ENDOSCOPIC ANATOMY OF THE LATERAL NASAL WALL, OSTIOMEATAL COMPLEX AND ANTERIOR SKULL BASE

A Step-by-Step Guide

Prof. Reda KAMEL, M.D.
Professor of Rhinology
Department of ENT, Cairo University, Egypt
WITH COMPLIMENTS
OF KARL STORZ
ENDOSCOPIC ANATOMY OF THE
LATERAL NASAL WALL,
OSTIOMEATAL COMPLEX
AND ANTERIOR SKULL BASE

A Step-by-Step Guide

86 Illustrations

Reda KAMEL, M.D.
Professor of Rhinology
Department of ENT, Cairo University, Egypt

Dedication
To my wife Azza and my daughters Menna, Sara and Rana.
They miss me most of the time because I am always busy in the field of
endoscopic sinonasal surgery, research, teaching and clinical practice.

Reda Kamel
Endoscopic Anatomy of the Lateral Nasal Wall, Ostiomeatal Complex and Anterior Skull Base

A Step-by-Step Guide

Prof. Reda KAMEL, M.D.
Professor of Rhinology,
Department of ENT,
Functional and Microscopic ENT Unit
61 Canal Street – Sawares Square
Maadi 11431
Cairo, Egypt

Phone: +20 23 80 29 55
+20 23 63 25 96
Fax: +20 23 59 6740
E-mail: rkamel55@hotmail.com
rkamel@mednet2.camed.eun.eg

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Preface

Transnasal endoscopic sinonasal surgery has become a widely accepted technique over the past decade. Though the technique usually is applied in the case of relatively minor diseases, it can involve major complications. It can be said with certainty that incomplete surgery is safe but ineffective, whereas complete surgery is effective but unsafe. The surgeon requires a sound background knowledge of the anatomical details of the sinonasal area in order to perform safe and effective surgery.

This booklet is an anatomic guide based on 14 years of academic and clinical experience gained by the author in transnasal endoscopic sinonasal surgery.

The aim of this volume is to impart basic information of the anatomy of the lateral nasal wall and Ostialmeatal area in a step-by-step manner. As such, it may serve as a ready reference for residents in training and practitioners of continuing medical education courses. For this reason, details of particular significance for dissection or actual surgical procedures are illustrated by schematic drawings. The author hopes that this manual will be a source of valuable information to its readers.

Reda Kamel, M.D.
Professor of Rhinology
Cairo University, Egypt, 2002

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I have to thank Dr. Tarek Kandid, Dr. Ashraf Khaled, Dr. Hany El Gamal, Dr. Hesham Abd El-Wahed and Dr. Mohammad Makhdoum for their help in editing and reviewing this book.

Reda Kamel
1.0 Anatomical Basics

Before commencing to study the detailed anatomy of the lateral nasal wall, one must be aware that there is a very wide range of possible anatomic variations, both between different people and even between the two sides of the same individual's nose. It is crucial for the surgeon to be able to identify any anatomic variation and/or pathological anomaly in the individual patient to ensure that the endoscopic sinus surgery is both efficacious and safe, and affords the desired optimal benefit for the patient. The identification of variations and pathologies must be based on a very detailed and thorough understanding of the usual anatomy of the ostiomeatal complex, lateral nasal wall and anterior skull base.

1.1 Nasal Turbinates

The lateral nasal wall is characterized by three turbinates (inferior, middle, and superior), each of which has its own meatus (inferior, middle and superior meatus) running below the structure. The sphenoidethmoidal recess is located just above, posterior and medial to the superior turbinate (Figs. 1a, b).

Fig. 1a
Lateral nasal wall – nasal turbinates (schematic depiction, coronal plane)

Fig. 1b
Lateral nasal wall – nasal turbinates (schematic depiction, sagittal plane)
1.2 Paranasal Sinuses

The frontal sinus, maxillary sinus and anterior ethmoid sinuses constitute the anterior group of the paranasal sinuses, all of which open into the middle meatus, while the posterior ethmoid cells and sphenoid sinus form the posterior group of the paranasal sinuses. The posterior ethmoids open into the superior meatus and the sphenoid sinus opens into the sphenoid-ethmoidal recess (Figs. 2a, b).

Fig. 2a
Drainage of the anterior paranasal sinuses (schematic depiction, coronal plane).

Fig. 2b
Drainage of the posterior paranasal sinuses (schematic depiction, sagittal plane).
1.3 The Osteomeatal Complex

The Osteomeatal Complex (OMC) is also termed Anterior Ethmoid Middle Meatus Complex. The osteomeatal complex consists of the air cells of the anterior ethmoid and their ostia, ethmoidal infundibulum, maxillary ostium, frontal ostium, and middle meatus. As a functional entity, the OMC represents the final section of the common drainage and ventilation pathway of the frontal, maxillary and anterior ethmoid sinuses (Figs. 3a, b, c).

Fig. 3a
Left Osteomeatal Complex (schematic depiction, coronal plane).

Fig. 3b
Right Osteomeatal Complex (schematic depiction, sagittal plane).

Fig. 3c
Left Osteomeatal Complex (schematic depiction, coronal plane).
The following structures can be identified under the endoscope as parts of the Osteomeatal Complex:

- Agger nasi cell.
- Uncinate process.
- Bulla ethmoidalis (Fig. 3d).
- Hiatus semilunaris inferior between the uncinate process and bulla ethmoidalis.
- Middle turbinate.
- Location of the maxillary sinus ostium posterior and inferior to the angle formed between bulla ethmoidalis and uncinate process.
- Location of the frontal sinus ostium anterior and superior to the angle formed between bulla ethmoidalis and uncinate process (Fig. 3e).
Proceed by insinuating the endoscope posteriorly between the middle turbinate and the ethmoidal bulla to identify the following structures (Figs. 3f, g, h):

- Basal lamella (second part of the middle turbinate, oblique part).
- Hiatus semilunaris superior and lateral sinus posterior and superior to the ethmoidal bulla.

The following structures can be identified by gently pushing medially the middle turbinate (Fig. 3i):

- Uncinate process.
- Agger nasi cell, anterior and superior to the uncinate process.
- Bulla ethmoidalis.
- Basal lamella.

Fig. 3f
Basal lamella, (yellow area) lateral sinus and hiatus semilunaris superior (red arrow) (endoscopic view).

Fig. 3g
Left Ostiomeatal Complex (schematic depiction, axial plane).

Fig. 3i
Left ostiomeatal complex (schematic depiction, sagittal plane).

Fig. 3h
Left ostiomeatal complex (schematic depiction, coronal plane).
1.4 Uncinate Process

The uncinate process is a thin bone located in a sagittal orientation and shaped like a hook. The uncinate process is attached to the following structures:

- Inferiorly and far posterior: to the ethmoid process of the inferior turbinate.
- Anteriorly and far superior: to the lamina papyracea, skull base or middle turbinate.
- Laterally: to the lamina papyracea and fontanelle area.

Its free posterior rim constitutes the free edge of the hiatus semilunaris inferior leading to the ethmoid infundibulum (Fig. 4a).

Superior attachment of the uncinate process: the uncinate process usually is attached to the lamina papyracea, whereas the ethmoidal infundibulum ends blindly in the terminal recess. Under these circumstances, the frontal recess opens directly into the middle meatus (Fig. 4b). Alternatively, the uncinate process may be attached to the skull base or the neck of the middle turbinate, a configuration where the frontal recess opens into the ethmoidal infundibulum (Figs. 4c, d).
1.5 Bulla Ethmoidalis

The bulla ethmoidalis (Figs. 5a, b, c) is a part of the air cells of the anterior ethmoid. It is attached laterally to the lamina papyracea and usually opens into the lateral sinus posteriorly. The spatial relationships can be summarized as follows:

- Anteriorly and inferiorly: the ethmoid infundibulum separates the bulla from the uncinate process.
- Superiorly: the suprabullar recess (the anterior and superior portion of the lateral sinus) separates the bulla from the fovea ethmoidalis.
- Posteriorly: the retrobullar recess (the posterior and inferior part of the lateral sinus) separates the bulla from the basal lamella of the middle turbinate.
- Medially: the middle meatus separates the bulla from the middle turbinate. The lumen between bulla ethmoidalis and middle turbinate is termed the conchal sinus.

1.6 Hiatus Semilunaris Inferior

The hiatus semilunaris inferior is a two-dimensional passage-way between the ethmoidal bulla and the free edge of the uncinate process, and leads to a three-dimensional lumen, (i.e. the ethmoidal infundibulum) between the anterior wall of the ethmoidal bulla and the posterior wall of the uncinate process.
Fig. 7
Left hiatus semilunaris inferior and ethmoid infundibulum (schematic depiction, sagittal plane).

Fig. 9a
Lateral sinus components: Suprabullar recess and retrobullar recess (schematic depiction, sagittal plane).

Fig. 8a
Lateral sinus and hiatus semilunaris superior (schematic depiction, sagittal plane).

Fig. 9b
Lateral sinus: no suprabullar recess (schematic depiction, sagittal plane).

Fig. 8b
Lateral sinus and hiatus semilunaris superior (schematic depiction, sagittal plane).

Fig. 9c
Lateral sinus: no retrobullar recess (schematic depiction, sagittal plane).
1.7 Ethmoid Infundibulum

The boundaries of the ethmoid infundibulum are defined as follows:

- Anteriorly: uncinate process.
- Posteriorly: anterior wall of the bulla ethmoidalis.
- Laterally: lamina papyracea anteriorly and fontanelle area posteriorly.
- Medially: hiatus semilunaris inferior and uncinate process.
- Anteriorly and superiorly: frontal recess area and frontal sinus ostium.
- Posteriorly and inferiorly: maxillary sinus ostium (Fig. 7).

1.8 Hiatus Semilunaris Superior

The hiatus semilunaris superior is a two-dimensional passage-way between the ethmoidal bulla (anteriorly and inferiorly) and the skull base (superiorly) and the basal lamella (posteriorly), and leads to a three-dimensional lumen, i.e. the lateral sinus (Figs. 8a, b).

1.9 Lateral Sinus

The lateral sinus is divided into a suprabullar recess and a retrobullar recess. In its anterior and superior location, the suprabullar recess is a space bordered by the ethmoidal bulla (inferiorly) and the ethmoidal fovea (superiorly). In contrast, the retrobullar recess in its posterior and inferior location is bordered by the ethmoidal bulla (anteriorly) and the basal lamella (posteriorly). If the ethmoidal bulla directly adheres to the ethmoidal fovea, no suprabullar recess is formed, whereas there is no retrobullar recess, if the ethmoidal bulla adheres to the basal lamella (Figs. 9a, b, c).

Far anterior, the suprabullar recess of the lateral sinus is separated from the frontal recess by the suprabullar lamella. In the absence of a suprabullar lamella the suprabullar recess of the lateral sinus and the frontal recess of the infundibulum form a continuous cavity (Figs. 9d, e).
1.10 Maxillary Sinus Ostium

The maxillary sinus ostium usually is located posterior and inferior at the angle formed by the ethmoidal bulla and the uncinate process. Size, exact location, shape, and orientation of the maxillary sinus ostium are subject to anatomic variations (Figs. 10a, b).

1.11 Fontanelle Area

The medial wall of the maxillary sinus is composed of bone with nasal mucosa medially and maxillary sinus mucosa laterally, the area of the fontanelle being an exception. In the area of the fontanelle, the bony wall is dehiscent and the nasal mucosa adheres to the maxillary sinus mucosa. The uncinate process separates the fontanelle area into the anterior and posterior fontanelles (i.e. anterior and posterior to the uncinate process). The natural maxillary sinus ostium is located in the posterior fontanelle. There may be one or more accessory maxillary sinus ostium/ostia in the anterior and/or posterior fontanelle (Fig. 11).
1.12 Frontal Recess

The frontal recess is a three-dimensional cavity defined by the following boundaries:

- Anteriorly: uncinate process and agger nasi cell.
- Posteriorly: bulla ethmoidalis and suprabullar lamella.
- Laterally: lamina papyracea.
- Medially: hiatus semilunaris inferior or neck of the middle turbinate.
- Inferiorly: ethmoid infundibulum.
- Superiorly: fovea ethmoidalis, supraorbital air cell, anterior ethmoid artery and frontal ostium.

The size of the frontal recess is determined by the size of the surrounding anterior ethmoid air cells namely: bulla ethmoidalis, agger nasi cell, supraorbital air cells and frontal cells. If the bulla ethmoidalis is large anteriorly and the agger nasi is large posteriorly, the frontal recess becomes very narrow and takes on the appearance of a fronto-nasal duct, which it is not (Figs. 12a, b, c).
1.13 Supraorbital Ethmoid Air Cell

The supraorbital ethmoid air cell arises from pneumatization of the orbital process of the frontal bone. It is located just posterior to the frontal sinus ostium. The anterior ethmoid artery [AEA] is present just posterior to the supraorbital cell and anterior to the suprabullar lamella in the fovea ethmoidalis. Pneumatization of the supraorbital air cell is subject to anatomic variation (Fig. 13).

1.14 Anterior Ethmoid Artery (AEA)

The anterior ethmoid artery is an orbital branch of the ophthalmic artery and exits the orbit through the anterior ethmoidal foramen in a medial position. From there, it passes into the orbito-cranial canal in the roof of the ethmoid, entering the lateral lamella of the cribiform plate and the olfactory fossa. Further on, the anterior ethmoid artery passes anteriorly into the ethmoidal sulcus to the cribiform plate. The vessel ultimately changes direction to run inferiorly into the cribroethmoidal canal to the nose (Figs. 14a, b).
1.15 Frontal Sinus Ostium

Located at the bulla-uncinate angle anteriorly and superiorly, the frontal sinus opens into the frontal recess through the frontal ostium. The frontal sinus, frontal ostium and frontal recess are distinguished by their hourglass appearance (Fig. 15).

1.16 Agger Nasi Cell

Located medial to the lacrimal sac and fossa and anterior to the uncinate process, the agger nasi cell is one of the air cells of the anterior ethmoid. The antero-medial wall of the structure can be seen through the endoscope directly anterior and superior to the neck of the middle turbinate. The posterolateral wall of the structure is hidden by the uncinate process and constitutes the anterior wall of the frontal recess. The size of the agger nasi cell contributes to the definition of the size and shape of the frontal recess (Figs. 16a, b).
1.17 Frontal Cells

The frontal cells (Figs. 17a, b, c, d) are anterior ethmoid air cells that pneumatize the frontal recess above the agger nasi cell. They may be:

- a single small cell above the agger nasi cell,
- multiple small cells above the agger nasi cell,
- a single large cell above the agger nasi cell extending to the frontal sinus,
- a single small cell inside the frontal sinus.

Larger sized frontal cells may compromise the naso-frontal pathway.
1.18 Middle Turbinates

Viewed from anterior, the middle turbinate is characterized by a conchal head, conchal neck, and conchal sinus. The conchal sinus is the cavity between the ethmoidal bulla and the middle turbinate (Fig. 18a). In a far anterior position, the structure is attached to the ethmoid crest of the maxillary bone and agger nasi cell. Far posteriorly, the structure is attached to the ethmoid crest of the perpendicular plate of the palatine bone. The middle turbinate consists of three discernible components (Fig. 18b): the first part in an anterior and medial position exhibits a sagittal plane and is attached vertically to the skull base, superiorly between the cribriform plate and the lateral lamella (Fig. 18c).
The second part is located in the middle of the structure, exhibits a frontal plane, and is attached laterally to the lamina papyracea in an oblique fashion (Fig. 18d). This part of the middle turbinate is termed the basal lamella. The third part is located posteriorly, exhibits a horizontal plane and is attached laterally to the perpendicular plate of palatine bone. It forms the roof of the posterior part of the middle meatus (Fig. 18e).

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<tr>
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<td>Frontal</td>
<td>Lamina papyracea</td>
</tr>
<tr>
<td>Third</td>
<td>(posterior)</td>
<td>Horizontal</td>
<td>Perpendicular plate of palatine bone</td>
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Fig. 18d
Second (middle) part of the left middle turbinate (schematic depiction, axial view).

Fig. 18e
Third (posterior) part of the left middle turbinate (schematic depiction, coronal view).
1.19 Basal Lamella

The basal lamella constitutes the middle portion of the middle turbinate and is an important landmark. It separates the anterior and posterior ethmoid air cells (Fig. 19a) and can be visualized by insinuating the endoscope between the middle turbinate and the ethmoidal bulla (Fig. 19b). The boundaries of the basal lamella are defined as follows (Figs. 19a, b, c):

- Superiorly: skull base (fovea ethmoidalis).
- Laterally: lamina papyracea.
- Inferiorly: the attachment of the third (posterior) part of the middle turbinate to the basal lamella.
- Medially: the attachment of the first (anterior) part of the middle turbinate to the basal lamella.

Fig. 19a
Second (middle) part of left middle turbinate (basal lamella) separates the anterior and the posterior ethmoids (schematic depiction).

Fig. 19b
Left basal lamella seen through the middle meatus (endoscopic view).

Fig. 19c
Lateral and medial attachments of the basal lamella (schematic depiction, axial view).
1.20 Ethmoid Labyrinth

The ethmoid labyrinth is composed of the frontal bone superiorly and ethmoid bone inferiorly, and contains the ethmoid air cells (Fig. 20).

1.21 Roof of the Ethmoids

The roof of the anterior ethmoids is composed of the frontal bone superiorly and laterally (this part is termed the fovea ethmoidalis) and the ethmoid bone inferiorly and medially (this part is termed lateral lamella of the cribiform plate). Part of the frontal bone, the fovea ethmoidalis is a thick bone (0.5 mm on average), whereas the lateral lamella is a rather thin (0.2 mm on average) part of the ethmoid bone. It should be noted that the dura of the anterior cranial fossa is relatively thin and adheres to the skull base. The roof of the anterior ethmoid has a stepladder-like appearance, whereas the roof of the posterior ethmoid is flat (Figs. 21a, b).

1.22 Lateral Lamella

The lateral lamella is thinnest at the location of the anterior ethmoid arterial passage, averaging 0.05 mm (i.e. 1/10 of the thickness of the fovea ethmoidalis), which is why this is the most common location for iatrogenic CSF leakage (Fig. 21a).

1.23 Cribiform Plate

The cribiform plate is perforated by the olfactory nerve fibers. The structure is attached to the crista galli and the perpendicular plate of the ethmoid bone medially, and to the neck of the middle turbinate and the lateral lamella laterally (Fig. 21a).
1.24 Olfactory Fossa

The olfactory fossa is located between the crista galli medially, cribriform plate inferiorly, and the lateral lamella laterally. The olfactory bulb is located here. The structure may be deep or shallow, depending on the length of the lateral lamella (Figs. 24a, b, c), a factor which also determines the difference in level between the cribriform plate and fovea ethmoidalis (ranging from 1–16 mm) (Figs. 24-d). The stepladder appearance of the anterior ethmoid roof, as defined by computed tomography, should always be born in mind during endoscopic sinus surgery, especially in contrast to the roof of the posterior ethmoid, which is flat and consists of frontal bone.

Fig. 24a
Shallow olfactory fossa (1-3 mm) due to the absence of a lateral lamella.

Fig. 24b
Olfactory fossa of average size (4-7 mm).

Fig. 24c
Deep olfactory fossa (8–16 mm).

Fig. 24d
The roof of the ethmoid (green arrow) is usually situated at a higher level than the cribriform plate (red arrow) (ranging from 1-16 mm) (schematic depiction, coronal view).
1.25 Posterior Ethmoid Cells

The posterior ethmoid cells are larger in size and fewer in number than the anterior ethmoid cells. Posterior ethmoid cells have the following anatomical relationships:

- Anteriorly: the basal lamella (middle third of the middle turbinate) separates the posterior ethmoid cells from their anterior counterparts;
- Posteriorly: the anterior wall of the sphenoid sinus separates the posterior ethmoid cells from the sphenoid sinus;
- Laterally: the lamina papyracea separates the posterior ethmoid cells from the orbit;
- Medially: superior meatus and superior turbinate (Fig. 25a);
- Superiorly: the flat fovea ethmoidalis separates the posterior ethmoid cells from the anterior cranial fossa;
- Inferiorly: posterior part of the middle turbinate (Fig. 25b).

Fig. 25a
Left posterior ethmoids (schematic depiction, axial view).

Fig. 25b
Left posterior ethmoids (schematic depiction, coronal view).
The posterior ethmoid cells are often found to be the cause of potential complications during endoscopic sinonasal surgery (orbital, cranial and/or bleeding) resulting from the following:

- the optic nerve is too close to the posterior ethmoid air cells.
- the medial rectus muscle is closer to the posterior ethmoid than to the anterior ethmoid, orbital fat being thinner here (Fig. 25c).
- the posterior ethmoid artery is located in the roof of the posterior ethmoid sinus just anterior to the anterior wall of the sphenoid sinus (Fig. 25d).
- the sphenoid sinus is located behind and below the posterior ethmoid air cells (Fig. 25e).
1.26 Sphenoethmoidal Cell (Onodi Cell)

The Onodi cell is a lateral and superior extension of the posterior ethmoids (relative to the position of the sphenoid sinus) and arises from hyperpneumatization of the posterior ethmoid air cells. This structure is very often closely related to the optic nerve and/or internal carotid artery (Figs. 26a, b, c, d).

Fig. 26a
Left sphenoethmoidal cell (Onodi cell) (schematic depiction, axial view). Red arrow indicates lateral and posterior hyperpneumatization of the posterior ethmoids.

Fig. 26b
Left sphenoethmoidal cell (Onodi cell) (schematic depiction, sagittal view). Red arrow indicates superior and posterior hyperpneumatization of the posterior ethmoids.

Fig. 26c
Left sphenoethmoidal cell (Onodi cell) and optic nerve (schematic depiction, axial view).

Fig. 26d
Left sphenoethmoidal cell (Onodi cell) and optic nerve (schematic depiction, coronal view).
1.27 Sphenopalatine Foramen

The sphenopalatine foramen is located behind the posterior end of the middle turbinate and is formed by the following structures:
- Superiorly: sphenoid bone.
- Posterily: sphenoid process of the palatine bone.
- Anteriorly: ethmoid process of the palatine bone.
- Inferiorly: palatine bone.

The sphenopalatine foramen leads to the pterygopalatine fossa, which forms the exit of the nasal neurovascular bundle (Fig. 27).

1.28 Sphenoid Sinus

Three different types of sphenoid sinus are classified on the basis of pneumatization, namely conchal, presellar, and sellar types. The spatial relationship of the structure is as follows:
- Superiorly: anterior cranial fossa;
- Anteriorly: spheno-ethmoid recess, superior turbinate, and posterior ethmoids (Fig. 28b);
- Medially: sphenoid septum or septae which may differ in location, direction, number, thickness, and attachment to other structures;
- Inferiorly: nasopharynx;
- Posterily: basi-sphenoid, sella, posterior cranial fossa;
- Laterally: middle cranial fossa and cavernous sinus (Fig. 28c).
1.29 Neurovascular Relationships of the Sphenoid Sinus

The sphenoid sinus is situated in close structural proximity to the following structures:

- Optic nerve inside the nerve canal (6% incidence of bony dehiscence).
- Internal carotid artery inside the cavernous sinus (20% incidence of bony dehiscence).
- Maxillary nerve in the foramen rotundum.
- Vidian nerve inside the pterygoid canal.

The infraoptic recess is situated between the optic nerve and the internal carotid artery. Its size and depth depend on the degree of pneumatization of the anterior clival process (Figs. 29a, b).

1.30 The Sphenoid Sinus Ostium

The sphenoid sinus ostium opens into the sphenethmoidal recess. It is located just medial to the posterior end of the superior turbinate and can be identified by tracing the roof of the nasopharynx, forming the floor of the sphenoid sinus, through the choana to the anterior wall of the sphenoid. The structure is located between the nasal septum and the inferior part of the superior turbinate (Fig. 30).
1.31 Nasopharynx

The examiner should identify the following structures in the nasopharynx:
- Ipsilateral Eustachian tube.
- Ipsilateral fossa of Rosenmüller.
- Roof of the nasopharynx.
- Posterior wall of the nasopharynx.
- Contralateral fossa of Rosenmüller.
- Contralateral Eustachian tube (Fig. 31).

1.32 Nasal Choana

The following structures demarcate the posterior nasal aperture (the nasal choana):
- Inferiorly: nasal floor.
- Medially: nasal septum.
- Superiorly: sphenoid sinus.
- Laterally: medial pterygoid plate (Fig. 32).
1.33 Anatomic Variations

The examiner must be aware that a large number of anatomic variations is encountered in this area, most commonly:

- Concha bullosa: pneumatized head of the middle turbinate (Fig. 33a).
- Interlamellar cell: pneumatized vertical lamella of the middle turbinate (Fig. 33b).
- Paradoxically bent middle turbinate: reversed C-shape of the middle turbinate (Fig. 33c).
- Medially bent uncinate process (Fig. 33d).
- Large bulla ethmoidalis (Fig. 33e)
- Unpneumatized bulla ethmoidalis: the bulla ethmoidalis is represented by a bony projection from the lamina papyracea termed torus lateralis (Fig. 33f).
- Infraorbital ethmoid cell (Haller cell): this is an ethmoid air cell positioned inferior and lateral to the ethmoid bulla and closely related to the maxillary sinus ostium and the infundibulum (Fig. 33g).
- Hypoplastic or aplastic maxillary sinus: in this variation, the maxillary sinus is smaller or non-existent, the adjacent maxillary bone is thicker, the uncinate process is hypoplastic and laterally dislocated and the ethmoid infundibulum is accordingly atelectatic (Fig. 33h).


Conclusion

A detailed and thorough understanding of the anatomy of the lateral nasal wall, ostiomeatal complex and anterior skull base is mandatory for conducting safe and effective surgery. Orbital and intracranial complications may result from any injury or damage inflicted on the sinonasal framework laterally and/or superiorly, a factor which should always be treated with respect during endoscopic sinus surgery (Fig. 34).

Suggested Reading

Instrument Sets for Endoscopic Diagnosis and Surgery of the Lateral Nasal Wall, Ostiomeatal Complex and Anterior Skull Base

as recommended by Prof. Reda KAMEL, M.D.

Telescopes, Instruments and Accessories
Cold Light Fountains and Imaging Systems for Video Documentation
Diagnostic Endoscopy Set

Recommended Set according to Prof. Reza KAMEL, M. D.

- **7230 BWA**: Wide-Angle Forward-Oblique Telescope 30°, enlarged view, diameter 4 mm, length 18 cm, autoclavable.
  - Fiber optic light transmission incorporated, color code: red.

- **7219 BA**: Protection Tube for 18 cm telescopes.

- **400500**: HARTMANN Nasal Speculum, for adults, length 13 cm.
- **430300**: LUBET-BARBON Nasal Dressing Forceps, working length 10.5 cm.
- **456001 B**: RHINOFORCE® BLAKESLEY Nasal Forceps, straight, working length 13 cm, size 1.
- **456501 B**: RHINOFORCE® STRUEMPEL-VOSS Nasal Forceps, 45° upturned, size 1.
- **203720**: Suction Tube, cylindrical, Luer, working length 9 cm, O.D. 2 mm.
- **203730**: Suction Tube, cylindrical, Luer, working length 11 cm, O.D. 3 mm.
-**586025**: EICKEN Antrum Cannula, long curved, Luer-lock, length 12.5 cm, O.D. 2.5 mm.

Optional Telescope for Diagnosis in Children

- **7219 BA**: Forward-Oblique Telescope 30°, diameter 2.7 mm, length 18 cm, autoclavable.
  - Fiber optic light transmission incorporated, color code: red.

- **723750 B**: Protection Tube for 18 cm telescopes.
Endoscopic Sinonasal Surgery Set

Recommended Set according to Prof. Reza KAMEL, M. D.

7230 AA 1 RHINOFORCE® Straight Forward Telescope 0°, enlarged view, diameter 4 mm, length 18 cm, autoclavable. Fiber optic light transmission incorporated. Color code: green.
723750 B 1 Protection Tube for 18 cm RHINOFORCE® telescopes.
723770 1 STAMMBERGER Telescope Handle, length 11 cm, flat, for use with 18 cm RHINOFORCE® telescopes.
810505 1 Septum Needle, angular, Luer-lock.
628001 1 Sickle Knife, 19 cm, pointed.
474000 1 FREER Elevator, double-ended, length 20 cm.
456001 B 1 RHINOFORCE® BLAKESLEY Nasal Forceps, straight, working length 13 cm, size 1.
456501 B 1 RHINOFORCE® STRUMPEL-VOSS Nasal Forceps, 45° upturned, size 1.
723005 A 1 Trocar and Cannula for sinuscopy, O. D. 5 mm, length of cannula 8.5 cm, fenestrated beak, for use with 4 mm RHINOFORCE® telescopes.
629820 1 Probe, double-ended, maxillary sinus ostium seeker, length 19 cm, ball sizes: diameter 1.2 and 2.0 mm.
459010 1 RHINOFORCE® STAMMBERGER Antrum Punch, working length 10 cm, upside backward cutting.
651410 1 KAMEL Middle Meatal Antrostomy Punch, circular cutting, punch head diameter 4.5 mm, 30° upturned, working length 13 cm.
651415 1 Same, 45° upturned.
457712 1 KAMEL Nasal Forceps, 45° upturned, cupped jaws 20 mm x 4 mm, working length 11 cm.
455010 1 RHINOFORCE® STRYCKEN Nasal Cutting Forceps, working length 13 cm.
449002 1 HEYMANN Nasal Scissors, medium size, working length 9.5 cm.
203720 1 Suction Tube, cylindrical, Luer, working length 9 cm, O.D. 2 mm.
203730 1 Same, working length 11 cm, O.D. 3 mm.
586200 1 v. EICKEN Antrum Cannula, long curved, Luer-lock, length 12.5 cm, O.D. 3.0 mm.
586040 1 Same, O.D. 4.0 mm.
15006 B 1 "ULTRA-STOP" Antifog Solution, 25 ml pipette bottle.
Additional Surgical Instruments and Accessories

Recommended Set according to Prof. Reda KAMEL, M. D.

7230 FA 1 Forward-Oblique Telescope 45°, enlarged view, diameter 4 mm, length 18 cm, autoclavable. Fiber optic light transmission incorporated. Color code: black.

7230 CA 1 Lateral Telescope 70°, diameter 4 mm, length 18 cm, autoclavable. Fiber optic light transmission incorporated. Color code: yellow.

723760 B 1 Protection Tube for 18 cm telescopes.

723772 1 STAMMBERGER Telescope Handle, length 11 cm, round, for use with 16 cm telescopes 30°, 45°, 70°, 90° and 120°.

451001 B 1 RHINOFORCE® BLAKESLEY Nasal Forceps, through-cutting, tissue-sparing, working length 13 cm, straight, size 1, 3.5 mm, wide.

451501 B 1 RHINOFORCE® BLAKESLEY Nasal Forceps, through-cutting, tissue-sparing, working length 13 cm, 45° upturned, size 1, 3.5 mm, wide.

455500 B 1 TAKAHASHI Nasal Forceps, straight, working length 13 cm.

456001 B 1 RHINOFORCE® BLAKESLEY Nasal Forceps, straight, working length 13 cm, size 1.

456502 B 1 RHINOFORCE® BLAKESLEY-WILDE Nasal Forceps, 45° upturned, working length 13 cm, size 0.

456501 B 1 RHINOFORCE® BLAKESLEY-WILDE Nasal Forceps, 90° upturned, working length 13 cm, size 1.

457711 1 KAMEL Nasal Forceps, 45° upturned, cupped jaws 12 mm x 4 mm, working length 11 cm.

651050 1 STAMMBERGER Punch, circular cutting, for sphenoid, ethmoid and choanal atresia, working length 18 cm, diameter 4.5 mm.

851415 1 KAMEL Middle Meatal Antrostomy Punch, circular cutting, punch head diameter 4.5 mm, 45° upturned, working length 13 cm.

648521 1 MCKENTY Sphenoid Punch, through-cutting, reversible, size 1.8 mm x 2 mm, working length 17 cm.

449201 1 RHINOFORCE® Nasal Scissors, working length 13 cm, straight.

Set continued overleaf.
Additional Surgical Instruments and Accessories

Recommended Set according to Prof. REDA KAMEL, M.D.

Continued from page 41.

Endoscopic Anatomy of the Lateral Nasal Wall, Osteomaal Complex and Anterior Skull Base
KARL STORZ CLEARVISION™ System
for intra-operative rinsing of the telescope lens

40334001 KARL STORZ CLEARVISION™,
irrigation pump for intra-operative rinsing of the telescope lens,
power supply: 100–240 VAC, 50–60 Hz,
consisting of:
40334020 CLEARVISION™
400 A Mains Cord.
20010130 One-pedal Footswitch
40334040 Silicone Tubing Set.

Optional Accessories:
MTP 031129-10 Disposable irrigation tube for CLEARVISION™,
package of 10

Submit your order to:
MTP Medical Technical Promotion GmbH,
p.O. Box 4529, D-78510 Tuttlingen, Germany
## KARL STORZ CLEARVISION™ System

**Compatibility Matrix of Irrigation Sheaths and HOPKINS® Telescopes**

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<thead>
<tr>
<th>Irrigation Sheath, proximally reinforced for use with holder 28172 SL</th>
<th>Compatible HOPKINS® Telescopes</th>
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<tr>
<td>28164 CBC</td>
<td>5.0 mm</td>
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UNIDRIVE® ENT

System Configurations recommended by KARL STORZ

![UNIDRIVE® ENT Image]

40 7116 01-1 UNIDRIVE® ENT
consisting of:
20 7116 20-1 UNIDRIVE® ENT with KARL STORZ
Communication Bus System SBB®,
100 – 120, 230 – 240 VAC, 50/60 Hz
400 A Mains Cord
20 0126 30 Two-Pedal Footswitch, two-stage,
with proportional function
20 7116 40 Silicone Tubing Set, for irrigation, sterilizable
20 7116 21 Clip-Set, for use with tubing set 20 7116 40
20 0901 70 SCB Connecting Cable, length 100 cm

Optional Accessories:
20 7110 32 High Performance EC Micro Motor
20 7110 72 Connecting Cable, to connect EC motor 20 7110 32
to control unit
40 7110 35 Micro Shaver Handpiece, straight, with integrated
EC micro motor and connecting cable for use with
UNIDRIVE® ENT
40 7110 39 STAMMBERGER Paranasal Sinus Shaver Handpiece, 90° angle,
with EC micro motor
consisting of:
40 7110 37 Housing of the Paranasal Sinus Shaver Handpiece
40 7110 38 Motor of the Paranasal Sinus Shaver Handpiece,
without connecting cable 20 7110 70
20 7110 70 Connecting Cable, to connect UNIDRIVE® ENT with
STAMMBERGER Paranasal Sinus Shaver Handpiece 40 7110 39, 90° angle
40 7110 40 STAMMBERGER-CASTELNUOVO DrillCut-X Shaver
Handpiece, for use with UNIDRIVE® ENT
280052 B Universal Sprayer, 0.5 l bottle, for use with 280052 C,
– HAZARDOUS GOODS – UN 1950
280052 C Spray Diffuser, for use with 280052 B
mtp* Set of Tubes, for single patient use

* This product is marketed by mtp.
For additional information, please apply to:
mtp medical technical promotion gmbh,
Postfach 4529, 78510 Tuttlingen, Germany
UNIDRIVE® ENT
System Components
Sinus Shaver Handpieces

Special Features:
- Strong and reliable suction
- Smooth operation
- Cuts the tissue without ripping; therefore less bleeding
- 360° rotating shaver blade
- Graduated outer sheath
- All handpieces are fully autoclavable
- For use with both straight or curved paranasal shaver blades

Paranasal Sinus Shaver Handpiece 40711039
- Ergonomically formed, 90° angled handpiece
- Oscillating operation mode. Max. drilling speed 7,000 rpm
- A rotation speed of 3,000 rpm is recommended as this provides the most efficient suction.
- Cooling vents prevent motor from overheating
- Straightforward, central irrigation channel enables optimal suction of blood and tissue
- Suction function can be switched off at the handpiece under sterile conditions
- Special lubrication holes ease maintenance (lubrication)
- Easy cleaning and maintenance. The housing (upper part 40711037) is machine-washable. Luer-Lock connection enables additional machine cleaning. Meets highest hygienic standards.
- The device can be dismantled easily into two pieces at the touch of a button: housing and motor unit

40711039 STAMMBERGER Paranasal Sinus Shaver Handpiece, 90° angled, with EC motor consisting of:
40711037 Paranasal Sinus Shaver Handpiece Housing
40711038 Paranasal Sinus Shaver Handpiece Motor, without connecting cable 20711070

20711070 Connecting Cable, to connect UNIDRIVE® ENT with STAMMBERGER Paranasal Sinus Shaver Handpiece 40711039, 90° angle

Micro Shaver Handpiece 40711035
- Ergonomically formed, straight handpiece
- Oscillating operation mode, max. drilling speed 3,000 rpm
- Powerful motor enables continuous operation
- Extremely light construction
- Fully immersible and machine-washable

40711035 Micro Shaver Handpiece, straight, with integrated EC micro motor and connecting cable for use with UNIDRIVE® ENT
STAMMBERGER-CASTELNUOVO DrillCut-X Shaver Handpiece

DrillCut-X Handpiece 40 7110 40
- Ergonomically formed, angled handpiece, optimally fits the hand
- Oscillating operation mode for shave blades, max. 7,000 rpm
- Rotating mode for sinus shavers, max. 12,000 rpm
  Drilling speed of 3,000 rpm is recommended as this provides the most efficient suction.
- Absolutely straight suction and irrigation channels
- With integrated irrigation – removed material is therefore more fluid to prevent blockages
- Very powerful motor, also suitable for removing harder material
- Very quiet operation, low vibration
- Special lubrication holes for easy maintenance
- With LOCK for positioning shaver blades and sinus shavers, if required
- Fully immersible and machine-washable

40 7110 40 STAMMBERGER-CASTELNUOVO DrillCut-X Shaver Handpiece, for use with UNIDRIVE® ENT
## Shaver Blades, straight
for Paranasal Sinuses and Skull Base Surgery

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<th>Detailed View</th>
<th>Suction Shaver Blade, length 12 cm</th>
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Shaver Blades, slightly curved
for Paranasal Sinuses and Skull Base Surgery

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<th>for use with DrillCut-X Handpiece, with longer blade and integrated irrigation, 40 7110 40</th>
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Shaver Blades, strongly curved
for Paranasal Sinuses and Skull Base Surgery

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<th>for use with DrillCut-X Handpiece, with longer blade and integrated irrigation, 40 7110 40</th>
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Sinus Burrs
for Paranasal Sinuses and Skull Base Surgery

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<td>70° curve, diamond head, burr diameter 3.6 mm, shaft diameter 4 mm, color code: red-yellow</td>
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</table>

for use with DrillCut-X Handpiece, with longer blade and integrated irrigation, 40 7110 40

for single use, sterile, package of 5
Camera System IMAGE™

Camera Control Unit

IMAGE™ is the first truly digital endoscopic video camera. This video camera system instantly converts optical images to digital at the earliest possible site: the CCD sensing chip. This sensor delivers Digital First, a digital signal "through and through" for visibly improved imaging on all digital recording and display devices.

The advantages over other systems are obvious: Only IMAGE™ offers the resolution and light sensitivity necessary for the highest digital image quality.

![IMAGE™ Camera Control Unit](image)

**22 2000 20-102** IMAGE™ Camera Control Unit, with integrated KARL STORZ Communication Bus System, integrated digital Image Processing Module and SDI Module consisting of:

- **22 2000 20-102** IMAGE™ Camera Control Unit, with SDI module
- 400 A Mains Cord
- 400 B Mains Cord, US-version
- **20 2001 30U** Keyboard, US-version
- **2x 20 2210 70** Connecting Cable, for controlling peripheral units, length 180 cm
- **3x 536 MK** BNC/BNC Video Cable, length 180 cm
- **547 S** S-Video (Y/C) Connecting Cable, length 180 cm
- **20 2032 70** Special RGB Connecting Cable, length 180 cm
- **20 0901 70** SCB Connecting Cable, length 100 cm

Please note:
Apart from the US-English set (tagged with the letter "U") KARL STORZ offers additional language-specific versions of the IMAGE™ Camera System. Please specify in your order the language preferred: "F" = French, "I" = Italian, "S" = Spanish, "P" = Portuguese

Specifications:

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<th>Signal-to-Noise Ratio</th>
<th>AGC</th>
<th>Video Output</th>
<th>Input</th>
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<td>Microprocessor controlled</td>
<td>- Composite signal at BNC socket</td>
<td>Keyboard for title generator, 5-pin DIN socket</td>
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<tr>
<td>- IMAGE™ One-Chip Camera Systems ≥ 54 dB</td>
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<td>- S-Video signal to 4 pin Mini DIN socket</td>
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<td>- RGB signal to D-Sub socket</td>
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<td>- DV signal to DV connector (only IMAGE™ with DV module)</td>
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<td>- SDI signal to BNC socket (only IMAGE™ with SDI module)</td>
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<tbody>
<tr>
<td>- KARL STORZ-SCB® at 6 pin Mini DIN socket (2x)</td>
<td>305 x 89 x 335</td>
<td>2.95</td>
<td>100 – 240 VAC, 50/60 Hz</td>
<td>IEC 601-1, 601-2-18, CSA 22.2 No. 601, UL 2601-1 and CE according to MDD, protection class I/CF</td>
</tr>
</tbody>
</table>
Camera System IMAGE™

Camera Heads

For use with IMAGE™ Camera Control Unit 22 2000 11U1xx

**IMAGE™ A³™ Three-Chip Camera Head**

22 2200 40-3 22 2201 40-3

**IMAGE™ A³™ Three-Chip Camera Head**

22 2200 40-3 22 2201 40-3

Color systems PAL/NTSC, autoclavable, with integrated Parfocal Zoom Lens f = 14 - 28 mm (2x), 2 freely programmable camera head buttons, incl. plastic container for sterilizing and storage 39301 ACT

**IMAGE™ A1™ One-Chip Camera Head**

22 2100 40-3 22 2101 40-3

**IMAGE™ A1™ One-Chip Camera Head**

22 2100 40-3 22 2101 40-3

Color systems PAL/NTSC, autoclavable, with integrated Parfocal Zoom Lens f = 14 - 28 mm (2x), 2 freely programmable camera head buttons, incl. plastic container for sterilizing and storage 39301 ACT

**IMAGE™ S³™ Three-Chip Camera Head**

22 2200 30-3 22 2201 30-3

**IMAGE™ S³™ Three-Chip Camera Head**

22 2200 30-3 22 2201 30-3

Color systems PAL/NTSC, with integrated Parfocal Zoom Lens f = 14 - 28 mm (2x), 2 freely programmable camera head buttons

**IMAGE™ S¹™ One-Chip Camera Head**

22 2100 30-3 22 2101 30-3

**IMAGE™ S¹™ One-Chip Camera Head**

22 2100 30-3 22 2101 30-3

Color systems PAL/NTSC, with integrated Parfocal Zoom Lens f = 14 - 28 mm (2x), 2 freely programmable camera head buttons
Cold Light Fountains and Imaging Systems for Video-Documentation

Recommended Set according to Prof. Reda KAMEL, M. D.

- 202120 40 1 KARL STORZ Endoscopy TELECAM® 1-Chip Camera Head, autoclavable, color system PAL, with integrated Parfocal Zoom Lens, f = 14 mm–28 mm, (2x); with 2 freely programmable buttons, including sterilisation tray 93091 ACT.
- 202121 40 Same, color system NTSC.
- 202130 11 1 TELECAM® SL II Camera Control Unit, color system PAL/NTSC, with integrated integrated Image Processing Module and DV-output; set, ready for use.

- 9415 NB Flat Screen Monitor, screen 15" / 36 cm, wall-mounted with VESA 100 mounting, color system PAL/NTSC, max. resolution 1024 x 768, input: SDI, S-Video, DV and XGA; brightness: 270 cd/m², contrast: 400:1, power supply: 100-240 VAC, 50/60 Hz consisting of:
  - 9415 NG 15" TFT Flat Screen
  - 9415 PS Power Supply
  - 400 A Mains Cord

- 9419 NB Flat Screen Monitor, screen 19" / 48 cm, wall-mounted with VESA 100 mounting, color system PAL/NTSC, max. resolution 1280 x 1024, input: SDI, Composite, S-Video RGB, DV and SXGA; brightness: 450 cd/m², contrast: 650:1, power supply: 100-240 VAC, 50/60 Hz consisting of:
  - 9419 NG 19" TFT Flat Screen
  - 9419 PS Power Supply
  - 400 A Mains Cord

- 547 M 1 Video Color Printer, color system PAL, NTSC, power supply: 110–240 VAC, 50/60 Hz, including mains cord.

- 201331 01-1 1 Cold Light Fountain XENON 300 with integrated SCB Module, with built-in antifog air-pump, including mains cord, BNC-connecting cable and silicone tubing set, power supply: 100 – 125 VAC/220 – 240 VAC, 50/60 Hz, ready for use.

- 201340 01 1 Cold Light Fountain XENON NOVA® 300, power supply: 100 – 125 VAC/220 – 240 VAC, 50/60 Hz, including mains cord, ready for use.

- 495 NA 1 Fiber Optic Light Cable, size 3.5 mm, length 220 cm.

- 29003 NA Mobile Video Cart, consisting of:
  - 29003 NAG Basic Mobile Cart, rides on 4 antiflatic double casters, 2 equipped with locking brakes, 1 shelf fixed, 1 shelf with mains switch, 1 shelf inclinable, 1 drawer unit with lock, 1 push bar with large lumen cable channels integrated in both columns, 1 set of non-sliding stands, 1 camera mount.
  - 29003 PB Power Box with electrical supply terminal strip with 12 plugs, 12 equipotential plugs.

Dimensions:
- Mobile Cart: 700 mm x 1260 mm x 626 mm (w x h x d)
- Shelf: 630 mm x 480 mm (w x d)
- Caster diameter: 125 mm

Please note:
IMAGE 1™ – the First Truly Digital Endoscopic Video Camera System see pages 54–55.
Notes: