum Petradae.

In order to demonstrate that the cavity to which the white arrow refers in Fig. 49 is actually the lacrimal sinus ostium, a few drops of dye may be applied to the maxillary sinus from outside. Just a few seconds later, the dye can be clearly visualized in the niche. Yellow arrow to tuberculum Mladinae. Black arrow to tuberculum Petradae.

The light emitted from the tip of the scope is shining through the maxillary bone and confirms that we have arrived at the proper site. The illuminated area clearly contrasts with the darker part (lacrimal sinus) and presents as an almost straight line, owing to the fact that the tip of the telescope is directed to the inferior fontanelles (see Fig. 45).
While performing the middle antrostomy, one should be fully aware that the maxillary and palatine sinuses in their posterior aspects are “covered” by an almost horizontal bony plate, the floor of the lacrimal sinus (Figs. 42–46, 64, 65, 67 and 76).

For this reason, it is strongly recommended that the middle antrostomy window be created starting from a site located in the posterior-most part to make sure that the lacrimal sinus is entered first. Once this has been accomplished, the antrostomy should be enlarged anteriorly first, using back-biting forceps. The horizontal bony plate, representing the floor of the lacrimal sinus, must be presented clearly. Removal of this plate opens up the view of the rim of the infraorbital nerve canal and its course. The procedure requires that the main part of the medial plate of the palatine sinus be removed. We commonly use the antrum punch for this maneuver (Fig. 55), which in most of the cases is required to clearly identify the white, distinct linear shape of the infraorbital nerve traversing the superior edge of the infraorbital rim (Figs. 20, 42, 43, 46, 54, 56–58 and 63). Total exposure of the floor of the palatine sinus requires that its medial wall be removed completely (Fig. 56).

Middle antrostomy involves that an opening be created first in the bone of the superior, larger fontanelle (see Fig. 45).

The antrum punch is used to remove the inferior part of the antrostomy.

The infraorbital rim has been clearly exposed (>). The floor of the palatine sinus is visible (>). – orbital wall.
Once the infraorbital rim has been fully exposed, and the course of the nerve becomes visible, an opening can be made in the nerve canal, allowing the nerve to be extracted (Figs. 57 and 58). The next step is performed from the outside and involves exposure of the exit point of the infraorbital nerve arising on the anterior surface of the maxillary bone (Fig. 59).

57 demonstrates that the infraorbital nerve has been partly removed from its canal. — maxillary sinus; — palatinal sinus. — refers to the orbital wall. ⭐ shows the lower portion of the most anterior ethmoid cells. Notice, that the orbital wall is located in dorsal aspects of them.

58 The infraorbital nerve is extracted and incised at the point where it enters the infraorbital canal of the maxilla. This is why it just hangs in the palatine sinus. — a part of the orbital wall.

59 shows the typical exit point of the infraorbital nerve on the maxilla. It can be identified even through the periosteum. The curette points to the course of the main nerve trunk.

60 Nicely exposed bifurcation of the infraorbital nerve.

61 View of the lumen of the infraorbital canal following nerve extraction.
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Consistent with human anatomy, the infraorbital nerve, after arising from the canal, gives off smaller branches thus forming a network resembling very much the pes anserinus of the orbital nerve in man (Fig. 60). The nerve than can be transected and removed from the bony canal, so as to accommodate the 2.7-mm scope (0° direction of view) which is inserted to gain access to the internal space of the maxillary, lacrimal and palatinal sinuses (Figs. 61–63).

In conclusion, it can be said that the maxillary sinus in lamb definitely exists. It is just a part of the specific “sinus complex” which contains three sinuses: lacrimal, palatinal and maxillary sinus proper. The lacrimal sinus is situated above the other two cavities, partly separated from them by an almost horizontal bony plate which is absent in the most anterior aspect of the complex (Fig. 64). The maxillary and palatine sinuses are divided by the rim of the infraorbital nerve canal (Figs. 56, 57). The former is located in the lateral compartment, while the latter belongs to the medial parts. Apart from that, we know exactly where the natural ostium of the lacrimal sinus is. Maxillary and palatine sinuses have their drainage through a common ostium. Finally, we know very well how to approach this sinus complex and how to perform a middle antrostomy. Once the middle antrostomy has been completed in compliance with the relevant surgical principles, we are ready to proceed with the next step of dissection: exploration of the ethmoid labyrinth and endonasal endoscopic orbital decompression.
The anatomical relationship between the lacrimal (13), maxillary (22) and palatinal (29) sinuses is nicely visible. They gradually merge into each other, forming a joint cavity in the most anterior parts of the complex (Fig. 66).
Maxillary and palatinal sinuses form a joint cavity in the most anterior parts of the complex.
Coronal anatomic section through the middle of the maxillary sinus.
Ethmoid Sinus

The ethmoid sinus in the lamb has a labyrinth-like appearance. It literally consists of an immense amount of small air cells that make up this unique and highly complex entity located just beneath the superior turbinate (Figs. 28, 47, 68 and 69), which obviously ends blindly just anterior to the skull base. In this way, the posterior end of the superior turbinate approaches the frontal sinus from below and from anterior.

Still, it seems that this well-pneumatized entity could be considered the counterpart of the ethmoid bulla in humans. Namely, it suffices to imagine that the region covered by the green oval in Fig. 68, after rotation to the left for 90°, mimics the natural position of the human ethmoid sinuses. In this new, most anterior position, the lamb’s superior turbinate in terms of anatomical arrangement and external appearance distinctly resembles an ethmoid bulla in humans. Finally, the position of the lamb’s frontal sinus, when translated onto the human cranium, results in some sort of hypothetic “parietal sinus” which, as everybody knows, does not exist in man at all. Therefore, the human anatomist is still faced with a great dilemma: is the pneumatized superior turbinate in lambs actually a counterpart of the human ethmoid bulla or not? (Fig. 69). It is well known that the anterior wall of the human ethmoid bulla leads directly to the narrowest parts of the naso-frontal recess. Even in Fig. 69, the recess between the superior turbinate and the posterior part (only on this image, otherwise, the inferior part) of the lamb’s frontal sinus makes the surgeon believe that, most probably, the ostium of the frontal sinus itself could be localized unequivocally, which proves to be a misconception.

This is due to the fact that the frontal sinus in lamb is divided in 8–10 compartments, so the core issue here is where and how they (if at all) communicate with each other, and where do they drain into? Do they drain through one and the same ostium on each side, or through several of them? These questions will be deferred to a subsequent chapter addressing the frontal sinus.

Sagittal CT scan of the lamb’s head. Pay attention to the area covered by the green oval. The  refers to the frontal sinus, the  shows a well-pneumatized superior turbinate, which obviously ends blindly, just anterior to the skull base. In this way, the posterior end of the superior turbinate approaches the frontal sinus from below and from anterior.  – ethmoid labyrinth.

Axial CT scan of the lamb’s ethmoid labyrinth after 90° rotation to the left, so as to imic human anatomy. The  shows the frontal sinus, the  refers to the superior turbinate, while the  indicates the floor of the fronto-ethmoid recess.

Axial CT scan of the lamb’s head. The  indicates the lateral prominence of the ethmoid labyrinth which forms the crest Zite (crista ethmoidalis sinus maxillaris Zite). The  indicates the very profound recess of the maxillary sinus, which is called orbital recess Tido (recessus orbitalis sinus maxillaris Tido). The  shows the crista galli.

The CT scan was taken at a lower level. The  indicates the lacrimal sinus. The  refers to the joint space interconnecting the maxillary and palatinal sinuses. The  indicates the plica recta. The ethmoid sinus stays at varying distance from the orbital wall. It is therefore prudent to bear this in mind when training endoscopic orbital decompression in the lamb. The  – crista galli.
Anyhow, the superior turbinate posteriorly approximates the cribriform plate, a thin piece of bone, behind which the olfactory bulb is found bilaterally (Fig. 25, No. 13, Fig. 80, No. 5 and Fig. 84). Medially, the superior turbinate stays in contact with the nasal septum, and in lateral direction closely approaches the orbital wall posteriorly. In anterior aspects, it touches the inner surface of the middle turbinate (Figs. 28, 74, 85, 86 and 99).

The largest area of contact between the ethmoid labyrinth and the orbit is found near the exit point of the infraorbital nerve on the orbit itself, i.e., at the very beginning of the course of this nerve, above the infraorbital rim. This suggests that one should keep medially when attempting to train orbital decompression in the lamb, because in this way, removal of a large portion of the orbital wall is both feasible and safe (Figs. 70–71). Nevertheless, the surgeon must be well aware of the fact that in this specific area a bony prominence can be found, namely the *crista ethmoidalis sinus maxillaris Zite* (Fig. 70). Removal of that crest is usually associated with strong, hard and forcible manipulations, which is incompatible with the minimally invasive technique and can rapidly cause an iatrogenic skull base trauma.

Fig. 74 nicely shows the relationship between the posterior ethmoid wall and the skull base, i.e. cribriform plate. The exact site where bone thickness is minimal can be visually detected by transillumination of the endoscope’s light. It is extremely important here to localize the point of insertion of the middle turbinate, which remarkably resembles the basal lamella in human medicine, i.e. the boundary between the anterior and posterior ethmoid labyrinth in humans, whereas in the lamb, it just defines the demarcation line between the nasal cavity and the ethmoid labyrinth as a whole. Figs. 74 and 75 clearly show the relationship between the posterior ethmoid and the endocranium. Figs. 70–73 and 76 nicely demonstrate the relationship between the ethmoid labyrinth and maxillary sinus, on one side, and the orbit, on the other.
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Left half of the lamb’s head. The green oval indicates the region of the ethmoid labyrinth that has just been emptied. The black arrow shows the endocranial space (brain has been already removed). The bony posterior ethmoid wall is extremely thin and appears translucent even for ambient light. The green arrow indicates the “basal lamella”, that is the inferior part of the middle turbinate.

The ethmoid labyrinth has been removed completely. The ambient light shines through the cribriform plate (posterior ethmoid wall). The region that borders the thinnest part of the bony skull base hence is located in the bifurcated zone between the inferior margin (green arrow) of the middle turbinate and its superior, free margin (yellow arrow).

Left half of the lamb’s head in the projection of the posterior part of the maxillary sinus viewed from medially to laterally. The medial maxillary sinus wall has been removed, so the exit point of the infraorbital nerve is clearly visible (white arrow). The blue arrows indicate the supero-anterior part of the orbital wall, the yellow arrows indicate the remaining (the deepest) part of the lacrimal sinus, while the orange arrows indicate the insertion of the ex bony plate which otherwise demarcates the lacrimal sinus from both the maxillary and palatinal sinuses. The red star refers to scarce remnants of the deepest ethmoid cells maintaining close proximity to the skull base.

Sagittal anatomic section through the lamb’s head. View of the left half. The white arrows indicate the entrance to the palatinal and maxillary sinuses, the black circle encloses the residual ethmoid cells, while the red arrow indicates the intersphenoid synchodrosis (the junction between two parts of the sphenoid bone – see Figs. 18b, 19 and 25). Proceeding with removal of the ethmoid cells in the direction of the yellow arrow, the cribriform plate would be directly approached.

Postero-anterior view of the left cranial fossa following its complete exposure. The anterior wall has an oval, large recess with a facet-like appearance. In fact, the floor of this cavity is the cribriform plate. In case the surgeon passes beyond any part of this region, particularly across its middle part, the instruments would enter into the posterior ethmoid labyrinth. The yellow arrow indicates the crista galli.

Axial CT scan at the level of the ethmoid labyrinth. It is quite obvious how deep the endocranium penetrates into the nasal cavity. The anatomic configuration of this particular case resembles Keros type III in human anatomy. As a rule, one should attempt to localize the posterior wall of the maxillary sinus, or better said, the exit point of the infraorbital nerve, which serves as anatomical landmark and helps to decide how deep one should go when exploring the ethmoid labyrinth (white arrow). Apart from that, inadvertent penetration into the endocranium can be prevented. The red arrows – olfactory bulbs, bilaterally.
The ethmoid labyrinth ends posteriorly, at the level of the cribiform plate. The olfactory bulb (No. 5) is located just behind it. The medial parts of the frontal sinuses’ “crown” are shown in this anatomical section. The ethmoid labyrinth stays in close proximity to the orbital walls. At least on the left side of this anatomical section, the maxillary sinus can be seen (No. 18).
The lateral parts of the frontal sinus “crown” are already visible, but their medial aspects are in a more posterior position, and therefore invisible on this specific anatomical section. The large borderline between the maxillary sinus and orbit is marked by the [os frontale].
Endonasal Endoscopic CSF Leak Repair

Repair of a CSF leak can be trained effectively with the lamb’s head. Both onlay and underlay techniques can be practiced.

The onlay technique involves that the graft be placed on the denuded bone of the skull base defect from “outside”, instead of inserting it below the defect margins. The point is to place the graft in such a way, that it fully covers the defect. As a rule of thumb, the diameter of the graft should be fashioned 1–2 millimeters larger than the defect itself. Once the graft has been placed successfully, we usually employ a synthetic, thin bioreabsorbable patch, affixed with human fibrinogen. The patch should always be placed in such a way that its active surface is in close contact with the dura (the active surface should, under any circumstances, be clearly distinguishable, preferably color-coded, to make sure that it cannot be confused with the opposite side of the material). The size of this second layer is approximately 2–5 millimeters larger, depending on the free space available to attach the platelet properly without wrinkling. Wrinkles in CSF leak repairs are absolutely unacceptable because they are usually associated with a failure of the procedure.

The onlay technique is used if the size of the defect is smaller than 5 millimeters in diameter, and if the leak is only of minor degree, or almost hardly visible. Besides, the technique is suitable for the repair of CSF leaks in the sphenoid sinus area, particularly when located on its lateral wall. The sphenoid sinus is surrounded by a great variety of vital structures (cavernous sinus, carotid artery, optic nerve, fronto-polar artery, basilar artery), so underlay technique could be very dangerous and not very reasonable.
Coronal CT scan of the lamb's head. The green dotted line connects two horizontal plates – the floors of the lacrimal sinuses. All of the structures located in a superior level, belong to the ethmoid labyrinth (yellow circles). If the surgeon continues penetrating into this region, particularly with the instrument directed mainly medially, the cribiform plate should be spotted very rapidly allowing the artificial defect to be created easily.

Left lateral nasal wall. — plica recta (more anteriorly), i.e. superior turbinate (more posteriorly), — the head of the middle turbinate, — the head of the biggest and most anterior ethmoid cell; — shows the inferior turbinate, while the tetrahedron encloses the part of the ethmoid labyrinth that has to be removed when targeting the cribiform plate.

The ethmoid sinus has been completely emptied. The cribiform plate seems to be almost transparent. Integrity of the middle turbinate, as the frame of the ethmoid labyrinth, has been completely preserved.

The deepest part of the left ethmoid labyrinth. E – Posterior and lateral residual ethmoid cells. — indicates the blind end of the superior turbinate, whereas the — refers to the artificial opening at the cribiform plate. A little amount of cerebrospinal fluid is visible at the boundaries of the defect.

Conversely, if the surgeon is faced with a defect larger than 5 millimeters in diameter, and particularly if discharge of cerebrospinal fluid is considerable, it is mandatory, that the defect be managed in an underlay fashion, which involves that the graft be placed in the epidural space below the margins of the bone defect, but still above the dura.

How to train such techniques on the lamb's head?

First of all, the trainee creates an artifical defect in the skull base. This can be achieved in the deepest parts of the ethmoid sinuses (Figs. 68, 70, 71, 74, 75, 77, 79, 80, 82 and 84). The best way to penetrate the endocranium is to advance into deeper layers by removing the ethmoid cells, but without exceeding the level of an imaginary line that connects the right and left horizontal plate of the (floor of the) lacrimal sinuses, i.e. slightly superior to the inferior edge of the middle turbinate (Figs. 85–87).

Once the deepest ethmoid cells have been removed and the tip of the instrument has reached as far as the cribiform plate, an artificial opening should be created so as to prepare the “operating field” for a CSF leak repair (Figs. 88 and 89). Once the onlay technique has been practiced several times, one can proceed with the underlay technique (Figs. 90–95 and 96). For training purposes, a maxillary peristeval graft should be harvested because a flap from this “donor site” can be easily elevated allowing a piece of practically any size to be adequately shaped and trimmed as per individual needs. The consistency of the flap is very similar to those used in human surgery for repair of CSF rhinorrhea. Preparation of the flap is demonstrated in Figs. 97a–c).
The left olfactory bulb is visible just beneath the archnoid membrane.

A previously fashioned layer of graft material is placed over the skull base defect with a Blakesley forceps.

The patch is being adapted.

A curved curette is used to fit in the patch until it assumes a proper position below the margins of the bone defect. The upper edge of the patch has already adhered to the dura and brain, whereas the lower edge still needs to be readjusted.

View of the underlay graft which has now been fitted into its proper position below the margins of the bone defect. No signs of wrinkles.

The image confirms that the overlap of the inserted patch exceeds the free margins of the bone defect for at least 2 millimeters.
The circular incision has been made on the periosteum covering the outer wall of the right maxillary sinus. Using the curette or some other appropriate instrument the periosteum is detached from the bone taking care to preserve integrity of the flap.

Elevation of the maxillary mucoperiosteal flap is almost complete. The remaining portion firmly adheres to the infraorbital nerve sheath. The nerve can be transected, and the flap is dissected free.

The pale side of the flap, i.e. the one pressed by the tip of the curette, should be placed over the dural defect. The darker side should be faced to the nasal cavity.
Endonasal Endoscopic Orbital Decompression (EEOD)

The relevant anatomical relationships in the lamb between the palatinal, maxillary and lacrimal sinuses – and in particular between the ethmoid labyrinth and the orbit – are very favorable for practicing endoscopic orbital decompression. In the author’s opinion, EEOD training is facilitated by this type of specimen, and, beyond any doubt, pleasant, because a steep learning curve rewards the trainees for all the time and effort put in to improve their surgical skills during each step of dissection training. Nonetheless, endoscopic orbital decompression, by all means, should not be the first thing to do for beginners in this field. Figs. 49, 51, 57, 63, 69-73, 76, 79, 80–82 serve to underpin this statement.

The trainee should be aware that the optic nerve canal in the lamb’s orbit is located inferiorly, coursing in a latero-medial direction through the skull base, arising from the medial wall of the orbit, and ending, as in humans, at the optic chiasm (Fig. 98).

The first step of the EEOD procedure in the lamb specimen involves opening of the lacrimal sinus in order to entirely remove its floor, i.e., the almost horizontal lamina which separates the lacrimal sinus from the maxillary and palatinal sinuses. Subsequently, it is possible to clearly expose the rim of the infraorbital nerve canal, and the exit point of the infraorbital nerve arising from the orbit. In reality, the infraorbital nerve arises from anterior orbital wall. One should bear in mind that most part of the anterior orbital wall in lamb is naturally covered by ethmoid cells (see Figs. 57, 58, 64, 75 – 76), so once the three sinuses (lacrimal, palatinal and maxillary sinuses) have been localized properly, the remaining adjacent ethmoid cells should be meticulously removed as well (Figs. 99 and 104).

Always bear in mind that the proper endoscopic approach to the orbit in the lamb specimen traverses the posterior wall of the lacrimal, maxillary and palatinal sinuses. Following proper identification of the superior orbital wall, any residual ethmoid cells are removed with meticulous care, making sure that any iatrogenic damage to the cribriform plate and the skull base is prevented. These structures can be easily localized just 1–2 cm superiorly and about one centimeter medially, which is clearly presented on Fig. 101.

After removal of the well-exposed bony walls of the orbit, one has to perform the incisions over the periorbit. Three parallel incisions are enough. It’s good to perform them cutting from posterior to anterior, and from superior to inferior. After the incisions of the periorbit have been completed, the surgeon has to press the eyeball from outside. The retrobulbar fat tissue than comes into the operating field. The endonasal endoscopic orbital decompression is completed (Figs. 102 and 103).
Left nasal cavity. Following extensive ethmoidectomy the entrance to the most anterior frontal sinus cell is visible (>). The <ref>infraorbital nerve protruding from its canal</ref>. The mass of the retrobulbar fat tissue is shown in the semi-transparent circle.

Orbital decompression has been partly completed. So far, the lateral portion has not been denuded (<>). The <ref>infraorbital nerve protruding from its canal</ref>. The mass of the retrobulbar fat tissue is shown in the semi-transparent circle.

View of the left nasal cavity. The remaining posterior ethmoid cells are removed with a Blakesley punch forceps. The surgeon should keep as lateral as possible to prevent penetrating the cribriform plate (<ref>posterior aspect of the superior turbinate that has been dissected off and ends blindly</ref>.

It is crucial to always keep in mind an essential rule that applies to periorbital incisions: such incisions should <b>always</b> be – with no exception – performed horizontally and longitudinally in order to prevent inadvertent injury to the extraocular muscles (particularly regarding the medial rectus muscle).

In conclusion, just a few brief instructions that should be carefully followed during the learning process required to build knowledge and skills needed to perform orbital decompression:

Anatomical landmarks should be identified and respected at all costs in order to reduce to the lowest possible level the risk of iatrogenic damage. Today, training on a lamb specimen – tomorrow, translating skills into practice in a real-patient setting.

While penetrating through the ethmoid labyrinth, it is highly recommended to stick to the superior turbinate, mostly to its inferior half, whenever the bony orbital walls should be broadly exposed (Fig. 104). As already mentioned in the chapter covering the ethmoid labyrinth, the posterior, pneumatized aspect of the superior turbinate is a very important reference structure that should be utilized during endoscopic procedures in this area. This anatomical landmark serves as a specific guard which protects the surgeon from adopting the wrong path, i.e., too proceed too far superiorly, which would involve heading towards the frontal sinus instead of the orbit.
Adopting a step-by-step strategy, which includes the identification of the lacrimal, palatinal and maxillary sinuses, must not be underestimated (Figs. 51–56 and 105). Proper identification of the infraorbital nerve and rim is of a paramount importance since this nerve leads the surgeon directly to the anterior orbital wall.

The infraorbital nerve, therefore, similar to the posterior portion of the superior turbinate, is another “bodyguard”, that plays a vital role in preventing inadvertent removal of anatomical structures that should be preserved at all costs (Figs. 105 and 106).

Once, the contours of the orbit have been clearly exposed, removal of bony fragments should be initiated at the very medial part of the anterior orbital wall (Figs. 107 and 108).

Prior to performing endonasal endoscopic orbital decompression in a lamb specimen, it is very useful for beginners to remove the orbital contents from outside first. Once the orbit has been completely exposed, maneuvering of the instrument tip is facilitated by improved visualization during removal of the bony walls because the ambient (natural or artificial) light in the operating room illuminates the orbital cavity and can be observed endoscopically as transillumination through its bony walls (Fig. 169) and vice versa, as shown on Fig. 112. The procedure can be performed very quickly and easily. Since the lacrimal gland is located superiorly, medially and posteriorly in the orbital cavity, it should be easily visualized during the procedure (Fig. 81, No. 12, and Figs. 109 and 110).
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Outside view of the tip of a Kerisson punch used to remove a bony fragment from the anterior orbital wall, which is performed here in its medial part.

Starting excision of the contents of the left orbit. → lacrimal gland.

Most of the orbital contents have already been removed. View of the scissors transecting the neurovascular bundle and the tendons of the extraocular muscles. → lacrimal gland.

The → refers to the entrance area of the nasolacrimal canal. The internal surface of the anterior orbital wall is meticulously enucleated with a curette.

As shown here, the thinnest part of the anterior orbital wall (resembling the lamina papyracea in humans) can be determined by use of diaphanoscopy. Light is emitted from the tip of the scope which has been placed directly above the lacrimal sinus. The lacrimal sinus itself is also illuminated (→).

Once all orbital contents have been removed, the inner surface of the bony orbital walls is enucleated meticulously (Figs. 111 and 112).

The next step is to remove the bony orbital walls, which can be achieved most easily from inside, i.e., by endonasal insertion of a Kerisson punch (Fig. 113).
Frontal Sinus

As mentioned above, the frontal sinus in the lamb specimen is located in an area, that, on the basis of sagittal CT scans, in human anatomy would be called parietal, or in rare cases, even occipital, rather than frontal (Fig. 114). Measured in the medio-sagittal plane, volume is smallest in the most anterior frontal sinus cell (Fig. 115). Interestingly, the frontal sinus is extensively developed above the orbit (Fig. 116). In fact, the frontal sinus in lamb comprises a group of chambers that are arranged in a circular fashion from anterior to posterior, with lateral compartments, altogether forming an array that resembles a crown. The space bordered by this specific “crown” is not hollow, of course, but is made up of hard bone directly overlying the brain (Fig. 119). Following removal of this part of the cranial bone, the supraorbital frontal sinus chamber, in terms of dimensions, gives a dominant impression. The contours of the orbit, particularly those of its superior wall, are clearly presented as well.

Sagittal CT scan of the lamb’s head through the lacrimal sinus space. The blue indicates a part of the joint nasal cavity, green relates to the lacrimal sinus, red – the inner space of the inferior turbinate, yellow – ethmoid labyrinth, white – orbit, black – the contours of the pneumatized posterior end of the superior turbinate, red – frontal sinus (supraorbital chamber), B – brain.

Medio-sagittal CT scan of the lamb’s nose. Red – extremely shallow most anterior frontal sinus cell, B – brain.

Some artificial collection of air at the floor of the orbit can be seen. There is also a real air space superior to the orbit (supraorbital chamber of the frontal sinus). White – orbit.

Following removal of the anterior part of the cranial bone, the most anterior frontal sinus chambers are clearly visible. On their posterior walls, the drainage openings are shown. The deep funnel of the naso-frontal recess is demonstrated well. The funnel communicates with the superior nasal meatus region (see Fig. 118). Pay attention to the supraorbital frontal sinus chamber indicated by red.
Endoscopic Surgical Anatomy of the Lamb's Head

Axial CT scan at a very superior level of the lamb's head which clearly shows that the frontal sinus is made up of several chambers that are arranged in a circular fashion around the thick, compact bone directly overlying the brain. This specific configuration of the frontal sinus chambers resembles very much the shape of a crown.

The zigzag blue line shows the drainage pathway of the frontal sinus from its starting point, the naso-frontal recess, which is located in most superior aspects of the upper nasal meatus (recessus ostiarum), immediately above the still pneumatized tail of the superior turbinate (No. 3). The lateral chambers are labelled as No. 2. The drainage bifurcates ( – ), thus forming the niches No 3 and 4 in the recessus ostiarum.
Endoscopic Surgical Anatomy of the Lamb’s Head

**Fig. 120** clearly shows how close to each other are the posterior end of the pneumatized tail of the superior turbinate and the anterior wall of the most anterior frontal sinus chambers. The blind end of the superior turbinate approaches the frontal sinus from below (**Fig. 121**).

Furthermore, **Figs. 122** and **123** clearly show that anterior and superior to the frontal portion of the lamb’s brain there are some frontal chambers. But, just a couple of centimeters posteriorly, the surgeon encounters a thick bone overlying the brain, and without any chambers at all.

The key issue here relates to the communication pathways between all chambers of the frontal sinus. It is obvious, that there are interconnections between the chambers since they are adequately ventilated. The problem is to clearly identify the “openings”, “ducts” or whatever morphological features the interconnections present. For endoscopic dissection training, this question, of course, is irrelevant, but it is good to know that the dye, administered into the supraorbital frontal sinus chamber from outside, travels to the site that corresponds to the nasofrontal recess in human anatomy (**Figs. 124** and **125**). The course of the dye is extremely difficult to observe on a native specimen, but can be facilitated by uncapping a group of overlying frontal sinus cells, so that the floor of each of these cells and the direction of the drainage pathway becomes visible from outside and from above (**Figs. 126–129**).
A few drops of dye have been administered into the supraorbital frontal sinus chamber to exactly trace the course along which it will be drained. The indicates the space where the whole group of chambers drain to, starting from the supraorbital chamber and flowing in anterior direction. The shows the most anterior frontal sinus cells that drain themselves directly into the third and fourth niches in the recessus ostiarum. indicates the brain, refers to the right supraorbital frontal sinus chamber, while the shows the roof of the right orbit.

The dye has drained into the nasofrontal recess through the openings that obviously serve as interconnections between all these chambers. Some of these openings are still invisible, but may be made out indistinctly, owing to the blue color of the dye recognizable through some of the bony walls. Following removal of the walls, the course of the dye’s drainage pathway is shown clearly and can be easily tracked, as depicted in Fig. 126.

Most part of the frontal sinus chambers and bony septa have been removed, which considerably facilitates tracking the course of the dye. Now, it becomes clear that the chambers of the “crown” of the frontal sinus in a lamb specimen are well interconnected owing to a “state-of-the-art underground sewage network”.

The indicates a part of the bony roof of one of the lateral frontal sinus chambers. The superior refers to a small opening through which the dye drains to the nose once administered into the anterior frontal sinus chambers. The inferior shows the same opening, which on this side, apparently, is wider than the contralateral one. Owing to this fact, the course of the dye, emanating from the left posterior supraorbital frontal sinus chamber, is nicely presented.

The bony septa dividing the lateral frontal sinus chambers are removed in a piecemeal fashion with a Blakesley punch forceps in order to visualize the drainage pathway of the dye. This dissection maneuver has already been performed on the left side.

The septum dividing the two most anterior frontal sinus chambers is removed with a Blakesley punch forceps. The maneuver is a mandatory step prior to performing the Draf III frontal sinus procedure, which will be discussed in the following chapter.
Finally, the dye is seen to escape from the nose. It commonly appears very quickly in the third and fourth niche of the recessus ostiarum (see Fig. 35).

In conclusion, we can say that, in practice, frontal sinus procedures typically involve two interesting criteria:

- the first one involves that the frontal sinus area be identified properly, followed by its meticulous exposure making use of the endonasal endoscopic technique. This of course, in most of the cases, is targeted to access the lateral chambers of the “crown” which involves passing through the superior parts of the ethmoid labyrinth by referring meticulously to the superior turbinate as the best landmark that guide the surgeon to the frontal sinus;

- the second criterion is related to all of the three frontal sinus endoscopic endonasal procedures classified by Draf.

Regarding the first criterion, it has already been described as to where the frontal sinus can be expected following removal of a great portion of the ethmoid labyrinth and after completion of the middle meatal antrostomy. The lateral chambers of the frontal sinus usually can be identified without difficulty (see also Fig. 120, semi-transparent, grayish ellipses and Figs. 123, 130 and 131). The medial chambers, situated most anteriorly and next to the blind end of the superior turbinate, are often so shallow, that it is seemingly impossible to create a window for access via an endoscopic approach.

The endonasal endoscopic frontal sinus procedures originally classified by Draf (Draf I, Draf II and Draf III) will be described in the next chapter.

**Endoscopic Endonasal Frontal Sinus Procedures according to Draf**

Endoscopic endonasal frontal sinus procedures according to Draf are not widely applied in clinical practice because of two reasons: – doctors often fail to establish the indications for the specific type of procedure, and – they are not quite sure about how to perform the procedure properly.

It seems, that there is a vicious circle between these two facts: surgical procedures that are rarely performed, usually involve that the surgeon is not experienced and skilled enough to safely perform them. If the surgeon is not skilled enough, establishing indications usually becomes increasingly difficult. In fact, the Draf procedures have a well-defined range of indications and validity when chronic inflammatory diseases of the frontal sinus are concerned. Fortunately, for this specific purpose, the lamb specimen can be used very effectively to train all three types of endoscopic endonasal frontal sinus procedures according to Draf.
Draf I

The scope of this procedure is minimal in comparison to types II and III. A type I procedure is indicated in patients suffering from unilateral, moderate pathology of the frontal sinus, which stubbornly recurs, regardless of how precisely and successfully previous procedures of whatever type have been performed. The main problem here, apparently, is related to the degree of patency of the drainage pathways in the naso-frontal recess, particularly in cases previously treated by means of endoscopic sinus surgery technique.

The relevant factor in this context is that surgeons, in general, highly respect the area of the anterior skull base, particularly its superior portion, which is where the bony walls are thinnest.

Everybody knows that the dura in this area is particularly fragile and vulnerable, and to make things worse, it adheres very firmly to the underlying bone, meaning that in this area any bony lesion of even minor degree (infraction, for instance) can immediately induce an iatrogenic CSF leak. In case, the surgeon promptly realizes the onset of a CSF leak, the successful outcome of surgery usually should not be affected adversely because the surgeon will swiftly attempt to close the dural defect, or a more experienced surgeon will be called to assist in managing the critical situation. The patient will immediately receive antibiotic prophylaxis and, in some cases, even a lumbar drainage for the next 72 hours.

The situation is by far worse if a CSF leak goes unnoticed and no attempt is made to close the defect without delay. The consequences, in such case, are usually serious and much more difficult to manage. In conclusion, probably, all these factors, acting together, account for the fact that endoscopic sinus surgeons, not infrequently, have reservations about surgical approaches in the area of the naso-frontal recess.

Ironically, the time required to perform a Draf I procedure in this area of predilection to iatrogenic CSF rhinorrhea is usually longer than expected. The procedure requires a meticulous radiological assessment of the related region which involves that high quality multi-slice CT scans (MSCT) in coronal, axial and sagittal planes are obtained, so as to have the thinnest lamellas and bony walls of the paranasal sinuses clearly demonstrated and amenable to detail detection prior to inspecting the area with the scope and endoscopic instruments. Fig. 132 shows the postoperative coronal CT scan three months after a right-sided Draf I procedure.
Close-up view of the left middle meatus and the recessus ostiarum. – niches 3 and 4 (see Fig. 35), the region of the frontal sinus drainage; – niche 2, (see Fig. 32) i.e. the site of lacrimal, palatinal and maxillary sinus drainage.

The back of the curette is in contact with the posterior wall of niche 4, (see Fig. 35).

Access to the naso-frontal recess has been obtained. Caution! The most anterior frontal chamber is located far superiorly. It lies cranio-posterior to the tail of the superior turbinate indicated by – niche 2 (see Fig. 32).

The indicates the tail of the superior turbinate. – posterior portion of the upper nasal meatus and naso-frontal recess (see Fig. 118 which describes frontal sinus drainage in detail).

It must be emphasized that anatomical relationships between neighbouring structures in this region are of complex nature. That is why endoscopic surgical approaches to the frontal sinus have been extensively analyzed and described in the literature. The surgeon must pay particular attention to the anatomical variability of the vertical insertion of the uncinate process: it may be attached to the lamina papyracea, to the cribriform plate itself, or occasionally, to the anterior skull base. The most critical configuration is, of course, when the uncinate process attaches to the cribriform plate. It is absolutely clear that dissection training on an animal model will not solve all these dilemmas, since they are related to human medicine, and to solve them properly, a great deal of knowledge, experience and painstaking care is needed, involving that any therapeutic decision-making be determined on a case-to-case basis. Nonetheless, training these types of surgical procedures on the lamb specimen can help the surgeon-in-training to feel more comfortable and confident during maneuvering of instruments, also in terms of how and when to use them in a space that is very much similar to that in man. The only difference is that, with a lamb’s head, there is no danger at all. Figs. 133–139 show how to perform a Draf I procedure on a lamb specimen.
Draf II

Compared to the type-I procedure, Draf type II is more complicated, but still unilateral. In human medicine, it is employed in patients suffering from severe, chronically recurring, unilateral pathology of the frontal sinus, refractory to previous treatment, both conservative and surgical therapeutic modalities.

The Draf I procedure refers to the area that stretches from the lamina papyracea to the lateral surface of the middle turbinate, i.e. it still remains within the boundaries of the ostiomeatal complex. Most part of the middle turbinate must be preserved. However, Draf II involves the removal of its most anterior portion. In human medicine, the initial step of the procedure involves clear identification of the first (most anterior) olfactory fiber, which is considerably facilitated if the surgeon removes a strip from the anterior margin of the middle turbinate. Following exposure of this anatomical detail, the surgeon should be able to exactly determine the extent of retrograde removal of the frontal sinus floor in order to avoid close proximity to the cribriform plate. The space that is usually left behind following a Draf II procedure extends from the lamina papyracea to the nasal septum, owing to the fact that the anterior portion of the middle turbinate has been resected. Fig. 140 is a CT-radiographic image taken after completion of a Draf II procedure.

The Draf II procedure on a lamb specimen is described in Figs. 141–145.

View of the left nasal cavity in the lamb specimen showing the upper half of the still pneumatized posterior end of the superior turbinate. The instrument tip is advanced in posterosuperior direction as far as the anticipated site of the anterior wall of the most anterior frontal sinus cell. Once the overlying tissue has been removed, access to the frontal sinus is obtained. This is another type of approach to the frontal sinus, more directly than the one previously described, as it is based on anatomical landmarks relevant for proper identification of the frontal sinus: the posterior end and the tail of the superior turbinate.

The most anterior frontal sinus cell comes into view. The anterior wall seems to be fragmented, very thin, almost transparent. The anterior half of the middle turbinate has been removed.

A wide opening has been created in the anterior wall of the most anterior frontal sinus cell (SEM-transparent circle). In the next step, this cell will be connected to the supraorbital cell ( ).

Upon completion of the Draf II procedure, a passageway has been established joining the two cells.
Draf III

Unlike the type-I and -II procedures, the Draf III procedure always involves bilateral resection of the frontal sinus floor. There is no unilateral Draf III procedure. This type of surgery is performed for the purpose of radical removal of frontal sinus pathology, as in Draf II, but on both sides. It also involves that most part of the superior half of the nasal septum be removed so that both openings in the infero-anterior wall of the frontal sinus in a human patient can be joined (e.g., with a diamond burr) to form one large opening. Fig. 146 is a CT-radiographic image taken after completion of a Draf III procedure.

The postoperative CT scan confirms bilateral absence of nasal septum, frontal sinus floor (yellow), and middle turbinate, demonstrating that one large cavity has been created.

Draf II procedures have been performed bilaterally. We use the curette to make an incision in the nasal septum. Fortunately, nasal septum in lamb is made up of cartilage only.

The left frontal sinus has been opened completely (pink). The yellow (?), refers to the region that will be surgically treated in the same way.

View of the right nasal cavity. The incised parts of the nasal septum have been removed with a Blakesley punch forceps directly or from the other nasal cavity, as shown above.
After performing Draf II on both sides, the nasal septum must be removed in its most superior aspects, which are in close proximity to the frontal sinus floor. Once this has been accomplished, the septum between the left and right most anterior frontal sinus cells can be seen. Next, the septum is removed as well.

The Draf III procedure on a lamb specimen is shown in Figs. 147–157.

Another alternative option is to use a back-biting forceps, as shown above.

![Image 150](150.png) A residual portion of the nasal septum along with a few pieces of prefrontal tissue are left to be removed to provide unobstructed vision of the frontal sinus cells.

![Image 151](151.png) The surgical maneuver shown in Fig. 150 may also be accomplished by use of a circular punch.

![Image 152](152.png) Another alternative option is to use a back-biting forceps, as shown above.

![Image 153](153.png) shows the opening in the tail of the right superior turbinate. The frontal sinus itself is located in superoposterior position ( ).
The left most anterior frontal sinus cell is clearly visible (right ). The contours of the right cell have only just appeared. Next, the instrument will be used at this site to create a second wide opening here. Subsequently, a medio-sagittal bony wall will stay behind in the area labelled by the yellow . This wall divides the two most anterior frontal sinus cells and should be removed until both cells have been joined to form one large opening.

The pointers refer to the right and left most anterior frontal sinus cells. A diamond burr is used to drill out the bony wall located in between.

shows the right supraorbital frontal sinus cell. The bony wall overlying the two anterior frontal sinus cells has been removed almost completely by use of a diamond burr.

The bony wall has been successfully drilled away. The anterior skull base is now clearly visible ( ). The last step that remains to be taken in order to finish the Draf III procedure is to remove a small piece of bone that obstructs vision of the left supraorbital frontal sinus cell.
Endonasal Endoscopic Dacryocystorhinostomy

Unfortunately, this kind of procedure cannot be trained on a lamb specimen, simply because there is no lacrimal sac at all. Evidence for this anatomical finding has been provided by means of dacryocystography which clearly showed that both superior and inferior canaliculi drain into the nasolacrimal duct. The superior canaliculus drains at an angle of approximately 170°, whereas the inferior one joins the duct at an almost perpendicular angle. Both angles are opened towards the snout (Fig. 158).

Based on dacryocystography images, it seems that the nasolacrimal duct ends somewhere in the middle portion of the inferior turbinate labyrinth (Figs. 159, 160 and 161).

However, anatomical dissections showed that the nasolacrimal duct is much longer, i.e. that it reaches as far as the most anterior aspects of the nasal cavity (Fig. 160). This was clearly confirmed by injection of methylene-blue dye (Figs. 161, 162 and 163).

The nasolacrimal duct in lamb is quite a long structure. It measures approximately 76 millimeters, and runs in an almost horizontal direction.

It seems that the distal part and the opening of the nasolacrimal duct is located below the anterior portion of the inferior turbinate, just as in human anatomy (Fig. 164).

![Image of a Blakesley punch forceps supporting the nicely exposed nasolacrimal duct from below.](image1)

A Blakesley punch forceps is used to support the nicely exposed nasolacrimal duct from below. It seems that the duct ends like a fan.

![Image showing the anticipated end of the nasolacrimal duct and the level of the anterior pole of the inferior turbinate.](image2)

![Images showing methylene blue dye spreading towards the anterior pole of the inferior turbinate.](image3)

At first sight, it seems that methylene blue dye, similarly to the contrast agent used during dacryocystography, does not descend deeper than half of the anticipated length of the nasolacrimal duct. After a short time, the dye spreads towards the anterior pole of the inferior turbinate. Methylene blue dye finally appears beneath the anterior pole of the inferior turbinate.
Endoscopic Surgical Anatomy of the Lamb’s Head

View of the left lamb’s eye from posterior to anterior. The eyeball is medialized with the instrument handle, allowing the entrance of the nasolacrimal duct and the infraorbital nerve to be clearly presented. View of the internal part of the anterior orbital wall. The shows the entrance of the bony canal, the bed of the nasolacrimal duct. The opening below is related to the infraorbital nerve. The indicates the concavity found in anterolateral aspects of the orbit. The corresponding convexity can be visualized endoscopically, as shown on Fig. 167. Endoscopic endonasal view of the anterior orbital wall. The convexity to which the previous figure refers, is indicated by This means that the most lateral part of the anterior orbital wall is endoscopically accessible. The shows the contours of the bony canal of the nasolacrimal duct. The indicates a deep, orbital recess of the maxillary sinus (recessus orbitalis sinus maxillaris Tido). Endonasal endoscopic view of the previously evacuated left orbit. The orbital cavity is illuminated exclusively by the diffuse light from the ceiling lamp in the operating room. As shown above, the transillumination effect allows to easily evaluate the thickness of the orbital wall. Note, that it is quite thin in close proximity to the ethmoid sinus labyrinth, while it seems to be rather thick medially from two bony canals: nasolacrimal and infraorbital. The indicates the entrance of the nasolacrimal canal. The bone overlying the canal seems to be thick as well, and therefore can be drilled away by use of a diamond burr, as shown in Fig. 170. The white ellipse encompasses an area of increased bone thickness where the maxillary and ethmoid sinuses merge, creating the crest (crista ethmoidalis sinus maxillaris Zite; see Fig. 70).
Even though we repeatedly attempted to access and localize several sites of particular surgical interest belonging to the lacrimal system (in lamb specimen), our efforts proved to be in vain, most probably because the junction between the lacrimal canalicula and the nasolacrimal duct itself is located in a far lateral position (Figs. 165 and 166).

Accordingly, endonasal endoscopic exposure of anatomical fine structures of the lacrimal system in the lamb specimen requires the use of a drill, because the surrounding bony structures are quite thick. The bone in this particular area has to be drilled away until amenable to further endoscope-assisted dissection (Figs. 169, 170, 171 and 172).

The floor of the excavated niche has a bluish appearance which undoubtedly suggests that the remaining bone is thin enough. The shows the previously evacuated, bony nasolacrimal canal. The indicates a part of the orbital wall at the floor of the deep ethmoid cell.

The tip of the curette is clearly visible. It has been inserted through the orbital entrance to the nasolacrimal canal.
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451502 B  Same, size 2, width 4 mm

452001 B  MACKAY-GRÜNWALD RHINOFORCE® II Nasal Forceps, through-cutting, tissue-sparing, straight, delicate, 8 x 3 mm, size 1, with cleaning connector, working length 13 cm
452002 B  Same, 11.5 x 3.5 mm, size 2

452501 B  MACKAY-GRÜNWAld RHINOFORCE® II Nasal Forceps, through-cutting, tissue-sparing, 45º upturned, delicate, 8 x 3 mm, size 1, with cleaning connector, working length 13 cm
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459010 Same, right side backward cutting

459011 Same, left side backward cutting

459016 STAMMBERGER RHINOFORCE® Antrum Punch, backward cutting, sheath 360° rotatable, with fixing screw, take apart, working length 10 cm, for use with cleaning adaptor 459015 LL

459015 LL Cleaning Adaptor
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459031 Same, right side backward cutting

459032 Same, left side backward cutting

459036 STAMMBERGER RHINOFORCE® Antrum Punch, small pediatric size, slender, backward cutting, sheath 360° rotatable, with fixing screw, take apart, working length 10 cm, for use with cleaning adaptor 459015 LL

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  STAMMBERGER Punch, tip egg-shaped, circular cutting, 65° upturned, for frontal sinus / recess, with cleaning connector, working length 12 cm, cupped jaws diameter 3 mm

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KUHN-BOLGER Frontal Sinus Curette, small, oblong, 55° curved, forward cutting, length 19 cm
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UNIDRIVE® S III ENT SCB/UNIDRIVE® S III ECO
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![UNIDRIVE® S III ENT SCB](image1)
![UNIDRIVE® S III ECO](image2)

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- SCB model with connections to the KARL STORZ Communication Bus (KARL STORZ-SCB)
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<td>Set values of the last session</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Optimized user control</td>
<td>●</td>
<td>-</td>
</tr>
<tr>
<td>Choice of user languages</td>
<td>●</td>
<td>-</td>
</tr>
<tr>
<td>Operating elements</td>
<td>●</td>
<td>-</td>
</tr>
<tr>
<td>One unit – multifunctional</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Two motor outputs</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Soft start function</td>
<td>●</td>
<td>-</td>
</tr>
<tr>
<td>Formulated error messages</td>
<td>●</td>
<td>-</td>
</tr>
<tr>
<td>Integrated irrigation and coolant pump</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Easy program selection</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Continuously variable revolution range</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Maximum number of revolutions and motor torque</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Maximum number of revolutions can be preset</td>
<td>●</td>
<td>-</td>
</tr>
<tr>
<td>SCB model with connections to the KARL STORZ Communication Bus (KARL STORZ-SCB)</td>
<td>●</td>
<td>-</td>
</tr>
<tr>
<td>Irrigator rod included</td>
<td>●</td>
<td>-</td>
</tr>
</tbody>
</table>
Motor Systems
Specifications

System specifications

<table>
<thead>
<tr>
<th>Mode</th>
<th>Order No.</th>
<th>rpm</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Shaver mode</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operation mode:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. rev. (rpm):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>oscillating in conjunction with Handpiece: DrillCut-X® II Shaver Handpiece</td>
<td>40712050</td>
<td>10,000*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Sinus burr mode</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operation mode:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. rev. (rpm):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>rotating in conjunction with Handpiece: DrillCut-X® II Shaver Handpiece</td>
<td>40712050</td>
<td>12,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>High-speed drilling mode</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operation mode:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. rev. (rpm):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>counterclockwise or clockwise in conjunction with: High-Speed Micro Motor</td>
<td>20712033</td>
<td>60,000/100,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Drilling mode</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operation mode:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. rev. (rpm):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>counterclockwise or clockwise in conjunction with: micro motor and connecting cable</td>
<td>[20711033]</td>
<td>40,000/80,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Micro saw mode</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. rev. (rpm):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>in conjunction with: micro motor and connecting cable</td>
<td>[20711033]</td>
<td>15,000/20,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Intranasal drill mode</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. rev. (rpm):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>in conjunction with: micro motor and connecting cable</td>
<td>[20711033]</td>
<td>60,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Dermatome mode</strong></td>
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<td></td>
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<tr>
<td>Max. rev. (rpm):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>in conjunction with: micro motor and connecting cable</td>
<td>[20711033]</td>
<td>8,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Power supply:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>100 – 240 VAC, 50/60 Hz</td>
<td></td>
</tr>
<tr>
<td><strong>Dimensions:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(w x h x d)</td>
<td>300 x 165 x 265 mm</td>
<td></td>
</tr>
<tr>
<td><strong>Two outputs for parallel connection of two motors</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Integrated irrigation pump:</strong></td>
<td>adjustable in 9 steps</td>
<td></td>
</tr>
</tbody>
</table>

* Approx. 4,000 rpm is recommended as this is the most efficient suction/performance ratio.

<table>
<thead>
<tr>
<th></th>
<th>UNIDRIVE® S III ENT SCB</th>
<th>UNIDRIVE® S III ECO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Touch Screen:</td>
<td>6.4&quot; / 300 cd/m²</td>
<td></td>
</tr>
<tr>
<td>Weight:</td>
<td>5.2 kg</td>
<td>4.7 kg</td>
</tr>
<tr>
<td>Certified to:</td>
<td>IEC 601-1 CE acc. to MDD</td>
<td>IEC 60601-1</td>
</tr>
<tr>
<td>Available languages:</td>
<td>English, French, German, Spanish, Italian, Portuguese, Greek, Turkish, Polish, Russian</td>
<td>numerical codes</td>
</tr>
</tbody>
</table>
Motor Systems

Special features of high-performance EC micro motor II
and of the high-speed micro motor

Special features of high-performance EC micro motor II:
- Self-cooling, brushless high-performance EC micro motor
- Smallest possible dimensions
- Autoclavable
- Can be processed in a cleaning machine
- Detachable connecting cable
- INTRA coupling enables a wide variety of applications
- Maximum torque 4 Ncm
- Number of revolutions can be continuously adjusted up to 40,000 rpm
- Provided a suitable handle is used, the number of revolutions can be continuously adjusted up to 80,000 rpm

**20711033**

**20711033** High-Performance EC Micro Motor II, for use with UNIDRIVE® II/UNIDRIVE® ENT/OMFS/NEURO/ECO and Connecting Cable **20 7110 73**, or for use with UNIDRIVE® S III ENT/ECO/NEURO and Connecting Cable **20 7111 73**

**20711173** Connecting Cable, to connect High-Performance EC Micro Motor **20711033** to UNIDRIVE® S III ENT/ECO/NEURO

Special Features of the high-speed micro motor:
- Brushless high-speed micro motor
- Smallest possible dimensions
- Autoclavable
- Can be processed in a cleaning machine
- Maximum torque 6 Ncm
- Maximum torque 6 Ncm
- Number of revolutions can be continuously adjusted up to 60,000 rpm
- Provided a suitable handle is used, the number of revolutions can be continuously adjusted up to 100,000 rpm

**20712033**

**20712033** High-Speed Micro-Motor, max. speed 60,000 rpm, including connecting cable, for use with UNIDRIVE® S III ENT/NEURO
UNIDRIVE® S III ENT SCB
UNIDRIVE® S III ECO

Recommended System Configuration

UNIDRIVE® S III ENT SCB

40 7016 20-1

UNIDRIVE® S III ENT SCB, motor control unit with color display, touch screen, two motor outputs, integrated irrigation pump and SCB module, power supply 100 – 240 VAC, 50/60 Hz including:

- Mains Cord
- Irrigator Rod
- Two-Pedal Footswitch, two-stage, with proportional function
- Silicone Tubing Set, for irrigation, sterilizable
- Clip Set, for use with silicone tubing set
- SCB Connecting Cable, length 100 cm
- Single Use Tubing Set*, sterile, package of 3

UNIDRIVE® S III ECO

40 7014 20

UNIDRIVE® S III ECO, motor control unit with two motor outputs and integrated irrigation pump, power supply 100 – 240 VAC, 50/60 Hz including:

- Mains Cord
- Two-Pedal Footswitch, two-stage, with proportional function
- Silicone Tubing Set, for irrigation, sterilizable
- Clip Set, for use with silicone tubing set

Specifications:

<table>
<thead>
<tr>
<th>Feature</th>
<th>UNIDRIVE® S III ENT SCB</th>
<th>Dimensions w x h x d</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Touch Screen</td>
<td>6.4&quot;/300 cd/m²</td>
<td>300 x 165 x 265 mm</td>
<td>5.2 kg</td>
</tr>
<tr>
<td>Flow</td>
<td>9 steps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power supply</td>
<td>100-240 VAC, 50/60 Hz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Certificated to</td>
<td>EC 601-1, CE acc. to MDD</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* mtp medical technical promotion gmbh,
  Take-Off GewerbePark 46, D-78579 Neuhausen ob Eck, Germany
UNIDRIVE® S III ENT SCB
NEW
UNIDRIVE® S III ECO
System Components

UNIT SIDE
PATIENT SIDE

DrillCut-X® II N Shaver Handpiece, for use with UNIDRIVE® S III ECO/ENT/NEURO

Shaver Blade

Shaver Blade, curved

Sinus Burr

High-Speed Micro-Motor

High-Spe C Micro Motor II

DrillCut-X® II Shaver Handpiece, for use with UNIDRIVE® S III ECO/ENT/NEURO

High-Speed Handpiece

INTRA Drill Handpiece

Silicone Tubing Set

Two-Pedal Footswitch

Intranasal Drill

2071033
20711033
20711173
40712050
40712055

252660 – 252692
252575 – 252590

41201 KN
41302 KN
41305 DN

20016630
20711640

662000

20712033
20711033
20711173

20712050
20712055

662000

41201 KN
41302 KN
41305 DN

HIGH-SPEED HANDPIECE

INTRA DRILL HANDPIECE

HIGH-SPEED MICRO-MOTOR

HIGH-SPEED MICRO-MOTOR II

HIGH-SPEED HANDPIECE

INTRANASAL DRILL

SHAVER BLADE

SHAVER BLADE, CURVED

SINUS BURR

Two-Pedal Footswitch

Silicone Tubing Set

UNIT SIDE
PATIENT SIDE

High-Speed Micro-Motor

High-Spe C Micro Motor II

DrillCut-X® II Shaver Handpiece, for use with UNIDRIVE® S III ECO/ENT/NEURO

High-Speed Handpiece

INTRA Drill Handpiece

Silicone Tubing Set

Two-Pedal Footswitch

Intranasal Drill

Shaver Blade

Shaver Blade, curved

Sinus Burr

20712033
20711033
20711173
40712050
40712055

252660 – 252692
252575 – 252590

41201 KN
41302 KN
41305 DN

662000

UNIDRIVE® S III ENT SCB
NEW
UNIDRIVE® S III ECO
System Components
## Optional Accessories

for UNIDRIVE® S III ENT SCB and UNIDRIVE® S III ECO

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>280053</td>
<td><strong>Universal Spray</strong>, 6x 500 ml bottles – HAZARDOUS GOODS – UN 1950 including:</td>
</tr>
<tr>
<td></td>
<td><strong>Spray Nozzle</strong></td>
</tr>
<tr>
<td>280053 C</td>
<td><strong>Spray Nozzle</strong>, for the reprocessing of INTRA burr handpieces, for use with Universal Spray 280053 B</td>
</tr>
<tr>
<td>031131-10*</td>
<td><strong>Tubing Set</strong>, for irrigation, for single use, sterile, package of 10</td>
</tr>
</tbody>
</table>

* mtp medical technical promotion gmbh, Take-Off GewerbePark 46, D-78579 Neuhausen ob Eck, Germany
DrillCut-X® Shaver Handpieces

Special Features

**Special Features:**

- Max. 10,000 rpm for shaver blades, max. 12,000 rpm for sinus shaver
- Straight suction channel
- Integrated irrigation channel
- Powerful motor, also suitable for harder materials
- Absolutely silent running, no vibration
- Completely immersible and machine-washable
- LOCK allows fixation of shaver blades and sinus shavers
- Extremely lightweight design
- Optional, ergonomic handle, detachable
- Can be adapted to navigation tracker

<table>
<thead>
<tr>
<th>Special Feature</th>
<th>DrillCut-X® II</th>
<th>DrillCut-X® II N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. 10,000 rpm for shaver blades, max. 12,000 rpm for sinus shaver</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Straight suction channel</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Integrated irrigation channel</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Powerful motor, also suitable for harder materials</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Absolutely silent running, no vibration</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Completely immersible and machine-washable</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>LOCK allows fixation of shaver blades and sinus shavers</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Extremely lightweight design</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Optional, ergonomic handle, detachable</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Can be adapted to navigation tracker</td>
<td>–</td>
<td>●</td>
</tr>
</tbody>
</table>

**DrillCut-X® II Shaver Handpiece**

40 7120 50

For use with UNIDRIVE® S III ECO/ENT/NEURO/OMFS

**DrillCut-X® II N Shaver Handpiece**

40 7120 55

For use with UNIDRIVE® S III ECO/ENT/NEURO/OMFS, optional adaptability to Shaver Tracker 40 8001 22.
**DrillCut-X® II Shaver Handpiece**

**Special Features:**
- Powerful motor
- Absolutely silent running
- Enhanced ergonomics
- Lightweight design
- Oscillation mode for shaver blades, max. 10,000 rpm
- Rotation mode for sinus shavers, max. 12,000 rpm
- Straight suction channel and integrated irrigation

- The versatile DrillCut-X® II Shaver Handpiece can be adapted to individual needs of the user
- Easy hygienic processing, suitable for use in washer and autoclavable at 134° C
- Quick coupling mechanism facilitates more rapid exchange of work inserts
- Proven DrillCut-X® blade portfolios can be used

---

**40 7120 50**

DrillCut-X® II Shaver Handpiece, for use with UNIDRIVE® S III ECO/ENT/NEURO/OMFS

---

**40 7120 90**

Handle, adjustable, for use with DrillCut-X® II 40 7120 50 and DrillCut-X® II N 40 7120 55

---

**Optional Accessory:**

**41250 RA**

Cleaning Adaptor, LUER-Lock, for cleaning DrillCut-X® shaver handpieces
DrillCut-X® II Shaver N Handpiece

**Special Features:**
- Powerful motor
- Absolutely silent running
- Enhanced ergonomics
- Lightweight design
- Oscillation mode for shaver blades, max. 10,000 rpm
- Rotation mode for sinus shavers, max. 12,000 rpm
- Straight suction channel and integrated irrigation
- The versatile DrillCut-X® II Shaver N Shaver Handpiece can be adapted to the individual needs of the user
- Easy hygienic processing, suitable for use in washer and autoclavable at 134° C
- Quick coupling mechanism facilitates more rapid exchange of working inserts
- Proven DrillCut-X® blade portfolios can be used
- Optional adaptability to Shaver Tracker 40 8001 22
- Allows shaver navigation when used with NPU 40 8000 01

**40 7120 55**  
DrillCut-X® II N Shaver Handpiece, optional adaptability to Shaver Tracker 40 8001 22, for use with UNIDRIVE® S III ECO/ENT/NEURO/OMFS

**40 7120 90**  
Handle, adjustable, for use with DrillCut-X® II 40 7120 50 and DrillCut-X® II N 40 7120 55

**Optional Accessory:**

**41250 RA**  
Cleaning Adaptor, Luer-Lock, for cleaning DrillCut-X® shaver handpieces
Handle for DrillCut-X® II Shaver Handpiece

for use with DrillCut-X® II 40712050 and DrillCut-X® II N 40712055

Special Features:
- Ergonomic design
- Ultralight construction
- Easy handle control allows individual adjustment
- The adjustable handle can be mounted to DrillCut-X® II or -X II N Shaver Handpiece
- Easy fixation via rotary lock
- Sterilizable

40712090

40712090 Handle, adjustable, for use with DrillCut-X® II 40712050 and DrillCut-X® II N 40712055
Shaver Blades, straight
for Nasal Sinuses and Skull Base Surgery

For use with DrillCut-X® II and DrillCut-X® II N

![Image of Shaver Blade 41201 GN]

Shaver Blades, straight, sterilizable

<table>
<thead>
<tr>
<th>Detail</th>
<th>for use with</th>
<th>Shaver Blade</th>
</tr>
</thead>
<tbody>
<tr>
<td>41201 KN</td>
<td>40 71 20 50 DrillCut-X® II Handpiece</td>
<td>serrated cutting edge, diameter 4 mm, color code: blue-red</td>
</tr>
<tr>
<td>41201 KK</td>
<td>40 71 20 55 DrillCut-X® II N Handpiece</td>
<td>double serrated cutting edge, diameter 4 mm, color code: blue-yellow</td>
</tr>
<tr>
<td>41201 GN</td>
<td></td>
<td>concave cutting edge, oval cutting window, diameter 4 mm, color code: blue-green</td>
</tr>
<tr>
<td>41201 LN</td>
<td></td>
<td>concave cutting edge, oblique cutting window, diameter 4 mm, color code: blue-black</td>
</tr>
<tr>
<td>41201 SN</td>
<td></td>
<td>straight cutting edge, diameter 4 mm, color code: blue-blue</td>
</tr>
<tr>
<td>41201 KSA</td>
<td></td>
<td>serrated cutting edge, diameter 3 mm, color code: blue-red</td>
</tr>
<tr>
<td>41201 KKSA</td>
<td></td>
<td>double serrated cutting edge, diameter 3 mm, color code: blue-yellow</td>
</tr>
<tr>
<td>41201 KKS B</td>
<td></td>
<td>double serrated cutting edge, diameter 2 mm, color code: blue-yellow</td>
</tr>
<tr>
<td>41201 LSA</td>
<td></td>
<td>concave cutting edge, oblique cutting window, diameter 3 mm, color code: blue-black</td>
</tr>
</tbody>
</table>

Optional Accessory:

41200 RA Cleaning Adaptor, Luer-Lock, for cleaning the inner and outer blades of reusable Shaver Blades 412xx
Shaver Blades, curved
for Nasal Sinuses and Skull Base Surgery

For use with DrillCut-X® II and DrillCut-X® II N

Shaver Blades, curved 35°/40°, sterilizable

<table>
<thead>
<tr>
<th>Detail</th>
<th>for use with</th>
<th>Shaver Blade</th>
</tr>
</thead>
<tbody>
<tr>
<td>41202 KN</td>
<td>40 7120 50 DrillCut-X® II Handpiece</td>
<td>curved 35°, cutting edge serrated backwards, diameter 4 mm, color code: blue-red</td>
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<tr>
<td>41204 KKF</td>
<td>40 7120 55 DrillCut-X® II N Handpiece</td>
<td>curved 40°, cutting edge serrated forwards, double serrated, diameter 4 mm, color code: blue-yellow</td>
</tr>
<tr>
<td>41204 KKB</td>
<td></td>
<td>curved 40°, cutting edge serrated backwards, double serrated, diameter 4 mm, color code: blue-yellow</td>
</tr>
<tr>
<td>41204 KKFA</td>
<td></td>
<td>curved 40°, cutting edge serrated forwards, double serrated, diameter 3 mm, color code: blue-yellow</td>
</tr>
<tr>
<td>41204 KKBA</td>
<td></td>
<td>curved 40°, cutting edge serrated backwards, double serrated, diameter 3 mm, color code: blue-yellow</td>
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</tbody>
</table>

Optional Accessory:

41200 RA Cleaning Adaptor, Luer-Lock, for cleaning the inner and outer blades of reusable Shaver Blades 412xx
Shaver Blades, curved
for Nasal Sinuses and Skull Base Surgery

For use with DrillCut-X® II and DrillCut-X® II N

Shaver Blades, curved 65°, sterilizable

<table>
<thead>
<tr>
<th>Detail</th>
<th>for use with</th>
<th>Shaver Blade</th>
</tr>
</thead>
<tbody>
<tr>
<td>41203 KNF</td>
<td>40 7120 50 DrillCut-X® II Handpiece 40 7120 55 DrillCut-X® II N Handpiece</td>
<td>curved 65°, cutting edge serrated forwards, diameter 4 mm, color code: blue-red</td>
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<tr>
<td>41203 KNB</td>
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<td>curved 65°, cutting edge serrated backwards, diameter 4 mm, color code: blue-red</td>
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<tr>
<td>41203 KKF</td>
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<td>curved 65°, cutting edge serrated forwards, double serrated, diameter 4 mm, color code: blue-yellow</td>
</tr>
<tr>
<td>41203 KKB</td>
<td></td>
<td>curved 65°, cutting edge serrated backwards, double serrated, diameter 4 mm, color code: blue-yellow</td>
</tr>
<tr>
<td>41203 KKFA</td>
<td></td>
<td>curved 65°, cutting edge serrated forwards, double serrated, diameter 3 mm, color code: blue-yellow</td>
</tr>
<tr>
<td>41203 KKBA</td>
<td></td>
<td>curved 65°, cutting edge serrated backwards, double serrated, diameter 3 mm, color code: blue-yellow</td>
</tr>
<tr>
<td>41203 GNF</td>
<td></td>
<td>curved 65°, concave cutting edge, oval cutting window, forward opening, diameter 4 mm, color code: blue-green</td>
</tr>
<tr>
<td>41203 GNB</td>
<td></td>
<td>curved 65°, concave cutting edge, oval cutting window, backward opening, diameter 4 mm, color code: blue-green</td>
</tr>
</tbody>
</table>

Optional Accessory:

41200 RA Cleaning Adaptor, Luer-Lock, for cleaning the inner and outer blades of reusable Shaver Blades 412xx
Shaver Blades, straight
for Nasal Sinuses and Skull Base Surgery

For use with DrillCut-X® II and DrillCut-X® II N

![Shaver Blades](image)

Shaver Blades, straight, **for single use**, sterile, package of 5

<table>
<thead>
<tr>
<th>Detail</th>
<th>for use with</th>
<th>Shaver Blade</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DrillCut-X® II Handpiece</td>
<td>length 12 cm</td>
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<tr>
<td>41301 KN</td>
<td>40 7120 50</td>
<td>serrated cutting edge, diameter 4 mm, color code: blue-red</td>
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<tr>
<td>41301 KK</td>
<td>40 7120 55</td>
<td>double serrated cutting edge, diameter 4 mm, color code: blue-yellow</td>
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<tr>
<td>41301 GN</td>
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<td>concave cutting edge, oval cutting window, diameter 4 mm, color code: blue-green</td>
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<tr>
<td>41301 LN</td>
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<td>concave cutting edge, oblique cutting window, diameter 4 mm, color code: blue-black</td>
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<tr>
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<td>straight cutting edge, diameter 4 mm, color code: blue-blue</td>
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<td>41301 KSA</td>
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<td>serrated cutting edge, diameter 3 mm, color code: blue-red</td>
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<tr>
<td>41301 KKSA</td>
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<td>41301 LSA</td>
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<td>concave cutting edge, oblique cutting window, diameter 3 mm, color code: blue-black</td>
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</table>
**Shaver Blades, curved**  
for Nasal Sinuses and Skull Base Surgery

For use with DrillCut-X® II and DrillCut-X® II N

Shaver Blades, curved 35°/40°, **for single use**, sterile, package of 5

<table>
<thead>
<tr>
<th>Detail</th>
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</thead>
<tbody>
<tr>
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<td>length 12 cm</td>
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<tr>
<td>41302 KN</td>
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<td></td>
<td>40712055 DrillCut-X® II N Handpiece</td>
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<tr>
<td>41304 KKF</td>
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<td>curved 40°, cutting edge serrated forwards, double serrated, diameter 4 mm, color code: blue-yellow</td>
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<td>41304 KKB</td>
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<td>curved 40°, cutting edge serrated backwards, double serrated, diameter 4 mm, color code: blue-yellow</td>
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<tr>
<td>41304 KKFA</td>
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<tr>
<td>41304 KKBA</td>
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### Shaver Blades, curved
for Nasal Sinuses and Skull Base Surgery

For use with DrillCut-X® II and DrillCut-X® II N

![Shaver Blade](image)

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<tr>
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<tbody>
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Sinus Burrs, curved
for Nasal Sinuses and Skull Base Surgery

For use with DrillCut-X® II and DrillCut-X® II N

Sinus Burrs, curved 70°/55°/40°/15°, for single use, sterile, package of 5

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<td>curved 55°, cylindric, drill diameter 3.6 mm, shaft diameter 4 mm, color code: red-blue</td>
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<td>curved 15°, bud drill, drill diameter 4 mm, shaft diameter 4 mm, color code: red-black</td>
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<td>41305 DN</td>
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<tr>
<td>41305 D</td>
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<td>curved 15°, diamond head, drill diameter 5 mm, shaft diameter 4 mm, color code: red-yellow</td>
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<td>41305 DW</td>
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Accessories for Shaver

39550 A **Wire Tray**, provides safe storage of accessories for KARL STORZ paranasal sinus shaver systems during cleaning and sterilization

**For storage of:**
- Up to 7 shaver attachments
- Connecting cable

*Please note:* The instruments displayed are not included in the sterilizing and storage tray.
INTRA Drill Handpiece
for Surgery in Ethmoid and Skull Base Area

Special Features:
- Tool-free closing and opening of the drill
- Right/left rotation
- Max. rotating speed up to 40,000 rpm / 80,000 U/min
- Detachable irrigation channels

INTRA Drill Handpiece, angled, length 15 cm, transmission 1:1 (40,000 rpm), for use with KARL STORZ high-performance EC micro motor II and burrs

INTRA Drill Handpiece, straight, length 13 cm, transmission 1:1 (40,000 rpm), for use with KARL STORZ high-performance EC micro motor II and burrs

<table>
<thead>
<tr>
<th>Detail</th>
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649600  Standard Straight Shaft Burr, stainless, size 014 – 070, length 9.5 cm, set of 11
649700  Diamond Straight Shaft Burr, stainless, size 014 – 070, length 9.5 cm, set of 11
649700 G Rapid Diamond Straight Shaft Burr, stainless, with coarse diamond coating for precise drilling and abrasion without hand pressure and generating minimal heat, size 023 – 070, length 9.5 cm, set of 9, color code: gold
280033  Rack, for 36 straight shaft burrs with a length of 9.5 cm, foldable, sterilizable, size 22 x 14 x 2 cm
INTRA Drill Handpiece
for Surgery in Ethmoid and Skull Base Area

Special Features:
- Tool-free closing and opening of the drill
- Right/left rotation
- Max. rotating speed up to 40,000 rpm/80,000 U/min
- Detachable irrigation channels
- Light construction
- Operates with little vibrations
- Low maintenance
- Can be processed in a cleaning machine
- Safe grip

INTRA Drill Handpiece, angled, length 18 cm, transmission 1:2 (80,000 rpm), for use with KARL STORZ high-performance EC micro motor II and burrs

Same, transmission 1:2 (80,000 rpm)

INTRA Drill Handpiece, straight, length 17 cm, transmission 1:1 (40,000 rpm), for use with KARL STORZ high-performance EC micro motor II and burrs

<table>
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649600 L Standard Straight Shaft Burr, stainless, size 014 – 070, length 12.5 cm, set of 11

649700 L Diamond Straight Shaft Burr, stainless, size 014 – 070, length 12.5 cm, set of 11

649700 GL Rapid Diamond Straight Shaft Burr, stainless, with coarse diamond coating for precise drilling and abrasion without hand pressure and generating minimal heat, sizes 023 – 070, length 12.5 cm, set of 9, color code: gold

280034 Rack, for 36 straight shaft burrs with a length of 12.5 cm, foldable, sterilizable, size 22 x 17 x 2 cm
Accessories for Burrs

280033  **Rack**, for 36 straight shaft burrs with a length of 9.5 cm, foldable, sterilizable, size 22 x 14 x 2 cm

280034  **Rack**, for 36 straight shaft burrs with a length of 12.5 cm, foldable, sterilizable, size 22 x 17 x 2 cm

NEW 280043  **Rack**, flat model, to hold 21 straight shaft burrs with a length of 7 cm (6 pcs) and 9.5 cm (15 pcs), folding model, sterilizable, size 17.5 x 11.5 x 1.2 cm

**Please note:** The burrs displayed are not included in the racks.
Accessories for Burrs

39552 A  **Wire Tray**, provides safe storage of accessories for KARL STORZ drilling/grinding systems during cleaning and sterilization, includes tray for small parts, for use with Rack 280030, rack *not* included

*for storage of:*
  - Up to 6 drill handpieces
  - Connecting cable
  - EC micro motor
  - Small parts

39552 B  **Wire Tray**, provides safe storage of accessories for KARL STORZ drilling/grinding systems during cleaning and sterilization, includes tray for small parts, for use with Rack 280030, rack *included*

*for storage of:*
  - Up to 6 drill handpieces
  - Connecting cable
  - EC micro motor
  - Up to 36 drill bits and burrs
  - Small parts

*Please note:* The instruments displayed are not included in the sterilizing and storage tray.
**UNIDRIVE® S III ENT SCB**

*New*

High-Speed Handpieces, angled, 100,000 rpm

For use with High-Speed Drills, shaft diameter 3.17 mm and with High-Speed Micro Motor 20 7120 33

---

**20 7120 33**

---

**252681**

*High-Speed Handpiece*, medium, angled, 100,000 rpm, for use with High-Speed Micro-Motor 20 7120 33

---

**252682**

*High-Speed Handpiece*, long, angled, 100,000 rpm, for use with High-Speed Micro-Motor 20 7120 33
UNIDRIVE® S III ENT SCB
High-Speed Handpieces, angled, 60,000 rpm

For use with High-Speed Drills, shaft diameter 2.35 mm
and with High-Speed Micro Motor 20 7120 33

252661  High-Speed Handpiece, short, angled, 60,000 rpm,
for use with High-Speed Micro-Motor 20 7120 33

252662  High-Speed Handpiece, medium, angled, 60,000 rpm,
for use with High-Speed Micro-Motor 20 7120 33

252663  High-Speed Handpiece, long, angled, 60,000 rpm,
for use with High-Speed Micro-Motor 20 7120 33
For use with High-Speed Drills, shaft diameter 2.35 mm and with High-Speed Micro Motor 20712033

UNIDRIVE® S III ENT SCB
High-Speed Handpieces, straight, 60,000 rpm

252691  High-Speed Handpiece, short, straight, 60,000 rpm, for use with High-Speed Micro-Motor 20712033

252692  High-Speed Handpiece, medium, straight, 60,000 rpm, for use with High-Speed Micro-Motor 20712033
UNIDRIVE® S III ENT SCB  
High-Speed Handpieces, malleable, slim, angled, 60,000 rpm

For use with High-Speed Drills, shaft diameter 1 mm  
and with High-Speed Micro Motor 20 7120 33

The handpieces have malleable shafts that can be bent up to 20° according to user requirements.

20 7120 33

108 mm

4.7 mm

252671

128 mm

4.7 mm

252672

252671  High-Speed Handpiece, extra long, malleable, slim, angled, 60,000 rpm, for use with High-Speed Micro-Motor 20 7120 33

252672  High-Speed Handpiece, super long, malleable, slim, angled, 60,000 rpm, for use with High-Speed Micro-Motor 20 7120 33
UNIDRIVE® S III ENT SCB<sup>NEW</sup>
High-Speed Standard Burrs, High-Speed Diamond Burrs

For use with High-Speed Handpieces, 100,000 rpm

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<th>Diameter in mm</th>
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UNIDRIVE® S III ENT SCB  
High-Speed Diamond Burrs, High-Speed Acorn, High-Speed Barrel Burrs, High-Speed Neuro Fluted Burrs

For use with High-Speed Handpieces, 100,000 rpm

<p>| High-Speed Coarse Diamond Burrs, 100,000 rpm, for single use, sterile, package of 5 |</p>
<table>
<thead>
<tr>
<th>Diameter in mm</th>
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<p>| High-Speed Acorn, 100,000 rpm, for single use, sterile, package of 5 |</p>
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<p>| High-Speed Barrel Burrs, 100,000 rpm, for single use, sterile, package of 5 |</p>
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<p>| High-Speed Neuro Fluted Burrs, 100,000 rpm, for single use, sterile, package of 5 |</p>
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**UNIDRIVE® S III ENT SCB**

*High-Speed Standard Burrs, High-Speed Diamond Burrs*

For use with High-Speed Handpieces, 60,000 rpm

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<td>–</td>
<td>–</td>
</tr>
<tr>
<td>1</td>
<td>330210 S</td>
<td>330210 M</td>
<td>–</td>
</tr>
<tr>
<td>1.5</td>
<td>330215 S</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>2</td>
<td>330220 S</td>
<td>330220 M</td>
<td>330220 L</td>
</tr>
<tr>
<td>3</td>
<td>330230 S</td>
<td>330230 M</td>
<td>330230 L</td>
</tr>
<tr>
<td>4</td>
<td>330240 S</td>
<td>330240 M</td>
<td>330240 L</td>
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<td>5</td>
<td>330250 S</td>
<td>330250 M</td>
<td>330250 L</td>
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<td>6</td>
<td>330260 S</td>
<td>330260 M</td>
<td>330260 L</td>
</tr>
<tr>
<td>7</td>
<td>330270 S</td>
<td>330270 M</td>
<td>330270 L</td>
</tr>
</tbody>
</table>
### UNIDRIVE® S III ENT SCB

**High-Speed Diamond Burrs, High-Speed Cylinder Burrs, LINDEMANN High-Speed Fluted Burrs**

For use with High-Speed Handpieces, 60,000 rpm

![Image of burrs]

<table>
<thead>
<tr>
<th>Diameter in mm</th>
<th>short</th>
<th>medium</th>
<th>long</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>330330 S</td>
<td>330330 M</td>
<td>330330 L</td>
</tr>
<tr>
<td>4</td>
<td>330340 S</td>
<td>330340 M</td>
<td>330340 L</td>
</tr>
<tr>
<td>5</td>
<td>330350 S</td>
<td>330350 M</td>
<td>330350 L</td>
</tr>
<tr>
<td>6</td>
<td>330360 S</td>
<td>330360 M</td>
<td>330360 L</td>
</tr>
<tr>
<td>7</td>
<td>330370 S</td>
<td>330370 M</td>
<td>330370 L</td>
</tr>
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</table>

### High-Speed Coarse Diamond Burrs, 60,000 rpm, for single use, sterile, package of 5

<table>
<thead>
<tr>
<th>Diameter in mm</th>
<th>short</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>330440 S</td>
</tr>
<tr>
<td>6</td>
<td>330460 S</td>
</tr>
</tbody>
</table>

### High-Speed Cylinder Burrs, 60,000 rpm, for single use, sterile, package of 5

<table>
<thead>
<tr>
<th>Diameter in mm</th>
<th>short</th>
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<tbody>
<tr>
<td>4</td>
<td>330511 S</td>
</tr>
<tr>
<td>2.3/26</td>
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### LINDEMANN High-Speed Fluted Burrs, 60,000 rpm, for single use, sterile, package of 5

<table>
<thead>
<tr>
<th>Size in mm (diameter x length)</th>
<th>short</th>
</tr>
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<tbody>
<tr>
<td>Diameter 2.1/11</td>
<td>330511 S</td>
</tr>
<tr>
<td>Diameter 2.3/26</td>
<td>330526 S</td>
</tr>
</tbody>
</table>
UNIDRIVE® S III ENT SCB

**High-Speed Diamond Burrs**

For use with High-Speed Handpieces, 60,000 rpm

<table>
<thead>
<tr>
<th>Diameter in mm</th>
<th>extra long</th>
<th>super long</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>320220 EL</td>
<td>320220 SL</td>
</tr>
<tr>
<td>3</td>
<td>320230 EL</td>
<td>320230 SL</td>
</tr>
<tr>
<td>4</td>
<td>320240 EL</td>
<td>320240 SL</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Diameter in mm</th>
<th>extra long</th>
<th>super long</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>320320 EL</td>
<td>320320 SL</td>
</tr>
<tr>
<td>3</td>
<td>320330 EL</td>
<td>320330 SL</td>
</tr>
<tr>
<td>4</td>
<td>320340 EL</td>
<td>320340 SL</td>
</tr>
</tbody>
</table>
Navigation Panel Unit (NPU)
Straightforward and efficient support for ENT surgery and skull base

Similar to car navigation technology, surgery also requires a tool that provides safe and secure orientation towards a destination by means of a patient roadmap, uncomplicated surgical routes and a clear indication of danger zones. The system should always enable the surgeon to determine the exact location of an instrument in a patient’s body. The KARL STORZ Navigation Panel Unit provides the surgeon with this ability.

Special Features:
- Mobile, space-saving system with intuitive handling
- Easy assembly and flexible use in the OR
- Durable, sturdy and autoclavable navigation instruments
- Reduced costs through autoclavable accessories and reduced duration of surgery
Navigation Panel Unit (NPU)
Straightforward and efficient support for ENT surgery and skull base

40 8000 01

Navigation Panel Unit NPU,
KARL STORZ SURGICAL COCKPIT® navigation system NPU,
including:
1x Navigation Panel
1x Optical Mouse
1x Navigation Camera
1x Electronic Box
1x Docking Adaptor
1x NPU Mobile Stand
1x Data Cable
1x Video Cable
1x Navigation Camera cable 250
1x Headband for Navigation, for single use
1x Patient Tracker II
1x Case Navigation
1x Navigation Probe
1x Mains Cord
Navigation Base Unit (NBU)
Space-saving integration in any operating room

The Navigation Base Unit NBU enables you to benefit from a seamlessly integrated high-performance navigation solution. The basic unit can easily be attached to a ceiling supply unit or integrated into an equipment cart. Mounted on a ceiling or an extension arm, the navigation camera allows an easy setup and optimal visualization of the surgical site combined with high flexibility. This results in a “zero footprint” navigation solution. Therefore the NBU is offered as a solution for the functional combination of all units in one place.
Navigation Base Unit (NBU)
Space-saving integration in any operating room

40 8100 01  Navigation Base Unit NBU, KARL STORZ
SURGICAL COCKPIT® Navigation System NBU,
including:
1x Navigation Base Unit
1x Optical Mouse
1x Navigation Camera
1x NBU Mobile Stand
1x Navigation Camera Cable 750
1x Headband for Navigation, for single use
1x Patient Tracker II
1x Transport Case Navigation
1x Navigation Probe
1x Mains Cord

Remark: Equipment cart and units are not delivered as a part of the NBU system
Probe, Patient Tracker and Headband
for Navigation Panel Unit (NPU)

40800110 Navigation Probe, with glass marker spheres incorporated, autoclavable, dimensions: 295 x 15 x 30 mm, for use with KARL STORZ SURGICAL COCKPIT® navigation systems

40800087 Patient Tracker II, with verification adaptor, 3 incorporated glass marker spheres and fixation screw, autoclavable, dimensions: 80 x 60 x 12 mm for use with KARL STORZ SURGICAL COCKPIT® navigation systems

40800083 Headband for Navigation, for single use, with plastic holder, for use with KARL STORZ SURGICAL COCKPIT® navigation systems

The autoclavable Probe 40800110 with glass spheres for position tracking is a versatile, basic instrument for navigation.

The autoclavable Patient Tracker 40800087 ensures position tracking and orientation of the patient.
Navigated Suction Tubes

angular, curved downwards, curved upwards

**FRAZIER Navigated Suction Tube**, angular, for right-handed use, with cut-off hole, 9 Fr., working length 9 cm, for use with KARL STORZ SURGICAL COCKPIT® Navigation Systems

**v. EICKEN Navigated Suction Tube**, curved upwards, for right-handed use, outer diameter 3 mm, length 16.5 cm, for use with KARL STORZ SURGICAL COCKPIT® Navigation Systems

**v. EICKEN Navigated Suction Tube**, curved downwards, for right-handed use, outer diameter 3 mm, length 16.5 cm, for use with KARL STORZ SURGICAL COCKPIT® Navigation Systems

**FRAZIER Navigated Suction Tube**, angular, for left-handed use, 9 Fr., working length 9 cm, total length 16 cm, for use with KARL STORZ SURGICAL COCKPIT® navigation systems
Navigated Suction Tubes
angular, curved downwards, curved upwards

**40 8001 40 R** FRAZIER *Navigated Suction Tube*, angular, for right-handed use, 9 Fr., working length 9 cm, total length 16 cm, for use with KARL STORZ SURGICAL COCKPIT® navigation systems

**40 8001 51** v. EICKEN *Navigated Suction Tube*, curved upwards, for left and right-handed use, outer diameter 3 mm, length 16.5 cm, for use with KARL STORZ SURGICAL COCKPIT® navigation systems

**40 8001 60 LM** v. EICKEN *Navigated Suction Tube*, curved to left, for left and right-handed use, outer diameter 3 mm, length 16.5 cm, for use with KARL STORZ SURGICAL COCKPIT® navigation systems

**40 8001 60 RM** FRAZIER *Navigated Suction Tube*, angular, for left-handed use, 9 Fr., working length 9 cm, total length 16 cm, for use with KARL STORZ SURGICAL COCKPIT® navigation systems
Instrument Tracker\textsuperscript{\textit{NEW}}
for Navigation Panel Unit (NPU)

The autoclavable instrument tracker is designed for the navigation of various instruments. The small size of the instrument tracker reduces the risk of collision and ensures very good instrument maneuverability.

Special Features:
- User-friendly handling thanks to optimized, miniaturized design
- Can be used for various navigation instruments

Tool Tracker, for navigated instruments, autoclavable, with 3 fix-mounted glass spheres, autoclavable, dimensions: 70 x 50 x 14 mm, for use with navigated instruments 4080014x, 4080015x, 4080016x and 4080017x
Wire Tray for Navigation Probe and Patient Tracker

The wire tray ensures hygienic and secure sterilization, cleaning and storage of standard navigation instrument sets.

39502 NAV1  **Wire Tray with Lid**, stackable, with silicone knob mat and fixation system, for the cleaning, sterilization and storage of one navigation probe and one patient tracker, external dimensions (w x d x h): 240 x 250 x 70 mm

**Please note:** The instruments displayed are not included in the rack.
Wire Tray for Suction Tubes and Instrument Tracker

The wire tray ensures hygienic and secure sterilization, cleaning and storage of the suction tube sets.

39502 NAV2  **Wire Tray with Lid**, stackable, with silicone knob mat and fixation system, for the cleaning, sterilization and storage of three suction tubes and three instrument trackers, external dimensions (w x d x h): 240 x 250 x 70 mm

**Please note:** The instruments displayed are not included in the rack.
IMAGE1 S Camera System

Economical and future-proof

- Modular concept for flexible, rigid and 3D endoscopy as well as new technologies
- Forward and backward compatibility with video endoscopes and FULL HD camera heads
- Sustainable investment
- Compatible with all light sources

Innovative Design

- Dashboard: Complete overview with intuitive menu guidance
- Live menu: User-friendly and customizable
- Intelligent icons: Graphic representation changes when settings of connected devices or the entire system are adjusted
- Automatic light source control
- Side-by-side view: Parallel display of standard image and the Visualization mode
- Multiple source control: IMAGE1 S allows the simultaneous display, processing and documentation of image information from two connected image sources, e.g., for hybrid operations
IMAGE1 S Camera System

Brilliant Imaging
- Clear and razor-sharp endoscopic images in FULL HD
- Natural color rendition

- Reflection is minimized
- Multiple IMAGE1 S technologies for homogeneous illumination, contrast enhancement and color shifting

FULL HD image

CLARA

FULL HD image

CHROMA

FULL HD image

SPECTRA A*

FULL HD image

SPECTRA B**

* SPECTRA A: Not for sale in the U.S.
** SPECTRA B: Not for sale in the U.S.
Endoscopic Surgical Anatomy of the Lamb’s Head

**IMAGE1 S Camera System**

TC 200EN

TC 200EN* **IMAGE1 S CONNECT**, connect module, for use with up to 3 link modules, resolution 1920 x 1080 pixels, with integrated KARL STORZ-SCB and digital Image Processing Module, power supply 100–120 VAC/200–240 VAC, 50/60 Hz including:
- **Mains Cord**, length 300 cm
- **DVI-D Connecting Cable**, length 300 cm
- **SCB Connecting Cable**, length 100 cm
- **USB Flash Drive**, 32 GB, USB silicone keyboard, with touchpad, US

*Available in the following languages: DE, ES, FR, IT, PT, RU

**Specifications:**

<table>
<thead>
<tr>
<th>Feature</th>
<th>TC 200EN (H3-Link)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HD video outputs</td>
<td>- 2x DVI-D</td>
</tr>
<tr>
<td></td>
<td>- 1x 3G-SDI</td>
</tr>
<tr>
<td>Format signal outputs</td>
<td>1920 x 1080p, 50/60 Hz</td>
</tr>
<tr>
<td>LINK video inputs</td>
<td>3x</td>
</tr>
<tr>
<td>USB interface</td>
<td>4x USB, (2x front, 2x rear)</td>
</tr>
<tr>
<td>SCB interface</td>
<td>2x 6-pin mini-DIN</td>
</tr>
<tr>
<td>Power supply</td>
<td>100–120 VAC/200–240 VAC</td>
</tr>
<tr>
<td>Power frequency</td>
<td>50/60 Hz</td>
</tr>
<tr>
<td>Protection class</td>
<td>I, CF-Defib</td>
</tr>
<tr>
<td>Dimensions w x h x d</td>
<td>305 x 54 x 320 mm</td>
</tr>
<tr>
<td>Weight</td>
<td>2.1 kg</td>
</tr>
</tbody>
</table>

For use with IMAGE1 S **IMAGE1 S CONNECT Module TC 200EN**

TC 300

TC 300 **IMAGE1 S H3-LINK**, link module, for use with IMAGE1 FULL HD three-chip camera heads, power supply 100–120 VAC/200–240 VAC, 50/60 Hz, for use with **IMAGE1 S CONNECT TC 200EN** including:
- **Mains Cord**, length 300 cm
- **Link Cable**, length 20 cm

**Specifications:**

<table>
<thead>
<tr>
<th>Feature</th>
<th>TC 300 H3-Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supported camera heads/video endoscopes</td>
<td>TH 100, TH 101, TH 102, TH 103, TH 104, TH 106 (fully compatible with IMAGE1 S), 22220055-3, 22220056-3, 22220053-3, 22220060-3, 22220061-3, 22220054-3, 22220085-3 (compatible without IMAGE1 S technologies CLARA, CHROMA, SPECTRA*)</td>
</tr>
<tr>
<td>LINK video outputs</td>
<td>1x</td>
</tr>
<tr>
<td>Power supply</td>
<td>100–120 VAC/200–240 VAC</td>
</tr>
<tr>
<td>Power frequency</td>
<td>50/60 Hz</td>
</tr>
<tr>
<td>Protection class</td>
<td>I, CF-Defib</td>
</tr>
<tr>
<td>Dimensions w x h x d</td>
<td>305 x 54 x 320 mm</td>
</tr>
<tr>
<td>Weight</td>
<td>1.86 kg</td>
</tr>
</tbody>
</table>

* SPECTRA A: Not for sale in the U.S.
** SPECTRA B: Not for sale in the U.S.
For use with IMAGE1 S Camera System
IMAGE1 S CONNECT Module TC 200EN, IMAGE1 S H3-LINK Module TC 300
and with all IMAGE1 HUB™ HD Camera Control Units

**IMAGE1 S Camera Heads**

**TH 100**

**IMAGE1 S H3-Z Three-Chip FULL HD Camera Head**, 50/60 Hz, IMAGE1 S compatible, progressive scan, soakable, gas- and plasma-sterilizable, with integrated Parfocal Zoom Lens, focal length $f = 15–31\text{ mm} (2x)$, 2 freely programmable camera head buttons, for use with IMAGE1 S and IMAGE1 HUB™ HD/HD

**Specifications:**

<table>
<thead>
<tr>
<th>IMAGE1 FULL HD Camera Heads</th>
<th>IMAGE1 S H3-Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product no.</td>
<td>TH 100</td>
</tr>
<tr>
<td>Image sensor</td>
<td>3x $1/3$ CCD chip</td>
</tr>
<tr>
<td>Dimensions w x h x d</td>
<td>39 x 49 x 114 mm</td>
</tr>
<tr>
<td>Weight</td>
<td>270 g</td>
</tr>
<tr>
<td>Optical interface</td>
<td>integrated Parfocal Zoom Lens, $f = 15–31\text{ mm} (2x)$</td>
</tr>
<tr>
<td>Min. sensitivity</td>
<td>F 1.4/1.17 Lux</td>
</tr>
<tr>
<td>Grip mechanism</td>
<td>standard eyepiece adaptor</td>
</tr>
<tr>
<td>Cable</td>
<td>non-detachable</td>
</tr>
<tr>
<td>Cable length</td>
<td>300 cm</td>
</tr>
</tbody>
</table>

**TH 104**

**IMAGE1 S H3-ZA Three-Chip FULL HD Camera Head**, 50/60 Hz, IMAGE1 S compatible, **autoclavable**, progressive scan, soakable, gas- and plasma-sterilizable, with integrated Parfocal Zoom Lens, focal length $f = 15–31\text{ mm} (2x)$, 2 freely programmable camera head buttons, for use with IMAGE1 S and IMAGE1 HUB™ HD/HD

**Specifications:**

<table>
<thead>
<tr>
<th>IMAGE1 FULL HD Camera Heads</th>
<th>IMAGE1 S H3-ZA</th>
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</thead>
<tbody>
<tr>
<td>Product no.</td>
<td>TH 104</td>
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<tr>
<td>Image sensor</td>
<td>3x $1/3$ CCD chip</td>
</tr>
<tr>
<td>Dimensions w x h x d</td>
<td>39 x 49 x 100 mm</td>
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<tr>
<td>Weight</td>
<td>299 g</td>
</tr>
<tr>
<td>Optical interface</td>
<td>integrated Parfocal Zoom Lens, $f = 15–31\text{ mm} (2x)$</td>
</tr>
<tr>
<td>Min. sensitivity</td>
<td>F 1.4/1.17 Lux</td>
</tr>
<tr>
<td>Grip mechanism</td>
<td>standard eyepiece adaptor</td>
</tr>
<tr>
<td>Cable</td>
<td>non-detachable</td>
</tr>
<tr>
<td>Cable length</td>
<td>300 cm</td>
</tr>
</tbody>
</table>
Monitors

9619 NB

19" HD Monitor,
color systems **PAL/NTSC**, max. screen resolution 1280 x 1024, image format 4:3, power supply 100–240 VAC, 50/60 Hz, wall-mounted with VESA 100 adaption, including:
- **External 24 VDC Power Supply**
- **Mains Cord**

9826 NB

26" FULL HD Monitor,
wall-mounted with VESA 100 adaption, color systems **PAL/NTSC**, max. screen resolution 1920 x 1080, image format 16:9, power supply 100–240 VAC, 50/60 Hz including:
- **External 24 VDC Power Supply**
- **Mains Cord**
## Monitors

<table>
<thead>
<tr>
<th>KARL STORZ HD and FULL HD Monitors</th>
<th>19&quot;</th>
<th>26&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Wall-mounted with VESA 100 adaption</strong></td>
<td>9619 NB</td>
<td>9826 NB</td>
</tr>
<tr>
<td>Inputs:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DVI-D</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Fibre Optic</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>3G-SDI</td>
<td>–</td>
<td>●</td>
</tr>
<tr>
<td>RGBS (VGA)</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>S-Video</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Composite/FBAS</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Outputs:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DVI-D</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>S-Video</td>
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<tr>
<td>Composite/FBAS</td>
<td>●</td>
<td>●</td>
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<tr>
<td>RGBS (VGA)</td>
<td>●</td>
<td>–</td>
</tr>
<tr>
<td>3G-SDI</td>
<td>–</td>
<td>●</td>
</tr>
<tr>
<td><strong>Signal Format Display:</strong></td>
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<td></td>
</tr>
<tr>
<td>4:3</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>5:4</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>16:9</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Picture-in-Picture</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>PAL/NTSC compatible</td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>

### Optional accessories:
- 9826 SF  **Pedestal**, for monitor 9826 NB
- 9626 SF  **Pedestal**, for monitor 9619 NB

### Specifications:

<table>
<thead>
<tr>
<th>KARL STORZ HD and FULL HD Monitors</th>
<th>19&quot;</th>
<th>26&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Desktop with pedestal</strong></td>
<td>optional</td>
<td>optional</td>
</tr>
<tr>
<td>Product no.</td>
<td>9619 NB</td>
<td>9826 NB</td>
</tr>
<tr>
<td>Brightness</td>
<td>200 cd/m² (typ)</td>
<td>500 cd/m² (typ)</td>
</tr>
<tr>
<td>Max. viewing angle</td>
<td>178° vertical</td>
<td>178° vertical</td>
</tr>
<tr>
<td>Pixel distance</td>
<td>0.29 mm</td>
<td>0.3 mm</td>
</tr>
<tr>
<td>Reaction time</td>
<td>5 ms</td>
<td>8 ms</td>
</tr>
<tr>
<td>Contrast ratio</td>
<td>700:1</td>
<td>1400:1</td>
</tr>
<tr>
<td>Mount</td>
<td>100 mm VESA</td>
<td>100 mm VESA</td>
</tr>
<tr>
<td>Weight</td>
<td>7.6 kg</td>
<td>7.7 kg</td>
</tr>
<tr>
<td>Rated power</td>
<td>28 W</td>
<td>72 W</td>
</tr>
<tr>
<td>Operating conditions</td>
<td>0–40°C</td>
<td>5–35°C</td>
</tr>
<tr>
<td>Storage</td>
<td>-20–60°C</td>
<td>-20–60°C</td>
</tr>
<tr>
<td>Rel. humidity</td>
<td>max. 85%</td>
<td>max. 85%</td>
</tr>
<tr>
<td>Dimensions w x h x d</td>
<td>469.5 x 416 x 75.5 mm</td>
<td>643 x 396 x 87 mm</td>
</tr>
<tr>
<td>Power supply</td>
<td>100–240 VAC</td>
<td>100–240 VAC</td>
</tr>
<tr>
<td>Certified to</td>
<td>EN 60601-1, protection class IPX0</td>
<td>EN 60601-1, UL 60601-1, MDD93/42/EEC, protection class IPX2</td>
</tr>
</tbody>
</table>
### Cold Light Fountains and Accessories

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>495 NT</td>
<td><strong>Fiber Optic Light Cable</strong>, with straight connector, diameter 2.5 mm, length 180 cm</td>
</tr>
<tr>
<td>495 NTW</td>
<td><strong>Fiber Optic Light Cable</strong>, diameter 2.5 mm, length 180 cm with 90° deflection to the light source</td>
</tr>
<tr>
<td>495 NTX</td>
<td><strong>Same</strong>, length 230 cm</td>
</tr>
</tbody>
</table>

### LED NOVA® 150, High-Performance LED Cold Light Fountain

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>20161201</td>
<td><strong>LED Nova 150, High-Performance LED Cold Light Fountain</strong> with one KARL STORZ light outlet, power supply 100 - 240 VAC, 50/60 Hz including: <strong>Mains cord</strong></td>
</tr>
</tbody>
</table>

### Cold Light Fountain XENON NOVA® 175

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>20131501</td>
<td><strong>Cold Light Fountain XENON NOVA® 175</strong> power supply: 100–125 VAC/220–240 VAC, 50/60 Hz including: <strong>Mains Cord</strong></td>
</tr>
<tr>
<td>20132026</td>
<td><strong>XENON Spare Lamp</strong>, only, 175 watt, 15 volt</td>
</tr>
</tbody>
</table>

### Cold Light Fountain XENON 300 SCB

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>20133101-1</td>
<td><strong>Cold Light Fountain XENON 300 SCB</strong> with built-in antifog air-pump, and integrated KARL STORZ Communication Bus System SCB power supply: 100–125 VAC/220–240 VAC, 50/60 Hz including: <strong>Mains Cord</strong> <strong>Silicone Tubing Set</strong>, autoclavable, length 250 cm <strong>SCB Connecting Cable</strong>, length 100 cm</td>
</tr>
<tr>
<td>20133027</td>
<td><strong>Spare Lamp Module XENON</strong> with heat sink, 300 watt, 15 volt</td>
</tr>
<tr>
<td>20133028</td>
<td><strong>XENON Spare Lamp</strong>, only, 300 watt, 15 volt</td>
</tr>
</tbody>
</table>
KARL STORZ AIDA® compact NEO advanced

Brilliance in documentation

Data Acquisition

Still images, video sequences and audio comments can easily be recorded during an examination or intervention by pressing the on-screen button, activating the footswitch, or pressing the camera head button. All captured data are displayed on the right-hand side as a thumbnail preview to ensure the data have been generated. Patient data can be entered via an onscreen or standard keyboard. The system also offers the possibility to transfer all relevant patient data via a DICOM worklist or a link to the hospital information system (HIS) without requiring manual entry in the patient entry screen.

Flexible Review, Data Storage and Efficient Data Export

Captured still images or video files can easily be viewed, edited, or deleted on-screen before final storage. KARL STORZ AIDA® compact NEO efficiently stores all recorded data on DVD, CD, USB stick, external/internal drive, the relevant network and/or on a FTP server. It is also possible to save the data directly on the PACS and/or HIS servers via HL7/DICOM. Data that cannot be stored successfully remains in a cache until final archiving is possible.

Special Features:

- SD and HD signal support:
  - Y/C (S-Video)
  - Composite input
  - DVI-D input
- Picture-in-Picture function:
  Display of channel 2 (SD) in channel 1 (FULL HD)
- Resolution:
  - Still images 1920 x 1080 and SD
  - Videos 1080p, 720p and SD
- Interface package (DICOM/H7) included
- NEO Secure security software
- Recommended applications:
  - Universal (cart or OR1™ installation)

20040913-EN* | KARL STORZ AIDA® compact NEO advanced
Documentation system for digital storage of still images, video sequences and audio files, power supply 115/230 VAC, 50/60 Hz

* Available in the following languages:
DE, ES, FR, IT, PT, PL, RU, DK, SE, JP, CN
Equipment Cart

Equipment Cart
wide, high, rides on 4 antistatic dual wheels equipped with locking brakes 3 shelves, mains switch on top cover, central beam with integrated electrical subdistributors with 12 sockets, holder for power supplies, potential earth connectors and cable winding on the outside,

Dimensions:
Equipment cart: 830 x 1474 x 730 mm (w x h x d),
shelf: 630 x 510 mm (w x d),
caster diameter: 150 mm

including:
Base module equipment cart, wide
Cover equipment, equipment cart wide
Beam package equipment, equipment cart high
3x Shelf, wide
Drawer unit with lock, wide
2x Equipment rail, long
Camera holder

Monitor Swivel Arm,
height and side adjustable, can be turned to the left or the right side, swivel range 180°, overhang 780 mm, overhang from centre 1170 mm, load capacity max. 15 kg, with monitor fixation VESA 5/100, for usage with equipment carts UG xxx
Recommended Accessories for Equipment Cart

**Isolation Transformer,**
200 V–240 V; 2000 VA with 3 special mains socket, expulsion fuses, 3 grounding plugs, dimensions: 330 x 90 x 495 mm (w x h x d), for usage with equipment carts UG xxx

**Earth Leakage Monitor,**
200 V–240 V, for mounting at equipment cart, control panel dimensions: 44 x 80 x 29 mm (w x h x d), for usage with isolation transformer UG 310

**Monitor Holding Arm,**
height adjustable, inclinable, mountable on left or right, turning radius approx. 320°, overhang 530 mm, load capacity max. 15 kg, monitor fixation VESA 75/100, for usage with equipment carts UG xxx
Notes:
WITH COMPLIMENTS OF
KARL STORZ — ENDOSKOPE