Hands-On Dissection Guide on
ADVANCED ENDOSCOPIC
ENDONASAL SINUS SURGERY

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**Online Video Content**

The authors have contributed a series of topic-related video clips. Click on the play button below to access the playlist in your internet browser.

[Video Playlist](http://go.karlstorz.com/96315005-en-1)

As an alternative option, just scan the QR Code or enter the short link to access the online video content.
1.1 Introduction

The dissection guide for the advanced course has been set up to serve as a supplement to that of the basic course, comprising advanced endonasal endoscopic surgery of the lacrimal drainage system and orbital cavity with dacryocystorhinostomy, orbital and optic nerve decompression, the prelacrimal approach to the maxillary sinus with medial maxillectomy as well as frontal sinus drainage type III and ablative surgery of the anterior skull base.

The ‘Basics for Surgical-Anatomic Dissection’, already presented in the dissection guide of the basic course, apply.

Special mention deserves the ‘four-hand technique’, which is not only sensible, but often mandatory, particularly in endonasal tumor surgery and in advanced endonasal sinus surgery in general.

For one thing, the ‘four-hand technique’ allows the surgeon to work with both hands while the assistant guides the endoscope and controls suction. Simultaneously, the concept of ‘two minds’ reflects the complementary expertise of two surgeons working together.

The dissection guide of the advanced course has been designed to systematically and comprehensively present the operative procedures in a sequential manner. They are described on the basis of anatomical cadaver specimens, graphic diagrams and endoscopic findings. The didactic concept gives due consideration to all relevant aspects of the topographic anatomy, current findings in physiology and pathophysiology, and state-of-the-art medical technology.

Accordingly, sinus surgery is presented in modular subunits that can be followed either in isolation or can be combined for a gradually extended procedure. Both the operative procedures under in-vivo conditions and hands-on cadaver dissection are conducted with the aid of predefined anatomic landmarks to ensure that procedures are performed correctly, safely, and completely, in accordance with the principles of good surgical practice.
Step 1: Dacryocystorhinostomy (DCR)

2.1 Objectives
A direct connection is established between the lacrimal sac and the nasal cavity, removing as much as possible of the medial bony wall along with its nasal mucosal lining and including resection of the entire medial wall of the lacrimal sac. Ultimately, the entry site of the united canaliculi to the lacrimal sac should be readily appreciated via the endonasal route and should be free of any obstruction.

2.2 Regional Anatomy
- The lacrimal sac is located in the lacrimal fossa (LF), which is formed anteriorly by the stronger frontal process of maxilla (FPM) and posteriorly by the thinner lacrimal bone (LB), which are connected by the vertical lacrimomaxillary suture. Their relative contributions to the LF differ individually, and there are ethnic differences as well. While the lacrimal bone is typically less than 0.1 mm thick,58 the thickness of the FPM is 2–3 mm on average, increasing cranially.54 The LF is approximately 16 mm high and 7–10 mm wide, becoming narrower in a cranial direction.
- The nasolacrimal canal, which contains the nasolacrimal duct (NLD), is formed laterally and anteriorly by the maxillary bone, medially by the lacrimal bone, and caudally by the turbinate bone. The canal has a length of approximately 6 mm (4–10 mm) and a diameter of approximately 5 mm (3–7 mm). It typically runs in a mediocaudal and dorsal direction, with a slight inclination of 5–16.5° to the frontal plane and 97–130° to the standard horizontal line anatomical position; in rare cases, it runs laterocaudally (-1° to -10° to the frontal plane).27 The NLD drains into the inferior meatus below the attachment of the inferior turbinate. The distance to the attachment of the turbinate bone at the lateral nasal wall is approximately 5 mm (0–12 mm), and to the nasal floor, it is approximately 13 mm (5–19 mm).27

2.3 Anatomical Landmarks
- Nasal septum and associated types of anterior deviations.
- Size and shape of the inferior and middle turbinate.
- Width of the inferior meatus and location of the nasolacrimal duct orifice.
- Width of the middle meatus with insertion, shape and extension of the uncinate process.
- Axilla of the middle turbinate.
- Agger nasi.
- ‘Maxillary line’.
- Lacrimal fossa (LF).
- Lacrimal sac.
- Nasolacrimal duct (NLD), nasolacrimal canal.
- Lacrimal bone (LB).
- Frontal process of maxilla (FPM).
- Uncinate process (UP).
- Agger nasi cell.
- Lamina papyracea.

Depending on the individual anatomy, the uncinate process, parts of an agger nasi cell, and occasionally, parts of the middle turbinate need to be removed in this process.
Fig. 2.1 Macroscopic lateral view of the right lacrimal fossa and adjacent craniofacial bones. Frontoethmoidal suture ①; frontal bone ②; frontal process of maxilla ③; lacrimomaxillary suture ④; lacrimal bone ⑤; anterior lacrimal crest ⑥; posterior lacrimal crest ⑦; lacrimal fossa (dotted line) ⑧; nasal bone ⑨.

Fig. 2.2 Anatomic structures of the lateral nasal wall and the anterior ethmoid bone in relation to the lacrimal fossa and lacrimal sac, viewed from medially (a–c: from lateral to medial).

a. Surrounding bones of the lacrimal fossa with lacrimal sac, nasolacrimal duct and entry site of the united canaliculi
b. with agger nasi cell, uncinate process;
c. with middle turbinate and a detailed view on the axilla.
2.4 Details of Dissection / Surgical Technique

Depending on the anatomy of the specimen, septoplasty may be necessary as a preliminary step. If a voluminous or deviated middle turbinate obscures vision or does not permit manipulations in the middle meatus, the middle turbinate should be reduced (see Dissection Guide, Basic Course).

First, the mucosa is incised at the anterior border of the FPM starting above the insertion of the inferior turbinate, proceeding initially in a cranial direction, then ascending along an arched line up to approximately 10 mm above the insertion of the middle turbinate. A horizontal incision is made superior to the insertion of the inferior turbinate along the protrusion of the NLD. The mucosal flap is subperiosteally dissected exposing the LF from medially as well as the bony canal of the NLD.

Exposing the LF and NLD in their osseous contour often requires the (partial) resection of the uncinate process and opening of the agger nasi cell, possibly including partial resection of the middle turbinate at its anterior insertion.

Dorsally at the uncinate process, the mucosal flap is vertically incised. It is flipped medially on the remaining pedicle at the lateral nasal wall superior to the insertion of the middle turbinate.

This is followed by bone removal of the LF and of the area above the NLD, cranial to the insertion of the inferior turbinate. This can be done in at least three ways, which are occasionally used in combination.

- Visualization of the osseous boundary between LB and FPM (lacrimomaxillary suture). The thin bone of the LB is typically mobilized with the sickle knife to allow its removal. Thereafter, a Kerrison punch is used to gently engage from dorsally behind the FPM and remove it step-by-step.
- Using a chisel, the FPM is removed from anteriorly.
- Using a diamond drill (preferably, an intranasal shaver, tip diameter 5 mm and a deflection of 15° or 40°), the entire bone is gradually removed. The use of this powered instrument is particularly advantageous if the bone to be removed is voluminous and extends far cranially.

All techniques share the goal of causing the medial circumference of the membranous lacrimal sac to protrude into the nasal cavity without being covered by bone. When removing the bone, one should take into account that the opening of the united canaliculi is 3–5 mm above the insertion of the middle turbinate. Dorsally, the passage to the lamina papyracea is demonstrated confirming that exposure is complete.

Next, the inferior lacrimal duct is probed, if necessary after dilating the inferior lacrimal punctum using a lacrimal duct probe (size 000–0000). The probe is advanced through the united canaliculi into the lacrimal sac, and its medial wall is elevated under endoscopic vision (‘tenting’). This allows to identify the entry site of the united canaliculi, facilitating subsequent incision of the lacrimal sac.

The following incision of the lacrimal sac with a sickle knife or with a radio frequency (RF) needle can be done in various ways and may include the optional use of a local flap:

- Incision at the anterior circumference with stepwise removal of the entire medial wall of the lacrimal sac.
- Incision at the anterior circumference and creation of a dorsally pedicled mucosal flap.
- Incision in the middle of the lacrimal sac and creation of swinging-door type mucosal flaps in an anterior and posterior direction.

Inspection of the opened lacrimal ducts, extraction of a lacrimal stone, if present, and exclusion of any tumors follows. Special scrutiny is required to endoscopically examine the passage leading to Hasner’s valve.

Once the lacrimal sac is exposed, the opening of the united canaliculi should be clearly demonstrated without any signs of obstruction.

During final irrigation, unimpeded outflow from the inferior lacrimal punctum should be confirmed.

In case of presaccular stenosis, placement of silicone lacrimal intubation stent and fixation, for instance with clips, is performed, making sure that the clip is neither too tight (risk of cutting into the lacrimal point and lacrimal duct; granulation tissue forming at the opening of the united canaliculi due to friction) nor too loose (risk of dislocation to the cornea). Preferable are self-retaining stents.

The nasal mucosal flaps are then positioned to ensure that all exposed bone surfaces are covered with mucosa. In the process, the large flap developed initially typically needs to be trimmed considerably.
Fig. 2.4a–f Endonasal dacryocystorhinostomy.

a. Preoperative endoscopic view (0°-HOPKINS® scope). Maxillary line ①; middle turbinate ②; agger nasi (presumed extension of lacrimal sac = hatched area) ③.

b. Endoscopic view after incision of the mucosal flap with a radiofrequency needle.

c. Once the mucosal flap has been elevated medially ①, the following anatomical structures come into view: frontal maxillary process ② and uncinate process (= hatched area); the latter is attached to the frontal process and covers the lacrimal bone.

d. Upon completion of dissection, the agger nasi cell is opened and may also be evaluated. Frontal process of maxilla ①; lacrimal bone ②; uncinate process ③; agger nasi cell ④; middle turbinate ⑤.

e. Removal of the frontal maxillary process ① with a Kerrison punch ②.

f. Once the bone overlying the lacrimal sac has been removed with a punch or by using an endonasal (shaver) drill, the lacrimal sac (dotted line) is seen to protrude into the nasal cavity. The lacrimal probe is passed through the inferior lacrimal punctum and advanced until the medial wall of the lacrimal sac is seen to tent ①. The lacrimal sac overlying the middle turbinate insertion ② is exposed (= dotted black line). As a matter of course, the agger nasi cell ③ covering the lacrimal sac is opened during exposure of the sac. Elevated flap of nasal mucosa with cranial pedicle ④; uncinate process and its mucosal lining are elevated from the lateral nasal wall ⑤.
2.4.1 Clinical Notes

Intraoperatively, the mucosa and lacrimal sac can be incised with an RF needle to reduce bleeding. In the process, contact of the RF needle with the lacrimal duct probe must be strictly avoided (stray current causing unintended coagulation).

Surgical success is considered subject to the creation of large fenestrations and mucosal flaps that abut on each other while covering the exposed bone surface. Apart from that, a DCR procedure with mucosal flap has been shown to require less intensive local aftercare.

Fig. 2.4g–j Endonasal dacryocystorhinostomy.

g. Endoscopic view following incision of the lacrimal sac. The united canaliculi (entry site of the lacrimal probe) is located just above the middle turbinate.

h. Meticulous care must be paid in a caudal direction at the passage to the nasolacrimal duct to prevent the formation of a blind sac. Therefore, it is recommended that the caudal aspect of the medial wall of the nasolacrimal duct be removed above the insertion of the inferior turbinate, e.g., by using a downward-cutting maxillary sinus punch.

i. Upon completion of the procedure, the entry site of the united canaliculi is freed completely and exhibits no signs of obstruction. Mucosal flaps optimally cover all of the raw bone surfaces in anterior, posterior, and cranial directions.

j. The agger nasi cell and the inferior opening of the frontal recess (circle) as well as the middle meatus (circle) are exposed. The free portions of the middle turbinate are left intact.
Step 2: Orbital Decompression

3.1 Objectives

Removal of the Lamina papyracea and Incision or Excision of the Periorbita

Following complete endonasal ethmoidectomy, subtotal to total removal of the lamina papyracea is accomplished between the LB anteriorly and the anterior sphenoid sinus wall posteriorly, the ethmoidal roof superiorly and the maxillary sinus roof inferiorly. If deemed necessary, the maxillary sinus roof may also be removed medial to the infraorbital nerve. The slightly protruding periorbita is incised using a small or large incision or, if required, excision of a large area, causing herniation of orbital fat into the ethmoid sinus and the reduction of intraorbital pressure or drainage of an inflammatory process.

3.2 Regional Anatomy

The lamina papyracea is a paper-thin bone (0.2–0.4 mm) which is part of the ethmoid bone and forms the sagitally oriented medial orbital wall. Its anteroposterior aspects extend from the posterior edge of the lacrimal bone to the anterior sphenoid sinus wall. Its superoinferior portions span from the ethmoidal roof to the maxillary sinus roof, where the bone thickness increases at the maxilloethmoidal angle and toward the dorsal edge.21

Medially, the lamina papyracea is covered by the thin ethmoidal mucosa that can be readily detached. Laterally, the periorbita as a thin but strong connective tissue layer forms the boundary to the orbital soft tissue (fat, eye muscles, etc.).

In close proximity to the skull base, the anterior and posterior ethmoidal arteries – and in 30% of cases, a medial ethmoidal artery – are found to exit the orbital cavity.

Anterior ethmoidal artery (AEA): From the orbital cavity, this branch of the ophthalmic artery traverses the anterior skull base and takes an endocranial course (olfactory fossa) at the upper attachment of the middle turbinate. At the ethmoid roof, it is typically interposed between the attachments of the 2nd and 3rd basal lamella, taking an oblique course in an anteromedial direction. The artery can be ‘suspended’ up to 2 mm from the skull base in a mesentery, exposing it to an elevated risk of iatrogenic injury. A small, funnel-shaped projection of the medial orbital wall accompanies the artery in the lateral ethmoid sinus. If the AEA is injured here, it can retract into the orbital cavity and result in orbital hematoma, which is considered a severe complication.

Posterior ethmoidal artery: The artery follows a fairly horizontal course near the anterior sphenoid sinus wall. It is typically located in the osseous skull base.

In 30% of cases, a third ethmoidal artery (middle ethmoidal artery) is found in addition to the anterior and posterior ethmoidal arteries.48

Fig. 3.1a, b  Lamina papyracea.

a. Anteroposterior view.

Frontal process of maxilla ①; lacrimo-maxillary suture ②; lacrimal bone ③; anterior border of lamina papyracea ④; lamina papyracea ⑤; posterior border of lamina papyracea ⑥; lateral wall of sphenoid sinus ⑦.

b. Craniocaudal view.

Skull base (ethmoid roof) ①; cranial border of lamina papyracea ②; lamina papyracea ③; caudal border of lamina papyracea ④; maxillary sinus roof ⑤.
Step 2: Orbital Decompression

3.3 Anatomical Landmarks

- Maxillary sinus, maxillary sinus roof.
- Lamina papyracea.
- Orbit and periorbita.
- Skull base (ethmoid roof).
- Frontal sinus (posterior wall, drainage pathway).
- Ethmoidal arteries (anterior, posterior, occasionally middle).
- Sphenoid sinus (anterior wall).

3.4 Details of Dissection / Surgical Technique

- First, complete ethmoidectomy, middle meatal antrostomy type II–III, and frontal sinus drainage type IIa (see Dissection Guide, Basic Course) are performed, and if necessary, a sphenoidotomy as well.
- All ethmoid cell septa and the mucosa on the lamina papyracea are removed. Important anatomical landmarks that need to be clearly identified are lacrimal bone, anterior sphenoid sinus wall, ethmoidal roof with ethmoidal arteries, and maxillary sinus roof (Fig. 3.3a).
- Once the medial orbit is exposed from the skull down to the maxillary sinus roof, gentle pressure is applied to the lamina papyracea anteriorly with an elevator – just enough to fracture the thin bone and allow detachment of the periorbita without injury (Fig. 3.3b).
- The lamina papyracea is removed to the extent feasible and necessary using a step-by-step medial levering technique, while at the same time enlarging the circumference of exposure by subperiosteal blunt dissection in a cranial, caudal, and dorsal direction.
- The area of dissection spans from the lacrimal drainage system to the optic nerve tubercle (distal optic canal). In the immediate vicinity of the frontal sinus approach, a strip of bone is left in place to provide for adequate frontal sinus drainage in the postoperative period.

Fig. 3.2 Frontal CT scans (a, b).

a. Between the superior oblique (1) and medial rectus muscle (2), the ethmoidal artery follows a slightly oblique course from the orbital cavity in or slightly below the skull base and traverses in a lateroposterior to medioanterior direction. In the frontal CT, it is often identified by a pointy projection of the lamina papyracea (area of the dotted circle) (3).

b. Further dorsally, a few millimeters anterior to the anterior sphenoid sinus wall, the posterior ethmoidal artery (dotted circle) runs transversely from lateral to medial. It is smaller and less prominent than the anterior ethmoidal artery.

Fig. 3.3a, b (Continued overleaf).

a. Condition after sphenoethmoidectomy on the left with frontal sinus drainage type IIa, maxillary sinus fenestration type III, and complete exposure of the lamina papyracea. Lamina papyracea (1); ethmoid roof (2); access to the frontal sinus (3); access to the maxillary sinus (4); sphenoid sinus (5); incised lacrimal sac (6).

b. The lamina papyracea is thinned using a diamond burr.
A sturdy elevator commonly also facilitates mobilization and removal of the medial orbital floor, proceeding as far as the infraorbital canal in a laterocaudal direction (Fig. 3.3c).

In rare cases of a thick lamina papyracea, it is recommended to thin the bone using a diamond burr (intranasal shaver, 5 mm in diameter, 15° or 40° of angulation).

Following bone removal, the periorbital connective tissue is exposed. Depending on the indication, the connective tissue is incised with the sickle knife along a dorsal-to-ventral course placing one or two incisions. Care must be taken to preserve integrity of the medial rectus muscle (Fig. 3.3d). In case of elective excision, the periorbita is released and removed after placement of vertical incisions (Fig. 3.3e).

The extent of fat tissue herniation can be modified by gentle ballottement of the eye from the outside. If necessary, the herniating fat tissue can be delivered into the ethmoid with grasping instruments, however, the fat is not resected.

### 3.4.1 Clinical Notes

The posteroanterior incision at the periorbita is intended to prevent any early obstructive anterior herniation of fat into the surgical field. Alternatively, the incision can be made from anterior to posterior using microscissors.

Provided a viable frontal sinus drainage pathway cannot be established in the course of the procedure, it may be helpful to opt for a proactive type IIb drainage (or accordingly, a maxillary sinus fenestration in the inferior meatus or a medial maxillectomy).

In cases where (supero)medial subperiosteal abscesses emerged as a complication of acute rhinosinusitis, the lamina papyracea is only removed in the affected area, thereby achieving sufficient drainage. Placing additional parallel incisions on the periorbita is not helpful in these cases. On the contrary, such a measure is susceptible to create an infection route into the orbital fat tissue.

In the presence of intraorbital abscess or retrobulbar orbital phlegmon, however, performing parallel incisions on the periorbita while creating the best possible drainage of the intraorbital abscess is clearly indicated.

In patients with Grave’s disease and severe exophthalmus, removal of the lamina papyracea and orbital floor as far as the infraorbital nerve should be considered.9,37

In cases where the orbital floor cannot be precisely and adequately removed via the middle meatus, additional alternative (prelacrimal) access routes are available.

If the final evaluation suggests that the endonasal intervention has failed to provide adequate decompression and to avoid undue medialization of the orbital axis, additional lateral decompression of the orbita (e.g., via a conjunctival approach) may be considered.
Step 3: Optic Nerve Decompression

4.1 Objectives

The optic nerve is exposed in its optic canal along the anterosuperior lateral wall of the sphenoid sinus and, if necessary, including the posterior ethmoid (sphenoethmoidal cell). Once the medial bony wall has been removed, the exposed connective tissue forming the optic nerve sheath may be incised.

4.2 Regional Anatomy

- The **optic nerve** is divided into four segments: the *intracranial* (about 10 mm), *intracanalicular* (optic nerve canal; 5–10 mm), *intraorbital* (25–30 mm), and *intraocular segments* (about 1 mm), of which the intracanalicular segment is most relevant for decompression.

- The **optic canal** is about 9 mm (5–10 mm) long and has a wall thickness of about 0.3–1 mm. Its anterior opening is located in a posterior ethmoid cell in 50% of cases, in the passage from the sphenoid sinus and ethmoid bone in 25% of cases, and in the sphenoid sinus in 25% of cases. The bone is thinnest in the middle medial part of the canal. Bony dehiscences are found in 4% of cases.

- The projection of the medial optic canal in the laterosuperior sinus wall at the anterior foramen of the optic nerve canal is also called the **optic nerve tubercle**.

- A connective tissue ring (annulus of Zinn, insertion of eye muscles) is found at the tip of the orbital apex in the area of the optic foramen and the superior orbital fissure. This ring is formed by a fusion of the periorbita and dura mater. In 15% of cases, the ophthalmic artery runs intradurally and inferomedially in the canal – placing it at risk of iatrogenic injury during transnasal incision of the optic nerve sheath. Therefore, the latter maneuver should always be performed superomedially.

4.3 Anatomical Landmarks

- **Ethmoid**
  - Lamina papyracea
- **Sphenoid sinus**
  - Opticocarotid recess (optic strut).
  - Optic nerve.
  - Optic tubercle.
  - Optic nerve canal.
  - Annulus of Zinn.
  - Internal carotid artery (anterior genu in the cavernous segment).

Fig. 4.1

a. Anatomical dimensions of the optic nerve canal.
b. Endoscopic-topographic anatomy of the left-sided optic nerve inside the optic nerve canal. Optic nerve ①; internal carotid artery ②; opticocarotid recess ③; lamina papyracea ④; posterior wall ⑤ and roof ⑥ of the sphenoid sinus.
4.4 Details of Dissection / Surgical Technique

- Initially, a complete ethmoidectomy with wide fenestration of the sphenoid sinus is performed. Septa of the sphenoid sinus adhering to the optic nerve canal are subtotally removed.
- The posterior 1 cm of the lamina papyracea at the orbital apex is removed exposing the optic nerve tubercle. For this purpose, the lamina papyracea is gently fractured, an elevator is engaged, and used to flake off the thin bone in a piecemeal fashion. The periosteum remains intact. If the initial attempt of bone removal fails, a diamond burr may be used.
- The following regional landmarks must be clearly identified: Optic nerve tubercle, optic canal, internal carotid artery (anterior genu in the cavernous segment) and opticocarotid recess. The optic canal is generally about 9 mm long.

- The medial osseous wall of the optic canal is thinned under endoscopic control, using a diamond burr and constant irrigation, making sure not to lose sight of the landmarks mentioned above. The thinned bony lamella can then be flaked off with a delicate elevator.
- Anteriorly, the annulus of Zinn should be split in a sagittal plane at the superomedial circumference, e.g., by using microscissors.
- The nerve sheath may be incised over the entire course of the intracanalicular optic nerve (optional maneuver) which – for safety reasons – needs to be performed in the upper medial quadrant. The surgeon should be alerted to the possibility of CSF leakage. In that case, the opened canal is covered in a final step, for instance, with a free mucosal graft secured by gelatine sponges.

[Fig. 4.2a, b]

a. Preparatory stage of the procedure.
   Anatomical orientation is facilitated by use of a surgical navigation system. Note the pointer indicating to the optic nerve ① which is in close proximity to the internal carotid artery ②.

b. A diamond burr is used under abundant irrigation to thin the bone overlying the optic nerve.

[Fig. 4.3a, b]

a. An elevator ① is used to elevate the thinned lamina papyracea toward the optic tubercle.
   Optic nerve ②; internal carotid artery ③; annulus of Zinn ④ (hatched area).

b. The periorbita is incised ① at approximately 1 cm from the annulus of Zinn ② (hatched area). Optic nerve ③; orbital fat ④.
4.4.1 Clinical Notes

- Transnasal decompression of the medial optic canal can be performed for a length of approximately 7 mm. Beyond the canal, bone removal can be extended toward the optic chiasm up to a total length of 15 +/- 2 mm.6,29,32

- When dissecting toward the sphenoid sinus, on average 100° of the total circumference of the optic canal is exposed. If the lesser wing of sphenoid bone is pneumatized, this portion may be larger. The area available for transnasal (medial) decompression of the optic nerve measures about 0.66 (0.37–1.15) mm². 14

- If cottonoid patties are applied, any pressure on the optic nerve should be avoided.

- Do not apply gauze strips soaked with adrenalin 1:1000 to the exposed optic nerve. In the proximity of the optic nerve, monopolar coagulation is prohibited!
5.1 Objectives
The prelacrimal approach to the maxillary sinus commonly affords a panoramic overview of the entire maxillary sinus, prelacrimal recess, and anterior maxillary sinus wall. Given the availability of dedicated instruments, a complete removal of inflammatory processes and (primarily benign) tumors should be feasible. The approach may be used to access the maxillary sinus, orbital cavity, and retromaxillary space or may be enlarged to create a medial maxillectomy. Integrity of the inferior turbinate and the nasolacrimal canal is preserved.

5.2 Regional Anatomy
See Dissection Guide, Basic Course, Step 2 and Advanced Course, Step 2 – DCR.
A prelacrimal recess is found in 30–85% of patients, with a mean depth of 4 mm (range = 0–15.2 mm) at the level of the insertion of the inferior turbinate at the lateral nasal wall. In the male population, the recess is larger (4.8 mm) than in women (3.4 mm).34,39 The more vertical the course of the NLD, the smaller the prelacrimal recess. In approximately 15% of cases, the prelacrimal recess is less than 4 mm in depth, and it is absent in another 15%.

5.3 Anatomical Landmarks
- Middle turbinate and middle nasal meatus.
- Inferior turbinate and inferior nasal meatus.
- Frontal process of maxilla.
- Lacrimal sac.
- Nasolacrimal duct.
- Piriform aperture.
- Uncinate process.

5.4 Details of Dissection / Surgical Technique59,60
- Most commonly, uncinectomy and middle meatal antrostomy type 1–2 (or 1–3) are performed first (see Dissection Guide, Basic Course, Step 2).
- Next, a mucosal incision is made from the dorsal rim of the frontal maxillary process, starting a few millimeters above the insertion of the inferior turbinate. The line of incision runs in an arcuate shape anteriorly along the insertion of the inferior turbinate at the lateral nasal wall to the nasal floor and from there, slightly dorsally (Fig. 5.2a, b).
- The incision can be made using a surgical knife or radio frequency (RF) needle.
- The mucosal flap is then developed and mobilized, exposing the osseous lateral nasal wall and the turbinate bone.
- Dissection and mobilization of the mucosal flap is typically slightly complicated at the anterior insertion of the turbinate bone to the lateral nasal wall and the related passage to the inferior meatus, which is why this part of the procedure should be performed slowly to prevent the risk of mucosal tears, that may impede progress of dissection and surgery.
- Using an osteotome or chisel, the turbinate bone is detached from the lateral nasal wall at its insertion. Typically, the bone fractures spontaneously anterior to / on the nasolacrimal duct, which is intended. Apart from that, the adjacent cranial part of the frontal maxillary process is released separately and removed by means of a chisel.
- The duct is bluntly freed out of its bony canal and medialized together with the inferior turbinate and also with the intact mucosa of the lateral inferior meatus (including the intact Hasner's valve).
- As determined by the anatomy and thickness of the bone, the maxillary sinus is entered anterior or lateral to the NLD, and the opening is enlarged in a sequential manner reaching anteriorly the piriform aperture, inferiorly the nasal floor, and superiorly the maxillary sinus roof. Initially, this is done with a Kerrison punch, and completion often requires the use of an angulated intranasal shaver burr.
- Depending on the indication for surgery, it may not be necessary to maximize the opening, particularly in an anterocaudal direction. Omitting this step reduces the risk of iatrogenic injury to sensory nerve fibers of the incisors.
- In order to facilitate the approach, the need may arise to remove parts of the piriform aperture and anterior maxillary sinus wall up to the level of the infraorbital nerve, a surgical maneuver that equals the former endonasal Denker operation or Sturman-Canfield operation,4,50 however, different from the latter, in this case, integrity of the inferior turbinate and nasolacrimal duct are preserved.
- Based on this approach, the entire medial maxillary sinus wall may be removed as well (commonly preserving the inferior turbinate and NLD) resulting in a nearly complete medial maxillectomy.
- For this purpose, the mucosa of the inferior meatus is transected along an anteroposterior course, starting caudal to the entrance of the NLD, and the bone is exposed on both sides.
To improve wound healing and prevent (minimize) scarring between the maxillary sinus and nasal cavity, the bony ridge should be completely removed and smoothed in this case, and a medially pedicled mucosal flap should be developed and placed over the bony edge into the maxillary sinus.

At the end of surgery, the inferior turbinate is returned to its position and secured in place with one or two sutures.

Finally, occlusion of the nose is applied for approximately 1 week after surgery.

Fig. 5.1a–g Diagrammatic representation showing the basics of the operative approach and the boundaries of bone resection for the prelacrimal route. Direction of the surgical approach (arrow); bone resection for the prelacrimal route (green); bone resection required for a complete medial maxillectomy (yellow).

Axial CT scans (a–c, caudal-to-cranial direction). Frontal CT scans (d–g, anterior-to-posterior direction). Frontal maxillary process ①; nasolacrimal duct ②; inferior turbinate ③; medial maxillary sinus wall ④.

Fig. 5.2a, b
a. Line of mucosal incision for the prelacrimal route (dotted line) on the left side. Plane of the bony attachment of the inferior turbinate ① (solid line). Middle meatus ② (hatched area).

b. Incision line for the prelacrimal route using an RF needle. In case of a scheduled medial maxillectomy with formation of a medially pedicled mucosal flap at the nasal floor, the incision should be modified (green line).
Fig. 5.2c, d
c. Mucosal dissection of the inferior turbinate ①, the adjacent lateral nasal wall, and the nasal floor with exposure of the bony attachment of the inferior turbinate ②.
d. The chisel is engaged at the insertion of the inferior turbinate ① and applied following a course toward the frontal maxillary process ②. The bone typically fractures just before or at the level of the nasolacrimal duct.

Fig. 5.2e, f
e. Once the bone removal has been completed (insertion of the inferior turbinate and parts of the frontal maxillary process), the intact nasolacrimal duct ① is mobilized in a medial direction. The lateral nasal wall ② corresponds to the medial maxillary sinus wall.
f. A Freer elevator is used to enter the maxillary sinus cavity lateral to the medialized nasolacrimal duct.

Fig. 5.2g, h
g. A Kerrison punch is used to enlarge the opening created so far, followed by stepwise bone removal which is carried from the piriform aperture until reaching (at least) . . .
h. . . . the nasolacrimal duct ①, and from the nasal floor ② as far as the roof of the maxillary sinus ③ or until adequate access to the maxillary sinus is obtained.
5.4.1 Clinical Notes

Numbness in the area of the terminal branches of the infraorbital nerve (particularly in proximity to the incisors) is expected to arise in a small proportion of patients. If the prelacrimal recess is small or absent, the prelacrimal route is more difficult to accomplish, but still feasible. In these cases, it can be necessary to mobilize and medialize the nasolacrimal duct even further. Occasionally, part of the piriform aperture must be removed. This can result in a visible external deformity with lowering of the alar base.

Fig. 5.2i, j
i. Typically, the entire maxillary sinus cavity, including even the anterior maxillary sinus wall, can be approached endoscopically. Zygomatic recess; maxillary sinus roof; posterior and lateral wall of maxillary sinus; alveolar recess; curved suction tube.

Fig. 5.2k, l
k. The osseous ridge is removed until a seamless passage to the maxillary sinus is created or until the mucosal lining of the hard palate is seen to shine through. Mucosal flap medially pedicled at the nasal floor. Inferior turbinate; dorsal end of mucosal incision.

j. Medial maxillectomy. The osseous ridge between maxillary sinus and nasal cavity is ground off with an angulated intranasal drill, once a sagittal mucosal incision has been placed inferior to Hasner’s valve, and carried in a dorsal direction, followed by the creation of a medially pedicled flap. Inferior turbinate; maxillary sinus.

l. Finally, the mucosal flap is flipped back onto the raw exposed bone to provide an adequate cover while making sure that the mucosal margins of the nasal floor and maxillary sinus are in contact with each other.

5.4.1 Clinical Notes

- Numbness in the area of the terminal branches of the infraorbital nerve (particularly in proximity to the incisors) is expected to arise in a small proportion of patients.
- If the prelacrimal recess is small or absent, the prelacrimal route is more difficult to accomplish, but still feasible. In these cases, it can be necessary to mobilize and medialize the nasolacrimal duct even further. Occasionally, part of the piriform aperture must be removed. This can result in a visible external deformity with lowering of the alar base.

Fig. 5.2m
At the end of surgery, the inferior turbinate is readapted, e.g., with two sutures. Provided a medial maxillectomy is performed in the same session, the opening to the maxillary sinus is readily visualized through the inferior meatus.
Step 5: Frontal Sinus Drainage Type III

6.1 Objectives
Maximal development of the connection of the frontal sinus to the nasal cavity and ethmoid by resection of narrowing osseous structures (frontal sinus floor, superior nasal septum, frontal sinus septum, anterior nasal spine, frontal maxillary process as well as adjacent parts of the frontal and ethmoid bones, resection of the middle turbinate to the frontal level of the posterior frontal sinus wall). The bone is thinned to create a smooth passage extending from the frontal sinus to the nasal cavity and ethmoid sinus. To improve wound healing, the raw bone surfaces are covered with mucosal grafts (free or pedicled grafts).

6.2 Regional Anatomy
See also Dissection Guide, Basic Course, Step 2 and Advanced Course, Step 2.

The frontal sinus is the pneumatized space of the frontal bone, which develops from the anterior ethmoid. Depending on the highly variable degree of pneumatization, the frontal sinus extends to a variable degree dorsally and laterally beyond the orbit, into the frontal bone cranially and the temporal bone laterocranially. It often assumes an asymmetric shape. Among the major parameters relevant to frontal sinus surgery are the anteroposterior diameter of the inferior medial frontal sinus, the width of the anterior ethmoid, the cell configuration of the anterior ethmoid, and the shape of the frontal beak. These parameters define the size and position of the frontal sinus drainage pathway.

Based on the most up-to-date knowledge of anatomy, the junction of the anterior ethmoid and frontal sinus is no longer considered the ‘proper’ frontal sinus ostium but rather a continuous drainage pathway between the frontal sinus and anterior ethmoid.

Nevertheless, for practical reasons, the ‘opening’ is often defined as the bottleneck of the passage between frontal recess and frontal sinus, which is formed anteriorly by the nasal spine and posteriorly by the skull base (posterior wall of frontal sinus). This is best appreciated on a parasagittal CT scan, in which the frontal sinus opening is seen as the narrowest point of an hourglass. The lateral border is formed by the lamina papyracea and the medial border by the cranial extension of the vertical lamella of the middle turbinate or the lateral wall of the olfactory fossa.

The frontal beak (synonyms: spina nasalis ossis frontalis, nasal spine of frontal bone) is an osseous projection of the frontal bone that protrudes posteriorly as the lowest aspect of the medial portion of the anterior frontal sinus wall. It is clearly noticeable in a parasagittal CT scan (Fig. 6.2b).

The frontal beak has a mean depth of 6 mm (maximum 11 mm) and a mean height of 10 mm (maximum 16 mm) (Fig. 6.1). The anteroposterior diameter of the frontal sinus including the frontal beak is on average 12–14 mm, but it is subject to considerable variation. The distance between the posterior wall of frontal sinus and the anterior ethmoidal artery is 0–19 mm (on average 9 mm). The distance between the posterior frontal sinus wall and the first olfactory fibre is on average 4 mm (0–11 mm) or 12 mm (4.7–21.25 mm).

* Synonyms: Median Drainage, Frontal Drillout, Modified Lothrop Procedure, Endoscopic Frontal Sinus Surgery Grade VI

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Fig. 6.1
Frontal sinus (1); posterior frontal sinus wall (2); anterior frontal sinus wall (3); frontal beak (4); rhinobasis (5); anterior ethmoid artery (6); anterior skull base (7); frontal sinus floor (8).
Mean height of the frontal beak (a) = 10 (2–16) mm; mean depth of the frontal beak (b) = 6 (0–11) mm; antero-posterior diameter of the frontal sinus cavity (c) = 12–14 mm; mean distance between the anterior ethmoid artery and the posterior frontal sinus wall (d) = 9 (0–19) mm.
Once the type III drainage procedure has been completed, the shape of the letter ‘T’ (socalled ‘Frontal T’) should be demonstrated by the local anatomy when viewing the endonasal surgical field in an anterior-to-posterior direction: the vertical crus of the letter ‘T’ corresponds to the cutting edge of the dorsal nasal septum and the horizontal crus to the bilateral skull base near the anterior lamina cribrosa. A special anatomic variant in which the anterior end of the olfactory fossa buckles anteriorly into the frontal sinus is termed ‘potentially dangerous frontal sinus’. In extended frontal sinus procedures, the presence of this variant poses the risk of intracranial injuries.

### 6.4 Details of Dissection / Surgical Technique

- In many cases – particularly with ethmoidectomy undertaken in the same session – frontal sinus drainage type IIa is performed first in the described manner (see Dissection Guide, Basic Course, Step 3).
- In cases where spacial orientation is hampered by specific anatomical circumstances, for instance after prior surgeries or type III drainage alone, it is recommended to open the frontal sinus from a medial and inferoanterior position (outside-in-approach).
- In general, as a prophylactic measure, it is recommended to remove the mucosa from bone surfaces that are to be operated on. The removed mucosa is stored in moist conditions throughout the procedure. At the end of surgery, the mucosa can be thinned and placed on the raw bone surfaces. As an alternative option, pedicled mucosal flaps may be developed.
- Unless removed in a previous surgery, the head of middle turbinate is initially resected along a virtual frontal plane drawn through the posterior frontal sinus wall. Important anatomic landmarks that determine the direction and extent of resection are the dorsal margin of the frontal maxillary process and the anterior ethmoidal artery. Resection should never transgress dorsally beyond the medially located entry point of this artery into the olfactory fossa or dorsal to the first olfactory fibre. To prevent undue resection, the middle turbinates may first be trimmed in a conservative fashion. Following clear identification of all relevant local landmarks, the final reduction may then be performed.
- The bone that is to be removed can be thinned in a step-by-step manner with a diamond or cutting burr, starting from the opened frontal sinus (inside-out) or from an anteroinferior position in the median-sagittal plane toward the frontal sinus (outside-in). The outside-in technique allows a more rapid procedure because the lateral boundary of the surgical field (junction of lacrimal sac – lateral nasal wall – orbital cavity) and anterior boundary of the surgical field (peristomeum / subcutaneous tissue of nasion) may be exposed in initial stages of the procedures.

### 6.3 Anatomical Landmarks

- Frontal sinus.
- Sinus ossis frontalis (frontal beak).
- ‘Frontal T’.
- Ethmoid roof.
- Frontal process of maxilla.
- Middle turbinate.
- Cribriform plate.
- First olfactory fibre.
- Anterior ethmoidal cells.
- Anterior ethmoidal artery.
- Anterior nasal artery.
- Frontal recess and anterior ethmoidal cells.

For drilling, curved sinus burrs have proven efficient because they permit irrigation and suction of the surgical site and help prevent thermal damage at the external nasal orifice or the surgical site.

A piece of the nasal septum, approximately 2 x 2 cm in size (or as large as necessary), is removed inferior to the frontal sinus floor to ensure that the contralateral FPM is readily visible from both sides. The dorsal resection margin is the virtual frontal plane through the posterior frontal sinus wall or the anterior margin of the reduced middle turbinate, or the dorsal margin of the FPM. In the direction of the nasal bridge, the naso bone serves to protect against instability. Here, the bone is thinned enough toward the nasion and the caudal part of the anterior frontal sinus wall in order to ultimately create a smooth transition or, if required, to develop a small area of peristomeum/subcutis.

As an alternative option, one may choose to start at a cranio medial site and subsequently enlarge the lateral expanse of resection (outside-in technique).

In the outside-in technique, the frontal sinus mucosa shines through as a greyish-blush structure when the overlying bone has been thinned. The frontal sinus that has already been accessed in the course of a type IIa drainage procedure, may also be used for orientation purposes.

In the end, there should be a large common (approximately kidney-shaped, when viewed from caudally) transnasal, smooth access to both frontal sinuses.
The frontal sinus septum is removed as far as possible in a cranial direction. Laterally, the bony medial orbital wall is exposed taking care to preserve the local mucosa to the extent possible. Dorso-laterally, the transition from the posterior frontal sinus wall to the ethmoid roof is smoothed while preserving integrity of the mucosal lining.

Dorso-medially, the shape of the so-called ‘Frontal T’ may come into view (with the vertical stroke of the ‘T’ running through the free edge of the dorsal septal resection and the horizontal stroke traversing the anterior margin of the cribiform plate). Meticulous care must be paid when removing tissue in the direction of the olfactory fossa. A point located about 6 mm anterior to the exit of the first olfactory fiber (which can be atraumatically exposed in a submucosal fashion) or the exit of a distal branch of the anterior ethmoidal artery arising from an anterior bone fissure should be respected as a safety margin.

The terminal branches of the anterior nasal artery should be carefully coagulated at the end of surgery to prevent postoperative bleeding.

Subsequently, reconstruction is performed by covering the raw bone surfaces with free or pedicled mucosal grafts to improve local wound healing. The free grafts are thinned and placed on areas most susceptible to restenosis.

If necessary, additional free mucosal grafts can be harvested from the nasal floor or the dorsal nasal septum.

The fashioning and placement of thin silicone sheets has been described in the literature as an alternative or adjunctive option.23,49

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Fig. 6.2a–f Areas of bone removal in a frontal sinus drainage procedure of type III. Median sagittal CT scan (a); parasagittal plane (b); frontal CT scan (c, d); axial CT scan (e, f).

Frontal beak; frontal process of maxilla; Agger nasi cell; ethmoid bulla; suprabullar ethmoidal cell; ground lamella of the middle turbinate; anterior ethmoidal artery; frontal intersinus septum; superior nasal septum; ethmoidal roof; olfactory groove; middle turbinate (cranial portion of the medial lamella).
Step 5: Frontal Sinus Drainage Type III

Fig. 6.3 Alternative options of bone resection procedures in endonasal endoscopic frontal sinus drainage procedures of type II and III. Each of the various color-coded anatomical structures can be resected in the incremental enlargement of the drainage / access pathway.8

- **Type IIa** (yellow);
- **Extended Type IIa** (yellow + orange [if necessary] + thinning of the frontal maxillary process [if necessary]);
- **Type IIb** (yellow + orange + green unilateral);
- **Extended Type IIb** (e.g., possible, in this case, on the right) = (Type IIb and blue);
- **Modified Type III** = Type IIb + red + blue ([if necessary] e.g., possible, in this case, on the right);
- **Type III** ([yellow + orange + green] bilateral + red + blue);
- **Extended Type III** = Type III + grey, e.g., optional resection of parts of the orbital roof.8

Fig. 6.4a, b
a. Partial resection of the anterior left-sided middle turbinate (if present). The incision line starts from the level of the frontal maxillary process (a) and ends before the frontal plane of the posterior frontal sinus wall (b, c). The anterior ethmoidal artery is a major landmark for this purpose, and its medially visible end should always stay dorsal to the resection margin.

b. Anterior vertical lamella of the middle turbinate (1); frontal maxillary process (hatched area) (2); axilla (3); anterior ethmoidal artery (4); basal lamella of middle turbinate (5); insertion site of a supraorbital ethmoidal cell at the skull base (6); posterior frontal sinus wall (7).
c. Harvesting of free mucosal grafts for subsequent reconstruction (see d).
Major landmarks are the frontal maxillary process ① and the posterior frontal sinus wall ② as well as the middle turbinate which may be partially resected ③.

d. The lateral part of the flap has already been incised. The complementary medial incisions are shown in dotted lines. The image above is from a different specimen than in (a–c) and was captured during harvesting of a free mucosal graft. View of the bone area to be resected in a type III drainage procedure.

Fig. 6.4c, d

e. Start of bone resection with removal of part of the superior frontal maxillary process and exposure of the upper end of the lacrimal sac and the lateral nasal wall. The site can be checked by applying gentle pressure to the soft tissue of the external nasal root from outside which may cause the local intranasal tissue to move correspondingly ②. Thinned frontal maxillary process ①; lacrimal sac / soft tissue of the lateral nasal wall ②; middle turbinate ③; posterior wall of frontal sinus ④; frontal process of maxilla / passage to the frontal sinus floor ⑤.

f. Following resection of the superior nasal septum ① – far enough to permit visualization of the contralateral frontal process of maxilla ② and to allow working on both sides – the bone of the anterior frontal sinus floor ③ and of the frontal beak ④ is removed using the outside-in technique or a combined approach by complementary use of the inside-out technique (shown in f).
Step 5: Frontal Sinus Drainage Type III

Fig. 6.4g, h

Careful blunt dissection with an elevator at the junction to the cribiform plate, where the anterior nasal artery ① is the first landmark that comes into view. Further dorsally, the first olfactory fibre ② is seen.

h. At the end of dissection, the endonasal frontal sinus should be maximally enlarged and exhibit a smooth passage to the nasal cavity and ethmoid sinus. Laterally, a small surface area of the peristeum, and accordingly, the soft tissue of the cranial part of the lateral nasal wall ① are exposed. The bone to the caudal portion of the anterior frontal sinus wall ② has been thinned. Dorsally, the ‘Frontal T’ is visible ③.

Fig. 6.4i

Free mucosal grafts (or as an alternative option, pedicled mucosal flaps) are used to cover the bone surfaces that have been exposed for reconstruction.
6.4.1 Clinical Notes

- Provided the frontal sinus approach – described above – is only expanded on one side, the procedure is termed a type IIb approach: removal of the frontal sinus floor between the nasal septum medially and the lamina papyracea laterally. The anterior process of the vertical lamella of the middle turbinate must be resected anterior to a virtual frontal plane that is drawn through the posterior frontal sinus wall. The resection of the superior nasal septum is an important and defining feature in type III procedures (e.g., in comparison to bilateral type IIb procedures) as it offers manipulation and visualization through both nostrils.52

- Depending on the anatomy and underlying pathology, additional types or modifications of frontal sinus drainage procedures apart from type IIb and type III can be defined. Individual surgical steps can be combined in a modular manner, for instance the resection of the nasal septum, frontal intersinus septum, frontal sinus floor between contralateral middle turbinate and nasal septum, middle turbinate, contralateral anterior ethmoid, or parts of the medial orbital wall or the orbital roof.8,52

- The distance between the posterior frontal sinus wall and the first olfactory fibre is on average 4 mm.47 When addressing the bony ‘Frontal T’, meticulous caution is needed to drill no further than 6 mm rostral to the first olfactory fibre. Based on this rule of thumb, the cribriform plate with the olfactory fibers remains intact in 80% of cases (at a distance of 7 mm; this proportion rises to 91%). However, this information is not very helpful for clinicians. A safe and more useful option is to use a blunt instrument for submucosal dissection in the border zone anterior to the olfactory cleft and to first skeletonize the anterior nasal artery and possibly further dorsally, to expose the exit site of the first olfactory fibre. This provides reliable orientation for subsequent bone thinning.

- In view of the expanded options of endonasal frontal sinus surgery, the last resort of obliterating the frontal sinus with fat is commonly indicated only if a type III procedure has proven to fail or (for anatomic reasons) is most likely to be not feasible.50–52

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Fig. 6.5a–d
Reconstruction after type III drainage using a pedicled mucosal flap on the right side and free grafts.
Once the type III drainage procedure is complete (c), a cranially pedicled mucosal flap – initially created at the lateral nasal wall (a) – is laid back medially to cover the exposed bone on the right side (b). The residual raw bone surfaces are covered with free grafts (d). Lateral nasal wall, right side (region of frontal process of maxilla) ①; pedicled mucosal flap ②; nasal septum ③; nasal dome ④; caudal portion of the anterior frontal sinus wall ⑤; small surface area of exposed peristome/subcutis on the left ⑥; “Frontal T” (in this case, relatively far anterior) ⑦; free mucosal grafts ⑧.
Step 6: Dissection of the Pterygopalatine Fossa

7.1 Objectives
- The creation of a transnasal-transethmoidal corridor with maximal fenestration of the maxillary sinus in the middle meatus.
- Transnasal opening of the pterygopalatine fossa from anteriorly by removing the medial posterior wall of the maxillary sinus. Visualization of the relevant neural structures and vessels in the fossa with exposure of its bony canals in the posterior wall.

7.2 Regional Anatomy
- In 90% of cases, the sphenopalatine foramen is located in the superior meatus directly posterior to the laterodorsal insertion of the basal lamella of the middle turbinate; in approximately 10% of cases, there are multiple adjacent foramina. The foramen is located between two projections of the superior palatine bone, the superolaterally oriented orbital process and the superomedially oriented sphenoidal process (Fig. 7.1).
- Lateral to the sphenopalatine foramen lies the pterygopalatine fossa. It is about 9 mm in depth and has an anterior compartment with the maxillary artery and its terminal branches (including posterior nasal artery, posterior superior alveolar artery, infraorbital artery, descending palatine artery, and palatovaginal artery), which are embedded in fat (Fig. 7.2). The posterior compartment contains nerves, particularly the maxillary artery, the infraorbital artery, the descending palatine artery, and also branches that pass to the foramen rotundum, the pterygoid canal, and the nasopharynx. The latter arteries are located in the pterygopalatine fossa anterior to the nerves (maxillary nerve, nerve of pterygoid canal – greater petrosal nerve, pterygopalatine ganglion, numerous connections).

**Fig. 7.1** Anterior aspect of the left palatine bone. Orbital process of the palatine bone ①. Sphenoidal process ①. The notch between both processes corresponds to the sphenopalatine foramen. Nearby, the ethmoid crest of the palatine bone should be visualized.

**Fig. 7.2** Diagram showing the distribution of nerve and arterial branches medial and lateral to the sphenopalatine foramen (adapted from①②③; Note: sections are placed at different levels laterally and medially). Terminal branches of the maxillary artery, besides the known septal artery and posterior lateral nasal artery, are the posterior superior alveolar artery, the infraorbital artery, the descending palatine artery, and also branches that pass to the foramen rotundum, the pterygoid canal, and the nasopharynx. The latter arteries are located in the pterygopalatine fossa anterior to the nerves (maxillary nerve, nerve of pterygoid canal – greater petrosal nerve, pterygopalatine ganglion, numerous connections).

**Key to Fig. 7.2**
① Maxillary artery.
② Sphenopalatine artery.
③ Foramen rotundum.
④ Maxillary nerve.
⑤ Inferior alveolar artery and nerve.
⑥ Ostium of sphenoid sinus.
⑦ Pterygopalatine ganglion.
⑧ Mandibular nerve.
⑨ Middle meningeal artery.
⑩ Pharyngeal arterial branch.
⑪ Optic chiasm.
⑫ Inferior turbinate.
⑬ Sphenomandibular ligament.
⑭ Medial pterygoid muscle.
⑮ Parotid gland.
⑯ Oculomotor nerve.
⑰ Pterygoid canal with nerve of pterygoid canal (vidian nerve, from the greater superior petrosal nerve) and artery.
⑱ Posterior septal artery (medial branch of the sphenopalatine artery).
⑲ Superior and inferior posterolateral branches of the sphenopalatine artery.
⑳ Descending palatine artery.
㉑ Posterior superior alveolar artery.
㉒ Infraorbital artery.
* Sections at different levels.
nerve with its branches, as well as the pterygopalatine ganglion and the nerve of pterygoid canal (termed 'vidian nerve'). The pterygopalatine ganglion forms an Y-shaped structure together with the nerve of the pterygoid canal, the branches of the maxillary nerve, and the greater palatine nerve.

- Through the pterygomaxillary fissure, the pterygopalatine fossa laterally merges with the infratemporal fossa. The course of the infraorbital nerve serves as corresponding clinical landmark that separates the pterygopalatine from the infratemporal fossa.
- At the posterior wall of the pterygopalatine fossa, critical landmarks are the nerve of pterygoid canal and the foramen rotundum. Between the two structures, a virtual line can be drawn in the frontal CT scan (so-called ‘VR Line’ = vidian-rotundum line, Fig. 7.3). This line allows quantifying the lateral and lateral-inferior dimensions of the sphenoid sinus in each individual patient, e.g., to plan a ‘transpterygoid corridor’ in the direction of lateral recesses of the sphenoid sinus or in the direction of Meckel’s cavity.

7.3 Anatomical Landmarks

- Palatine bone (sphenopalatine foramen, orbital and sphenoidal process of the cranial palatine bone).
- Maxillary artery, sphenopalatine artery, posterior nasal artery, pharyngeal artery.
- Nerve of the pterygoid canal (also termed ‘vidian nerve’) with its bony canal.
- Intraorbital nerve, maxillary nerve and foramen rotundum.
- The pterygopalatine ganglion, the nerve of pterygoid canal, and the maxillary nerve are all located superior and lateral to the sphenopalatine foramen. The distance between the sphenopalatine foramen and the ostium of the pterygoid canal measures only approximately 2 mm, and the foramen rotundum, located in a superolateral direction, is another 7 mm away. Viewed from anteriorly, an imaginary letter ‘H’ can be drawn in the frontal plane, with its vertical strokes formed by the bilateral vertical lamella of the palatine bone and extended toward the lateral sphenoid sinus walls. The horizontal stroke connecting the vertical lines is at the level of the sphenoid sinus floor (both sides). The nerve of pterygoid canal is slightly lateral to the junction of the horizontal and vertical lines of the ‘H’. The pharyngeal (palatovaginal) canal (canalis palatovaginalis, CPV) – coursing in a mediodorsal direction between the sphenoid palatine process and the sphenoid bone, and transmitting a pharyngeal (palatovaginal) artery and pharyngeal branches of the maxillary nerve – must be clearly identified. The distance between the pharyngeal canal and the nerve of the pterygoid canal is 2–4 mm.
Step 6: Dissection of the Pterygopalatine Fossa

7.4 Details of Dissection / Surgical Technique

The first surgical sub-step consists of establishing the necessary transnasal corridor to the pterygopalatine fossa:

- Ethmoidectomy with visualization of the posterior aspects of the lamina papyracea.
- The creation of a maximally enlarged, dorsally oriented opening into the maxillary sinus in the middle meatus.
- Ample sphenoid fenestration (transethmoidal).

This is followed by visualization of the sphenopalatine foramen (landmark: ethmoidal crest) and the medial posterior maxillary sinus wall (through the neo-ostium in the middle meatus). If necessary, the posterior projection of the middle turbinate and a few millimeters of the inferior boundary of the superior turbinates may be removed as well. If the procedure is planned to allow a ‘four hands – two minds’ technique to be applied using both nostrils for the surgical corridor, then 1.5 cm of the posterior nasal septum may also be resected in highly selective cases.

The sphenopalatine foramen is enlarged with the Kerrison punch. Using the osteotome, the medial posterior maxillary sinus wall can be ‘circumcised’, released, and removed. In a similar fashion, parts of the orbital process of the palatine bone are removed (as an alternative option, the surgeon may choose to continue working with a Kerrison punch or diamond burr).

The medial branches of the maxillary artery (sphenopalatine artery, posterior nasal artery, palatovaginal artery as well as pharyngeal branches) are identified and transected (intraoperatively, after bipolar coagulation). The descending palatine artery is identified and spared. Subsequently, the periorbita along with the soft tissue is stripped off the underlying bony posterior wall of the pterygopalatine fossa and mobilized in an inferolateral direction.

Medially, the opening of the nerve of the pterygoid canal is visualized. This is most easily achieved by removing the inferior and posterior margin of the sphenopalatine foramen, which corresponds to the superior sphenoid process of the palatine bone, e.g., using straight Blakesley nasal forceps or a diamond burr. This maneuver provides access to the floor of the funnel-shaped entrance to the pterygoid canal, which is also referred to as ‘gutter’.

Using a sickle knife or slender elevator, subperiosteal dissection is carried out in a lateral direction, keeping in mind that the nerve of the pterygoid canal is just above the instrument. In order to clearly identify and skeletonize the nerve of the pterygoid canal completely, the artery and nerve that branch medially into the palatovaginal canal are cautiously transected. Once the nerve of the pterygoid canal along with its opening are clearly identified, dissection is completed around the foramen.

The infraorbital nerve is identified at the dorsal aspect of the maxillary sinus roof (forming the lateral surgical boundary). The nerve is followed proximally. It should also be noted that posterior to the infraorbital canal, the nerve runs medially in the direction of the foramen rotundum and may form a small caudal ‘loop’ in the lateral pterygopalatine fossa (Fig. 7.4h).

Schematic sequence showing the dissection of a pterygopalatine fossa on the left. No wide surgical ‘corridor’ was created.

Key to acronyms: Sphenopalatine artery (A.sph.); ethmoidal crest of the palatine bone (Cr.e.); sphenoidal process of palatine bone (P.s.); pharyngeal artery (Ph.a.); middle turbinate (Co.m.).

Fig. 7.4a–f (Continued overleaf)

a. Following creation of a subperiosteal mucosal flap in the posterior middle meatus, the sphenopalatine foramen is visualized referring to the local landmark (Cr.e.).

b. The sphenopalatine foramen is enlarged, and the pterygopalatine fossa can be dissected from medially. Direction of the palatovaginal canal (→); location of the nerve inside the pterygoid canal which is obscured by soft tissue (●).

c. The palatovaginal artery (Ph.a.) (→) can be visualized in its course through the pharyngeal canal following subperiosteal tunneling of the mucosa (A.sph.) (●); bone to be resected (P.s.) (●).

d. When stripping the soft tissue of the pterygoid fossa subperiosteally from medial to lateral and inferior, the nerve of the pterygoid canal is revealed just lateral to the vertical lamella of the palatine bone (●); transected palatovaginal artery (●).

e. The mucosa of the posterior maxillary sinus wall is stripped away laterally and cranially, and the medial portions of the wall are mobilized using the osteotome (●); osseous incision lines (→).

f. The circumcised portions of the osseous posterior wall of maxillary sinus (●) are mobilized and removed, and the periosteum of the anterior wall of the pterygopalatine fossa is exposed.
In proximity to vessels and nerves, the need may arise to selectively and cautiously remove fatty tissue for the specific purpose of demonstrating the maxillary nerve and the proximal course of the infraorbital nerve. At the posterior wall of the pterygopalatine fossa, the periosteum can be locally slit and stripped off. As a result, the foramen rotundum is seen when following the course of the nerve.

Once the nerve of the pterygoid canal and the maxillary nerve with the foramen rotundum are identified, a transpterygoid approach to the lateral sphenoid sinus may be chosen, sufficient lateral and lateral-inferior pneumatization of the sphenoid sinus provided. In doing so, parts of the posterior wall of the pterygopalatine fossa are removed proceeding from medial to lateral.

### 7.4.1 Clinical Notes
Additional surgical procedures on the pterygopalatine fossa should be guided by a surgical navigation system.

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**Fig. 7.4g–i** Continued from page 31.

**g.** The exposed periosteum is incised (_green arrow_ with a sickle knife (_blue) revealing the anterior soft tissue compartment with fat and vessels.

**h.** Following dissection and lateralization of fat and vessels, the arcuate course of the infraorbital nerve (_red arrow_) is visible from the maxillary sinus roof (_blue arrow_) in the direction of the foramen rotundum (Green).

**i.** When transecting the branches of the maxillary nerve and the nerve of pterygoid canal, and stripping the periosteum away from the posterior wall of the pterygoid fossa, the spatial relationships of the foramen rotundum (Green) and pterygoid canal (N.c.p.) can be appreciated more distinctly (elevator, *).

---
Step 7: Transcribriform Skull Base Approach

8.1 Objectives
- Transnasal resection of the bone and, if necessary, the dura of the olfactory fossa and adjacent structures interposed between the posterior frontal sinus wall anteriorly and the planum sphenoidale posteriorly, as well as the lamina papyracea on both sides.

8.2 Regional Anatomy
- The anterior cranial fossa is formed by the orbital process of the anterior frontal bone, the cribriform plate of the ethmoid bone centrally, and the lesser wing of sphenoid bone as well as the body of sphenoid bone dorsally.
- The cribriform plate is bilaterally located in a depression between the bilateral orbital roof and delimits the anterior cranial fossa from the nasal cavity. Fifteen to 20 small foramina connect the olfactory fibers with the olfactory bulb.
- The crista galli projects upward in the midline in the anterior part of the cribriform plate and serves as attachment of the falx cerebri. Interposed between the crista galli and the frontal bone lies the foramen caecum in the frontoethmoidal suture, through which an emissary vein runs to the superior sagittal sinus.
- The anterior (middle, if present) and posterior ethmoidal arteries course from the orbital cavity through the ethmoidal roof in the lateral part of the cribriform plate to reach the endocranium.
- Posterior to the cribriform plate is the sphenoid body with the planum sphenoidale, the limbus sphenoidale, the chiasmatic sulcus, the tuberculum sellae, the pituitary fossa, and the dorsum sellae. The planum sphenoidale forms the roof of the posterior ethmoid and the anterior aspect of the sphenoid sinus roof, and it borders on the posterolateral optic canal.

8.3 Anatomical Landmarks
- Frontal sinus, posterior frontal sinus wall.
- Crista galli.
- Cribriform plate.
- Ethmoid, roof of ethmoid.
- Sphenoid, planum sphenoidale.
- Lamina papyracea.
- Superior sagittal sinus.
- Falx cerebri.
- Olfactory bulb and tract, olfactory fibers.
- Gyrus rectus and orbitofrontal cortex.
- Anterior and posterior ethmoidal arteries.

Special intracranial landmarks
- Anterior cerebral artery and its frontopolar and orbitofrontal branches.

8.4 Details of Dissection / Surgical Technique
The entire dissection at the skull base should be performed using the ‘four-hand’ technique.\textsuperscript{19,24,26,55}

In unilateral surgery with a transcribriform approach to the anterior skull base, the region of the cribriform plate is resected and the crista galli is spared.

- The classic bilateral approach with dural resection is typically initiated with a complete sphenethmoidectomy, maxillary antrostomy through the middle meatus (type III), and frontal sinus drainage type III. The (partial upper) resection of the nasal septum as well as that of the middle and superior turbinates is performed depending on the type and extent of the pathology.
- As determined by the planned coverage of the skull base defect, the vascularized naso-septal flap (NSF) is dissected at the start of the operation and kept aside for the duration of surgery, e.g., in the nasopharynx or in the maxillary sinus.
- The vascularized naso-septal flap (NSF) is a mucosal flap from the nasal septum that is pedicled at the posterior nasal artery.\textsuperscript{13,16} The artery exits the sphenopalatine foramen in its posterosuperior part and runs along the anterior sphenoid sinus wall inferior to the sphenoid sinus ostium to reach the nasal septum. It separates into two main branches either proximally or distally.
- The inferior-posterior incision (made to create the dorsal stalk of the flap) follows the choana. A corresponding horizontal superior incision is placed near the sphenoid sinus ostium. The sagittal, anterior-inferior incision is placed at the junction of the septum to the nasal floor (in case of need, it may be placed even at the lateral
nasal floor). The superior incision on the nasal septum should spare the olfactory mucosa (superior 1.5 cm) – however, anterior to the head of the middle turbinate, this incision may be carried directly upward to the nasal roof. The aforementioned incisions are connected by placing additional vertical incisions posteriorly along the posterior edge of the nasal septum and also anteriorly in the nasal vestibule.

- To cover the cartilaginous and bony portions dissected free at the nasal septum after harvesting the NSF, a so-called ‘reverse flap’ can be formed from the contralateral septal mucosa as an anteriorly pedicled turnover flap. Initially, bone and cartilage of the posterior half of the nasal septum are resected. The contralateral mucosa is circumcised in a U-shape, i.e., cranially, posteriorly, and caudally, and swung around the new dorsal septal edge in an anterior direction. The flap is secured by anterior mucosal sutures, adjunctive transseptal mattress sutures, or septal silicone sheets.

- The dissection margins in the transcribriform approach pass lateral to the medial wall of the orbital cavity, anterior to the frontal sinuses, and posterior to the sphenoid sinuses.

- The anterior, posterior, and, if present, middle ethmoidal artery on both sides are identified, bipolar coagulation is applied, and the arteries are transected (early devascularization of a tumor).

- At least the superior nasal septum is removed along with the middle and superior turbinates on both sides.

- A diamond burr is used to thin down or remove the inferior aspect of the anterior frontal sinus wall, the ethmoidal roof on both sides, and the posterior planum sphenoidale of the cribriform plate, optimally without opening the dura at that time. Any remaining thin bony lamella can be removed with an elevator and / or a Kerrison punch.

- Prior to opening the dura, the crista galli can be released by subperiosteal dissection, also without opening the dura.

- The dura is incised in an anterior-to-posterior direction.

- The dura is bilaterally opened well lateral to the falx cerebri (in proximity to the orbit), e.g., with delicate scissors. If necessary, the superior sagittal sinus should be packed, e.g., using oxidized regenerated cellulose.

- The attachment of the falx cerebri to the crista galli is the only residual attachment holding the skull base. It often harbors vessels and should be coagulated before being transected. It may extend more than 1 cm in a posterior direction.

- The falx cerebri is cut through in a step-by-step manner and, if required, it is detached from any residual part of the crista galli that is still in situ or from the specimen of the resected skull base. In this operative step, it has proven useful to place the connective tissue of the specimen under gentle traction.

- After final delivery of the skull base specimen in the area of the planum sphenoidale, the surgeon is provided with an endocranial bilateral view of the olfactory bulb and tract, the basal cerebral vessels, and portions of the frontobasal brain. Often, the olfactory bulb is already included in resection and also delivered when the specimen ‘drops down’.

- Final coverage of the dural defect is then performed, which is typically done in layers, e.g., with a first graft of fascia lata as an intracranial underlay graft, a second fascia lata graft as a far-overlapping onlay graft from the nasal side, and finally the vascularized naso-septal flap (NSF). As an alternative option, a triple-layered dural repair can be performed with the ‘Triple F’ technique, using fat, fascia, and the NSF.

---

**Fig. 8.1a, b**

*a.* Subperiosteal dissection of the vascularized naso-septal flap in a dorsal direction (right side). The incision line starts dorsally, inferior to the natural sphenoid sinus ostium ①, and is then carried superiorly to the skull base (preserving 1.5 cm of olfactory mucosa) ② ascending anterior to the middle turbinate. Integrity of the mucosa of the medial olfactory rim ③ is preserved.

*b.* For optimal mobilization, the caudal dorsal incision is placed at the inferior border of the choana (dotted line) to the lateral nasal wall.
Fig. 8.2a–h (Continued overleaf)

a. The anterior aspect of the cribriform plate is precisely demonstrated by surgical navigation.

b. Detachment of the crista galli ① from the dura ② after thinning of the bone with a diamond burr, whereby particular attention is paid to the anterior bony bridges. Posterior frontal sinus wall ③.

c. Clearly note the bilateral anterior boundaries of the cribriform plate a and the anticipated resection line (dashed line).

d, e. Thinning of the skull base with a diamond burr. Inferior aspect of the posterior frontal sinus wall ①; right ② and left ethmoidal roof ③; planum sphenoidale ④.

f. The skull base is revealed once it has been caudally mobilized from all sides. Inferior aspect of the posterior frontal sinus wall ①; ethmoidal roof ③; planum sphenoidale ④; lamina papyracea ④; posterior ethmoidal artery ③.

g. Incision of the anterior dural layer.

h. Following bilateral incision of the anterior dural layer, the skull base, held in place by the falx cerebri ①, comes into view. Posterior frontal sinus wall ②; ethmoidal roof ③.
8.4.1 Clinical Notes

- If possible, it is recommended to leave a small bony strut at the ethmoidal roof and particularly anteriorly (toward the posterior frontal sinus wall) serving as a support bearing for the grafts.
- The repaired skull base defect is covered with a layer of gelatin or other dissolvable nasal packing material to prevent dislocation of the grafts after removal of the nasal packing.

- Clinically, the procedure is performed under antibiotic prophylaxis. On a regular basis, a lumbar drain is not required.52
References


42. SOYKA MB, TREUMANN T, SCHLEGEL CT. The agger nasi cell and uncinate process, the keys to proper access to the nasolacrimal drainage system. Rhinology 2010;48(3):364–7.


Telescopes, Instrument Sets and Videoendoscopic Equipment for Advanced Endonasal Endoscopic Sinus Surgery
**HOPKINS® Telescopes**

Diameter 4 mm, length 18 cm

![Image](7230 AA)

**HOPKINS® Straight Forward Telescope 0°**, enlarged view, diameter 4 mm, length 18 cm, **autoclavable**, fiber optic light transmission incorporated, color code: green

![Image](7230 BA)

**HOPKINS® Forward-Oblique Telescope 30°**, enlarged view, diameter 4 mm, length 18 cm, **autoclavable**, fiber optic light transmission incorporated, color code: red

![Image](7230 FA)

**HOPKINS® Forward-Oblique Telescope 45°**, enlarged view, diameter 4 mm, length 18 cm, **autoclavable**, fiber optic light transmission incorporated, color code: black

![Image](7230 CA)

**HOPKINS® Lateral Telescope 70°**, enlarged view, diameter 4 mm, length 18 cm, **autoclavable**, Fiber optic light transmission incorporated, Color code: yellow

It is recommended to check the suitability of the product for the intended procedure prior to use.
**Accessories**

- **STAMMBERGER Telescope Handle**, flat, standard model, length 11 cm, for use with HOPKINS® straight forward telescopes 0° with diameter 4 mm and length 18 cm
- **STAMMBERGER Telescope Handle**, round, standard model, length 11 cm, for use with HOPKINS® telescopes 30°–120° with diameter 4 mm and length 18 cm

**Instruments**

- **FREER Elevator**, double-ended, semisharp and blunt, length 20 cm
- **FREER-WEBER Elevator**, double-ended, one side slightly curved FREER elevator, semisharp, other side strongly curved, sharp, length 19 cm
- **COTTLE Elevator**, double-ended, semisharp and blunt, graduated, length 20 cm
- **Sickle Knife**, pointed, length 19 cm
- **Antrum Curette**, oblong, small, length 19 cm
- **KUHN-BOLGER Frontal Sinus Curette**, 55° curved, oval, forward cutting, length 19 cm
- **Probe**, double-ended, maxillary sinus ostium seeker, ball-shaped ends diameter 1.2 and 2 mm, length 19 cm
- **CASTELNUOVO Frontal Sinus Probe**, double-ended, curved, length 22 cm
Instruments

586026  v. EICKEN Antrum Cannula,
LUER-Lock, with cut-off hole, long curve,
outer diameter 2.5 mm, length 12.5 cm

586030  v. EICKEN Antrum Cannula,
LUER-Lock, long curved, outer diameter 3 mm,
length 12.5 cm

529309  FRAZIER Suction Tube,
with mandrel and cut-off hole,
with distance marking at 5– cm, 9 Fr.,
working length 10 cm

213314  WULLSTEIN Scissors,
curved, sharp/sharp, length 14 cm

174200  COTTLE Metal Mallet,
length 18 cm

484004  COTTLE Chisel,
flat, graduated, straight, width 4 mm,
length 18.5 cm
Nasal Forceps

451000 B  GRÜNWALD-HENKE RHINOFORCE® II Nasal Cutting Forceps, straight, through-cutting, tissue-sparing, BLAKESLEY shape, size 0, width 3 mm, with cleaning connector, working length 13 cm

451500 B  GRÜNWALD-HENKE RHINOFORCE® II Nasal Cutting Forceps, 45° upturned, through-cutting, tissue-sparing, BLAKESLEY shape, size 0, width 3 mm, with cleaning connector, working length 13 cm

456001 B  BLAKESLEY RHINOFORCE® II Nasal Forceps, straight, size 1, with cleaning connector, working length 13 cm
Nasal Forceps

456501 B  BLAKESLEY-WILDE RHINOFORCE® II Nasal Forceps,
45° upturned, size 1, with cleaning connector,
working length 13 cm

634824  STRÜMPEL Forceps,
with oval, fenestrated, cupped jaws, straight, width 2.5 mm,
working length 12.5 cm

651010  STAMMBERGER RHINOFORCE® II Double Spoon Forceps,
vertical opening, 65° upturned, spoon diameter 3 mm,
with cleaning connector, working length 12 cm
Nasal Scissors

663300  Scissors, straight, working length 18 cm

663307  Scissors, 45° curved upwards, extra delicate, working length 18 cm
Punches

459010  STAMMBERGER RHINOFORCE® II Antrum Punch, upside backward cutting, with cleaning connector, working length 10 cm

459040  PARSONS RHINOFORCE® II Punch, for resection of the uncinate process, upward backward cutting, movable jaw with round tip, diameter 2.5 mm, with cleaning connector, working length 10 cm

651065  STAMMBERGER Punch, circular cutting, 65° upturned, for frontal sinuses recess, diameter 4.5 mm, with cleaning connector, working length 17 cm, including Cleaning Tool 651050 R
HOSEMANN **Frontal Sinus/Recess Punches and Sphenoid Punch**

*with integrated irrigation channel*

651503

**HOSEMANN Frontal Sinus/Recess Punch,**
70° upturned, slender model, punch head diameter 3.5 mm, not through-cutting, upper part of punch fixed, lower part of punch movable, sheath diameter 2.5 mm, central irrigation channel with concealed LUER-Lock irrigation adaptor, working length 13 cm

651504

**HOSEMANN Sphenoid Punch,**
straight, slender model, punch head diameter 3.5 mm, not through-cutting, front part of punch fixed, rear part of punch movable, sheath diameter 2.5 mm, central irrigation channel with concealed LUER-Lock irrigation adaptor, working length 13 cm

651505

**HOSEMANN Frontal Sinus/Recess Punch,**
70° upturned, robust model, punch head diameter 5.5 mm, not through-cutting, upper part of punch fixed, lower part of punch movable, sheath diameter 3.5 mm, central irrigation channel with concealed LUER-Lock irrigation adaptor, working length 13 cm
STAMMBERGER **Antrum Punches**

459051  STAMMBERGER *Antrum Punch*,
right side downward and forward cutting,
with cleaning connector, working length 10 cm

459052  STAMMBERGER *Antrum Punch*,
left side downward and forward cutting,
with cleaning connector, working length 10 cm
KERRISON Bone Punches

662122
KERRISON Bone Punch, detachable, rigid, upbiting 40° forward, size 2 mm, working length 17 cm

662123
KERRISON Bone Punch, detachable, rigid, upbiting 40° forward, size 3 mm, working length 17 cm
**UNIDRIVE® S III ENT SCB**
**UNIDRIVE® S III ECO**

Recommended System Configuration

**UNIDRIVE® S III ENT SCB**

![UNIDRIVE® S III ENT SCB Image]

40701620-1  **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
- **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**

![UNIDRIVE® S III ECO Image]

40701420  **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
- **Clip Set**, for use with silicone tubing set
- **Single Use Tubing Set***, sterile, package of 3

* Specifications:

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* denotes sterility
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

40712050  DRILLCUT-X® II Shaver Handpiece, for use with UNIDRIVE® S III ECO/ENT/NEURO/OMFS

40712090  Handle, adjustable, for use with DRILLCUT-X® II N shaver handpiece

Optional Accessory:

41250 RA  Cleaning Adaptor, Luer-Lock, for cleaning DRILLCUT-X® shaver handpieces
### Shaver Blades, straight
for Nasal Sinuses and Skull Base Surgery

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

#### Shaver Blades, straight, sterilizable

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| 41201 KN | serrated cutting edge, diameter 4 mm, color code: blue-red |
| 41201 KK | double serrated cutting edge, diameter 4 mm, color code: blue-yellow |
| 41201 KSA | serrated cutting edge, diameter 3 mm, color code: blue-red |
| 41201 KKSA | double serrated cutting edge, diameter 3 mm, color code: blue-yellow |

### 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

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| 41204 KKB | curved 40°, cutting edge serrated backwards, double serrated, diameter 3 mm, color code: blue-yellow |

**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

41203 KKF

Shaver Blades, curved 65°, sterilizable

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Optional Accessory:

41200 RA Cleaning Adaptor, Luer-Lock, for cleaning the inner and outer blades of reusable Shaver Blades 412xx

Sinus Burrs, curved
for Nasal Sinuses and Skull Base Surgery

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

41305 RN

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

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Further available blades or burrs can be found in the UNIDRIVE catalog excerpt as well as in the ENT catalog.
DRILLCUT-X® II Handpiece with 35k Sinus Burrs
for rapid and accurate drilling

- **Handpiece optimized for the highest speeds**
  Up to 35,000 rotations per minute allows powerful and precise work

- **Burr inserts**
  Five different models available

- **Compatibility**
  Handpiece and burr inserts can be used with the existing UNIDRIVE® S III ENT motor system

- **EM navigation**
  Can be expanded with the shaver blade tracker for electromagnetic navigation of sinus burrs and shaver attachment

---

40712035  **DRILLCUT-X® II-35 Shaver Handpiece,** for use with UNIDRIVE® S III ENT/NEURO

40712090  **Handle,** adjustable, for use with DRILLCUT-X® II N shaver handpiece

**Optional Accessory:**

41250 RA  **Cleaning Adaptor,** Luer-Lock, for cleaning DRILLCUT-X®/DRILLCUT-X® II shaver handpieces
Sinus Burrs 35 k
for Nasal Sinuses and Skull Base Surgery

For use with DRILLCUT-X® II-35 Shaver Handpiece 40 7120 35 and
DRILLCUT-X® II-35 N Shaver Handpiece 40 7125 35

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<tr>
<td>4135 DS</td>
<td>with integrated irrigation, curved 40°, diamond-shaped cutting, burr diameter 4 mm, shaft diameter 4 mm color code: red</td>
</tr>
</tbody>
</table>
KARL STORZ NAV1 electromagnetic

KARL STORZ navigation system with advanced tracking technology

The new KARL STORZ navigation system, NAV1 electromagnetic, supports surgeons in otorhinolaryngology and skull base surgery. It uses a sophisticated electromagnetic tracking system.

Experience the excellent quality and precision of the KARL STORZ navigation system NAV1 electromagnetic.

Benefits of KARL STORZ NAV1 electromagnetic

- High precision thanks to sensor location in instrument tip
- Navigated instruments can be autoclaved 30x
- Wide range of instruments; simultaneous tracking of up to 3 instruments possible
- Display of complete instrument geometry in the patient's radiology data
- Planning and monitoring of high-risk structures with intraoperative DistanceControl
- Better orientation through waypoint navigation
- Automatic and reliable documentation of the navigated procedure
- Infinitely adjustable CT-MRI fusion
- Import of patient data via USB, CD or PACS
KARL STORZ NAV1 electromagnetic

Components of NAV1 electromagnetic

40820001 NAV1 electromagnetic

including:
- NAV1 Module
- NAV1 electromagnetic Module
- NAV1 electromagnetic Field Generator
- Headband for Navigation, for single use*
- EM Patient Tracker
- EM Navigation Probe
- Optical Mouse
- Mains Cord, length 300 cm
- Module Connecting Cable, length 250 cm
- DVI Connecting Cable, length 300 cm

*A headrest with integrated EM field generator is included in delivery.
Instruments for NAV1 electromagnetic

40820105  **EM Navigated Probe**, for patient registration and navigation, reusable 30 times

40820110  **EM Navigated Probe**, malleable, straight, reusable 30 times

40820111  **EM Navigated Frontal Sinus Probe**, with curved working end, reusable 30 times

40820112  **EM Navigated Probe**, malleable, curved, reusable 30 times
<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>40820130</td>
<td>EM Navigated Curette, 90°,</td>
<td>reusable 30 times</td>
</tr>
<tr>
<td>40820131</td>
<td>EM Navigated Curette, 0°,</td>
<td>reusable 30 times</td>
</tr>
<tr>
<td>40820145</td>
<td>EM Navigated Suction Tube,</td>
<td>straight, reusable 30 times</td>
</tr>
<tr>
<td>40820165</td>
<td>EM Navigated Suction Tube,</td>
<td>curved, reusable 30 times</td>
</tr>
</tbody>
</table>
With the IMAGE1 S™ camera platform, KARL STORZ once again sets a new milestone in endoscopic imaging, consolidating their reputation as an innovative leader in minimally invasive surgery. The IMAGE1 S™ camera platform offers surgeons a single system for all applications. As a modular camera platform, IMAGE1 S™ combines various technologies (e.g., rigid, flexible and 3D endoscopy) in one system and can therefore be adapted to individual customer needs. Furthermore, near infrared (NIR/ICG) for fluorescence imaging, the integration of operating microscopes and the use of VITOM® 3D exoscopes is possible via the camera platform.

Brilliant imaging

- Versatile visualization options for diagnosis and therapy
- Innovative S-Technologies for easy differentiation of tissue structures
- Clear and razor-sharp imaging
- Natural color rendition
- Automatic light source control

**CLARA + CHROMA:** Homogeneous illumination + contrast enhancement

**CLARA:** Homogeneous illumination

**CHROMA:** Contrast enhancement

*SPECTRA A:* Color hue shift and exchange (filtering reds)

*SPECTRA B:* Spectral color shift (intensification of greens and blues)

*SPECTRA A:* Not available for sale in the U.S.A.

*SPECTRA B:* Not available for sale in the U.S.A.
IMAGE1 S™
As individual as your requirements

Innovative Design
- Side-by-side View: Parallel display of standard image and visualization mode possible
- Multiple source management: Simultaneous control, display and documentation of two image sources possible (e.g., hybrid procedures)
- Intuitive user guidance (dashboard, live menu and setup menu)
- Intelligent icons display settings and status
- Individual presets possible
- 50 patient data records can be archived

Dashboard

Economical and futureproof
- Modular platform: Rigid, flexible and 3D technology can be selected according to individual preferences
- Easy integration of new technologies
- Forward and backward compatibility
- No additional equipment (e.g., special light sources) required for S-Technologies

* SPECTRA A: Not available for sale in the U.S.A.
* SPECTRA B: Not available for sale in the U.S.A.
IMAGE1 S™
As individual as your requirements

IMAGE1 S™ 3D
IMAGE1 S™ 3D is a further component in the IMAGE1 S™ camera platform. The 3D system provides surgeons with excellent depth perception. Furthermore, the 3D stereoscopic imaging system is particularly valuable for activities that demand a high degree of spatial perception. The 3D camera platform from KARL STORZ impresses with its wide range of applications – from laparoscopy, gynecology, ENT to microsurgical interventions.

Benefits of IMAGE1 S™ 3D
- Brilliant and razor-sharp imaging in 2D and 3D
- Switchover from 3D to 2D at the touch of a button
- Easy integration into the IMAGE1 S™ platform
- CLARA, CHROMA, SPECTRA* in 2D and 3D
- 3D system with video endoscopes with diameters of 10 mm and 4 mm as well as VITOM® 3D

Benefits of 3D integration into the IMAGE1 S™ camera platform
- Communication between all units
- One system for multiple applications
- Reduced space requirements
- One user interface for all applications
- Synergy effects between the OR workflow and financing

* SPECTRA: Not available for sale in the U.S.A.
IMAGE1 S™ – A System for all Requirements

Connects all technologies
IMAGE1 S CONNECT™

10 mm 3D video laparoscope

4 mm 3D video endoscope

Flexible video endoscopes

1-chip camera heads

PDD camera heads

Microscopy camera head

Near Infrared (NIR/ICG) 3-chip camera head Fl

3-chip camera heads

Open to future technologies

e.g.,
4K/UHD

2D endoscopy
IMAGE1 S™
X-LINK

2D endoscopy
IMAGE1 S™
H3-LINK

3D endoscopy
IMAGE1 S
D3-LINK™

VITOM® 3D

10 mm 3D video laparoscope

4 mm 3D video endoscope

Flexible video endoscopes

1-chip camera heads

PDD camera heads

Microscopy camera head

Near Infrared (NIR/ICG) 3-chip camera head Fl

3-chip camera heads

Open to future technologies

e.g.,
4K/UHD

2D endoscopy
IMAGE1 S™
H3-LINK

3D endoscopy
IMAGE1 S
D3-LINK™

VITOM® 3D

10 mm 3D video laparoscope

4 mm 3D video endoscope

Flexible video endoscopes

1-chip camera heads

PDD camera heads

Microscopy camera head

Near Infrared (NIR/ICG) 3-chip camera head Fl

3-chip camera heads

Open to future technologies

e.g.,
4K/UHD
IMAGE1 S™ Camera System

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*</th>
</tr>
</thead>
<tbody>
<tr>
<td>HD video outputs</td>
<td>- 2x DVI-D</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 CONNECT™ Module TC 200EN

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™)</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>
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<tr>
<td>Weight</td>
<td>1.86 kg</td>
</tr>
</tbody>
</table>

* SPECTRA A: Not available for sale in the U.S.A.
** SPECTRA B: Not available for sale in the U.S.A.
IMAGE1 S™ Camera Heads

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

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 mm (2x), 2 freely programmable camera head buttons, for use with IMAGE1 S™ and IMAGE1 HUB™ HD/HD

| Specifications: | | |
|-----------------|-----------------|
| **IMAGE1 FULL HD Camera Heads** | **IMAGE1 S™ H3-Z** |
| Product no. | TH 100 |
| Image sensor | 3x 1/3” CCD chip |
| Dimensions w x h x d | 39 x 49 x 114 mm |
| Weight | 270 g |
| Optical interface | integrated Parfocal Zoom Lens, f = 15–31 mm (2x) |
| Min. sensitivity | F 1.4/1.17 Lux |
| Grip mechanism | standard eyepiece adaptor |
| Cable | non-detachable |
| Cable length | 300 cm |

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 mm (2x), 2 freely programmable camera head buttons, for use with IMAGE1 S™ and IMAGE1 HUB™ HD/HD

| Specifications: | | |
|-----------------|-----------------|
| **IMAGE1 FULL HD Camera Heads** | **IMAGE1 S™ H3-ZA** |
| Product no. | TH 104 |
| Image sensor | 3x 1/3” CCD chip |
| Dimensions w x h x d | 39 x 49 x 100 mm |
| Weight | 299 g |
| Optical interface | integrated Parfocal Zoom Lens, f = 15–31 mm (2x) |
| Min. sensitivity | F 1.4/1.17 Lux |
| Grip mechanism | standard eyepiece adaptor |
| Cable | non-detachable |
| Cable length | 300 cm |
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

KARL STORZ HD and FULL HD Monitors

<table>
<thead>
<tr>
<th></th>
<th>19&quot; (optional)</th>
<th>26&quot; (optional)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall-mounted with VESA 100 adaption</td>
<td>9619 NB</td>
<td>9826 NB</td>
</tr>
</tbody>
</table>

Inputs:
- DVI-D
- Fibre Optic
- 3G-SDI
- RGBS (VGA)
- S-Video
- Composite/FBAS

Outputs:
- DVI-D
- S-Video
- Composite/FBAS
- RGBS (VGA)
- 3G-SDI

Signal Format Display:
- 4:3
- 5:4
- 16:9
- Picture-in-Picture
- PAL/NTSC compatible

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>Desktop with pedestal</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>

Optional accessories:
- 9826 SF Pedestal, for monitor 9826 NB
- 9619 NB Pedestal, for monitor 9619 NB
Data Management and Documentation
KARL STORZ AIDA® – Exceptional documentation

The name AIDA stands for the comprehensive implementation of all documentation requirements arising in surgical procedures: A tailored solution that flexibly adapts to the needs of every specialty and thereby allows for the greatest degree of customization.

This customization is achieved in accordance with existing clinical standards to guarantee a reliable and safe solution. Proven functionalities merge with the latest trends and developments in medicine to create a fully new documentation experience – AIDA.

AIDA seamlessly integrates into existing infrastructures and exchanges data with other systems using common standard interfaces.

WD 200-XX* AIDA Documentation System, for recording still images and videos, dual channel up to FULL HD, 2D/3D, power supply 100–240 VAC, 50/60 Hz including:
- USB Silicone Keyboard, with touchpad
- ACC Connecting Cable
- DVI Connecting Cable, length 200 cm
- HDMI-DVI Cable, length 200 cm
- Mains Cord, length 300 cm

WD 250-XX* AIDA Documentation System, for recording still images and videos, dual channel up to FULL HD, 2D/3D, including SmartScreen® (touch screen), power supply 100–240 VAC, 50/60 Hz including:
- USB Silicone Keyboard, with touchpad
- ACC Connecting Cable
- DVI Connecting Cable, length 200 cm
- HDMI-DVI Cable, length 200 cm
- Mains Cord, length 300 cm

*XX Please indicate the relevant country code (DE, EN, ES, FR, IT, PT, RU) when placing your order.
Workflow-oriented use

**Patient**

Entering patient data has never been this easy. AIDA seamlessly integrates into the existing infrastructure such as HIS and PACS. Data can be entered manually or via a DICOM worklist. All important patient information is just a click away.

**Checklist**

Central administration and documentation of time-out. The checklist simplifies the documentation of all critical steps in accordance with clinical standards. All checklists can be adapted to individual needs for sustainably increasing patient safety.

**Record**

High-quality documentation, with still images and videos being recorded in FULL HD and 3D. The Dual Capture function allows for the parallel (synchronous or independent) recording of two sources. All recorded media can be marked for further processing with just one click.

**Edit**

With the Edit module, simple adjustments to recorded still images and videos can be very rapidly completed. Recordings can be quickly optimized and then directly placed in the report. In addition, freeze frames can be cut out of videos and edited and saved. Existing markings from the Record module can be used for quick selection.

**Complete**

Completing a procedure has never been easier. AIDA offers a large selection of storage locations. The data exported to each storage location can be defined. The Intelligent Export Manager (IEM) then carries out the export in the background. To prevent data loss, the system keeps the data until they have been successfully exported.

**Reference**

All important patient information is always available and easy to access. Completed procedures including all information, still images, videos, and the checklist report can be easily retrieved from the Reference module.
Fiber Optic Light Cable

Fiber Optic Light Cable, with straight connector, extremely heat-resistant, with safety lock, increased light transmission, diameter 3.5 mm, length 230 cm, can be used for ICG applications.

Cold Light Fountain Power LED 300

Cold Light Fountain Power LED 300, with integrated KARL STORZ-SCB, high-performance LED module and one KARL STORZ light outlet, power supply 100–240 VAC, 50/60 Hz
including:
Mains Cord

Cold Light Fountain XENON 300 SCB

Cold Light Fountain XENON 300 SCB 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:
Mains Cord
SCB Connecting Cable, length 100 cm
Spare Lamp Module XENON with heat sink, 300 watt, 15 volt
XENON Spare Lamp, only, 300 watt, 15 volt
**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
Notes