

OPEN ACCESS ATLAS OF OTOLARYNGOLOGY, HEAD & NECK OPERATIVE SURGERY



BASIC FUNCTIONAL ENDOSCOPIC SINUS SURGERY (FESS): A STEP-BY-STEP GUIDE WITH SURGICAL VIDEOS AND ILLUSTRATION OF ANATOMICAL LANDMARKS IN CADAVERIC DISSECTION

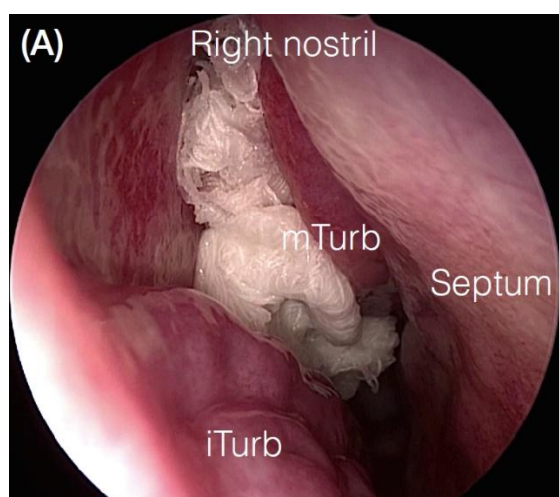
Yves Brand and Narayanan Prepageran

Gate System of Paranasal Sinuses

We consider four important landmarks in basic FESS. These landmarks are important to gain entry to the maxillary sinus, anterior ethmoid, posterior ethmoid and the sphenoid sinus. Each landmark serves as a gate to a defined space within the paranasal sinuses. This chapter presents an overview to better understand this Gate System.

Nasal decongestion (Figure 1 A)

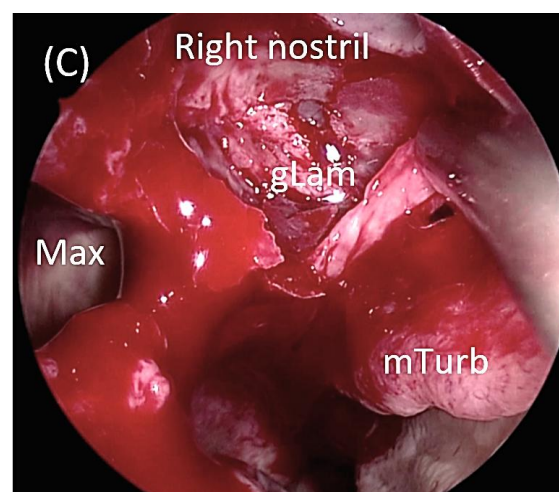
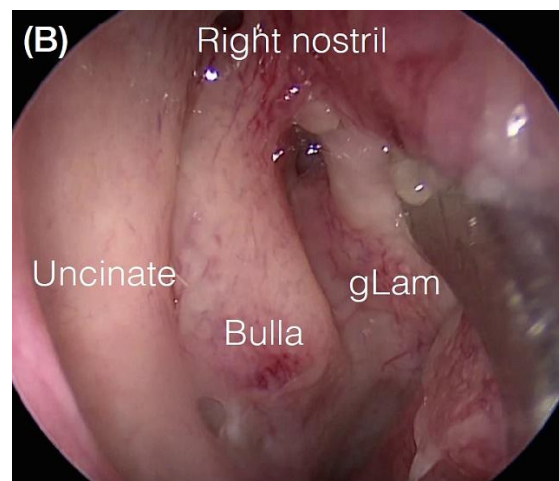
To visualise the different structures of the nose, the nasal cavity is decongested. This can be done with cotton ribbon gauze soaked in Moffat's solution (1ml adrena-line 1:1000, 2mls 10% cocaine, 4mls 8.4% sodium bicarbonate, 13mls water/saline) for several minutes. Alternatively, adrenaline 1:1000-soaked cotton ribbon gauze can be used. It is important to pack the middle meatus under endoscopic vision (A).



Gate 1 (Figures 1 B, C): The uncinete process is the gate to the maxillary sinus (B). Once the uncinete is removed the maxillary sinus can be seen through its natural ostium (C)

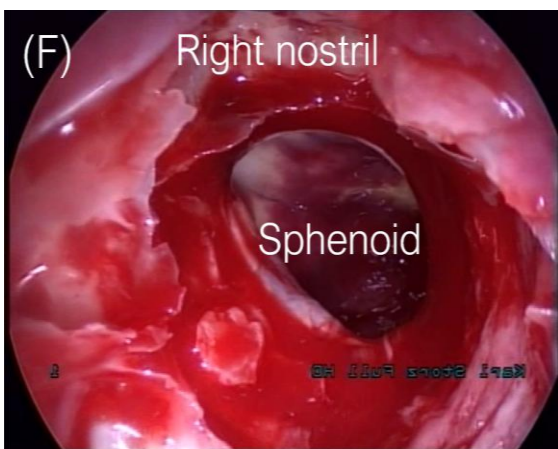
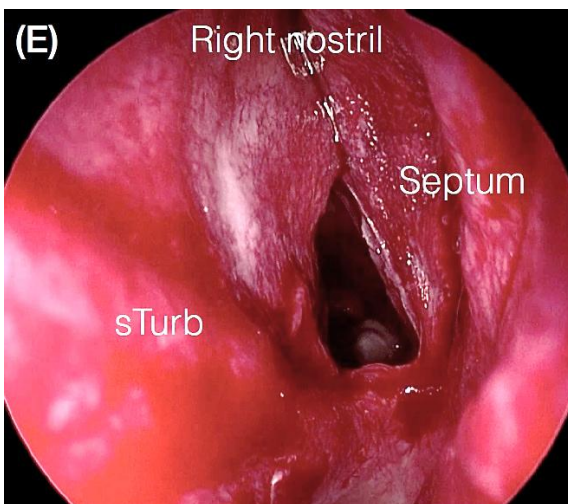
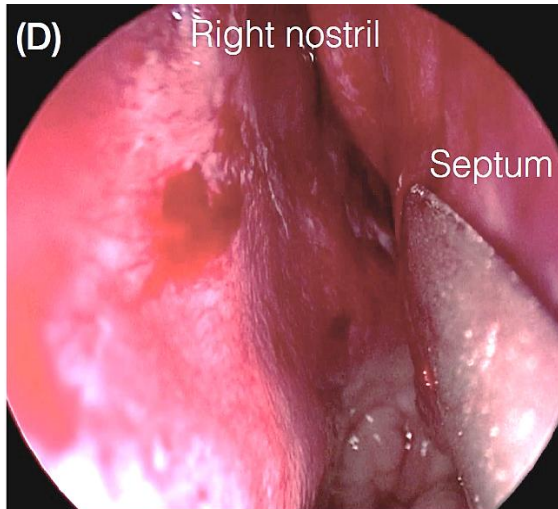
Gate 2 (Figure 1 B): The bulla ethmoidalis is found posterior to the uncinete process (B). The anterior wall of bulla ethmoidalis is the gate to the anterior ethmoid.

Gate 3 (Figures B, C): The ground lamella of the middle turbinate separates the anterior from the posterior ethmoid (B, C). The ground or basal lamella of the middle turbinate is the gate to the posterior ethmoid.



Gate 4 (Figures 1 D-F): The anterior wall of the sphenoid sinus is the gate to the sphenoid sinus. The natural ostium is located between the superior turbinate and the

septum (D, E). It can also be entered through the posterior ethmoid (F)



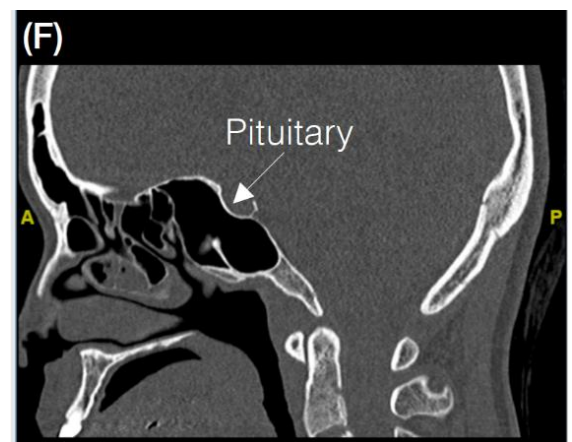
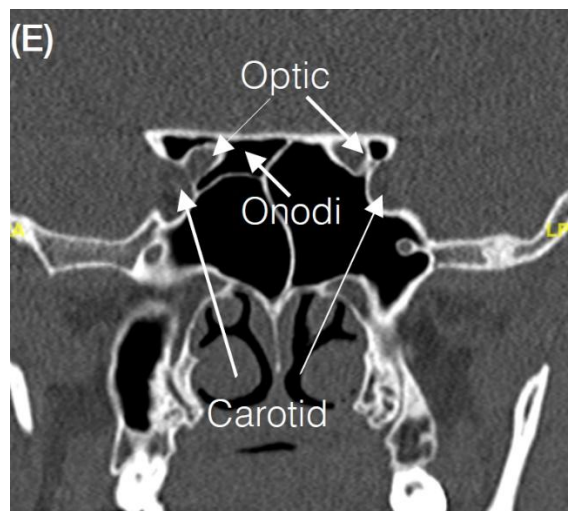
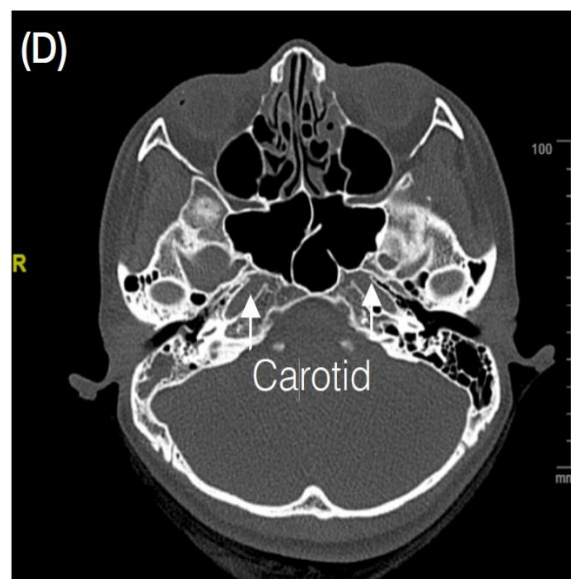
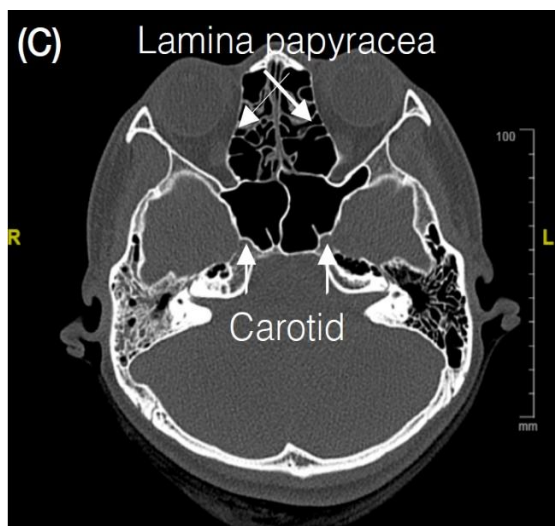
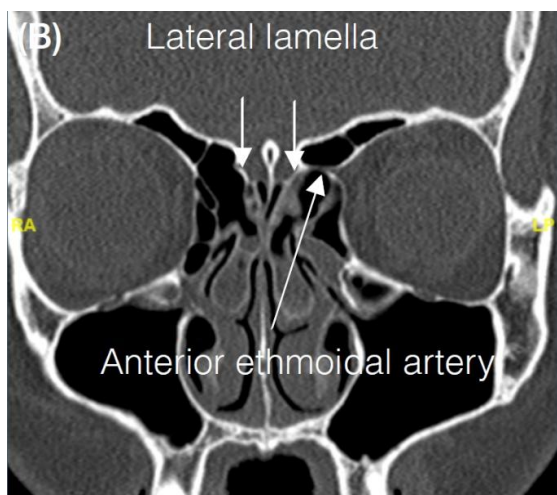
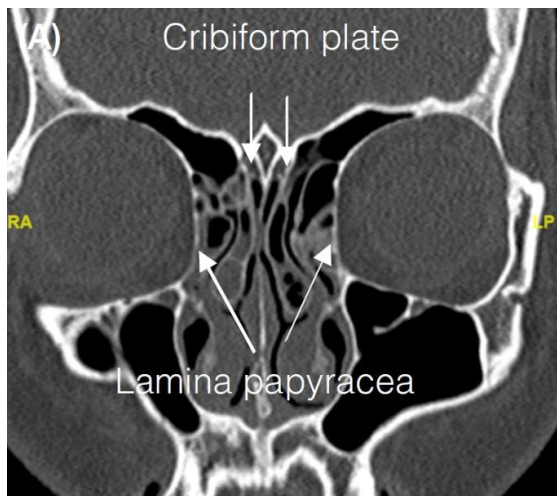
What to look for in a CT scan before performing FESS

CT scans give important information to the surgeon and should be carefully analysed prior to surgery. The scans should be in the operating theatre during the entire procedure to consult them whenever necessary. Always check the name of the patient on the scan.

We use the mnemonic “CLOSE” to identify and memorise important structures on the CT scan.

C	C ribiform plate: How low down is it? C arotid artery: Identify it. Does it have any impression/dehiscence into the lateral walls of the sphenoid sinus?
L	L ateral lamella: How long does it extend down? L amina papyracea: Is there any dehiscence?
O	O rbit: Any dehiscence and relation to the maxillary sinus? O nodi cell: Is there one present, position of carotid and optic nerve?
S	S phenoid sinus: Identify optic nerve, carotid artery, pituitary, and optic nerve location
E	E thmoidal arteries: Location of anterior and posterior ethmoidal arteries

Figures 1 A-F: Decongestion & Gates 1-4



Figures 6 A-F: Mnemonic “CLOSE” is used to identify and memorise important structures

Important things before starting surgery

1. Obtain written consent prior to surgery. It is important that the patient is aware of the surgery and its risks
2. Make sure the patient is aware that follow-up care and saline irrigation are important after surgery
3. Check for medical conditions that contraindicate surgery. Check whether the patient is taking any drugs (e.g. anticoagulants) or has any allergies
4. Review the CT scans prior to surgery. Be aware of important anatomical landmarks. It is mandatory to have the scans displayed within the operating room in case they need to be consulted during the procedure
5. The intubation tube should not be in the surgeon's way
6. Insert a throat pack once the patient is intubated. Remember to remove the throat pack at the end of the procedure. Therefore, the throat pack must be clearly visible for the surgeon and the anaesthetist
7. Position the patient's head in a slightly flexed position for basic FESS. This is important to avoid injury to the skull base which can more easily happen if the head is in an extended position
8. The surgeon must maintain a comfortable position to avoid fatigue and pain in the back and/or shoulder. Some surgeons prefer to sit while others prefer to stand during surgery
9. Place the monitor in a way that it can be easily viewed by the surgeon (*Figure 2*)
10. For most procedures a 0° (or 30°) endoscope should be used. For the beginner the use of a 0° endoscope is easier
11. Anchor the endoscope at the dome of the nose and insert the instruments below (*Figures 3, 4*)



Figure 2: Monitor placed so easily viewed by surgeon



Figure 3: Endoscope anchored at the dome of the nose



Figure 4: Instruments passed below the endoscope

12. Only a few instruments are required to perform basic FESS (*Figure 5*). Make sure the basic instruments are available: Freer elevator, backbiting forceps, suction, through-cutting Blakesley forceps. Bipolar cautery is useful to control bleeding
13. Powered instrumentation is a useful adjunct, but not a necessity
14. ***Always remember that the surgery can be stopped if orientation is lost, and surgery becomes dangerous. It is always safer to pack the nose, wait and regain orientation than to risk injury***

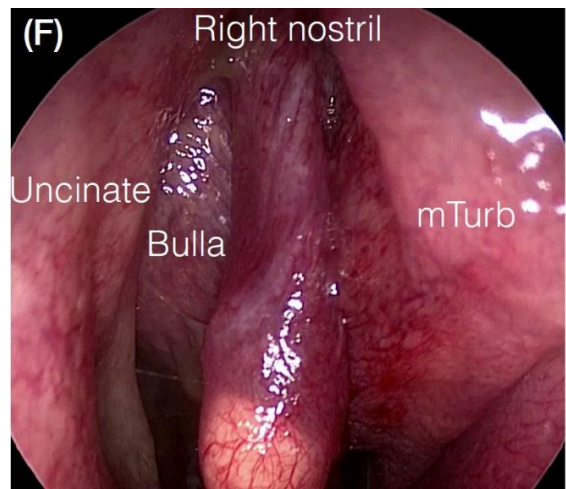
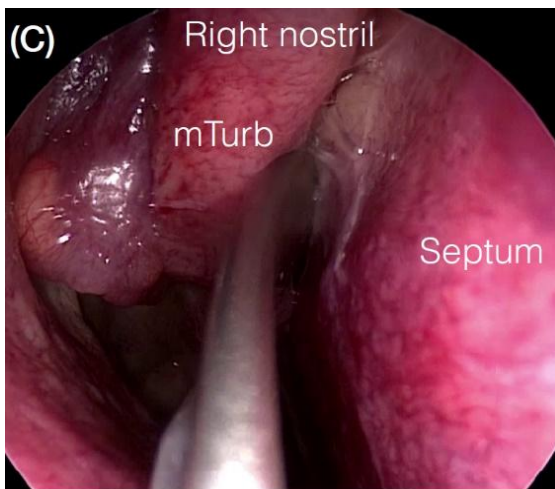
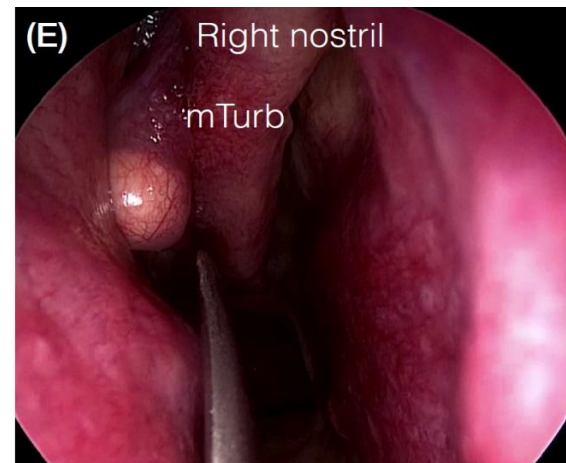
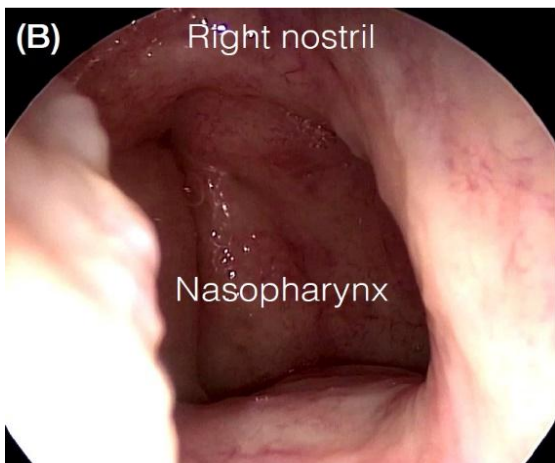
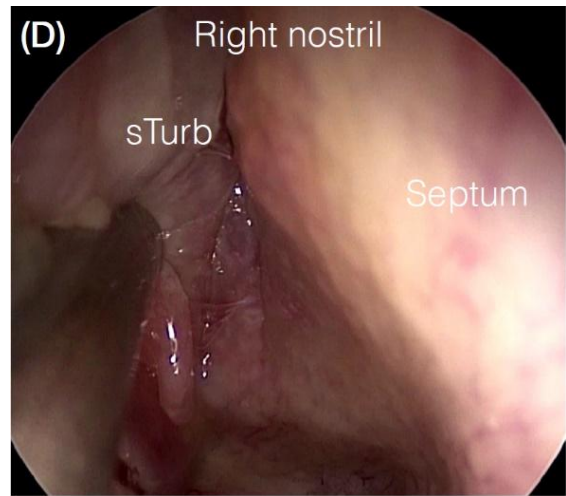
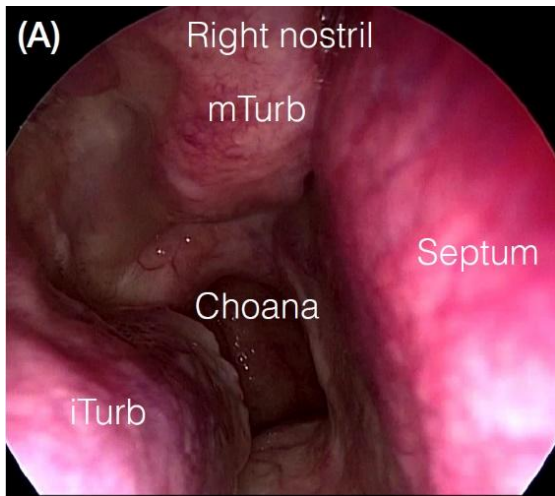


Figure 5: Instruments for basic FESS

Endoscopic evaluation of the nose (*Figures 6 A-E*)

It is important to systematically inspect the nose prior to surgery. We recommend (as suggested by Prof Stammberger) 3 passes through the nasal cavity.

- Decongest the nose
- Inspect the nose with either a 0° or 30° endoscope
- ***First pass***
 - Pass the endoscope through the widest nasal passage. This is usually along the floor of the nose
 - Inspect the choana, vomer, opening of the eustachian tube and the nasopharynx
- ***Second pass***
 - Pass the endoscope between the septum and turbinates (middle and superior)
 - This allows visualisation of the sphenoidal recess, the ostium of the sphenoid sinus between the septum and the superior turbinate, and the olfactory region
- ***Third pass***
 - In acute and chronic pathology of the sinuses this is usually the most important step of the endoscopic evaluation of the nose
 - To achieve adequate visualisation gently push the middle turbinate medially with a Freer elevator
 - Take care not to fracture the middle turbinate
 - The attachment of the middle turbinate with its ground lamella, the unciniate process and the bulla ethmoidalis can be seen
 - The natural ostium of the maxillary sinus is obstructed by the unciniate process is usually not visible
 - If an ostium is visible, it is usually an accessory ostium or from prior surgery



Figures 6 A-F: Endoscopic evaluation of the nose



Gate 1: Uncinate Process - Anterograde Approach (Figures 7 A-F)

Step 1

- Pack the middle meatus with Moffat's solution or 1:1000 adrenaline packing
- Take care not to injure the mucosa to avoid bleeding
- Gently push the middle turbinate medially

Step 2

- After removing the pack visualise the uncinat process, ethmoid bulla, and ground lamella of the middle turbinate
- Now focus on the first gate: the uncinat process (A)

Step 3

- Gently palpate the uncinat process with a Freer elevator
- The uncinat process is a thin bone that can be gently moved
- The anterior border of the uncinat process is the lacrimal crest. It is a hard bone and is identified by palpation

Step 4

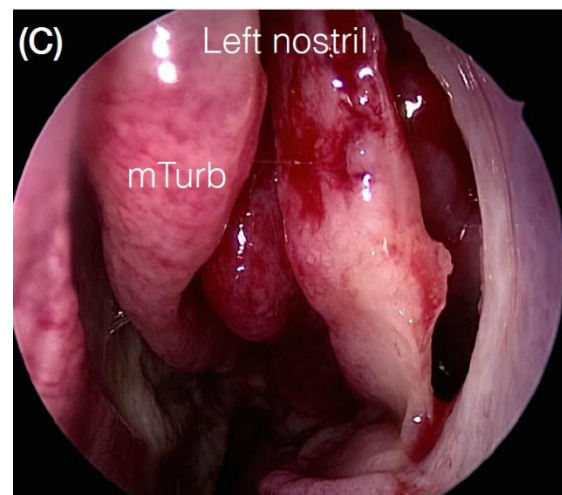
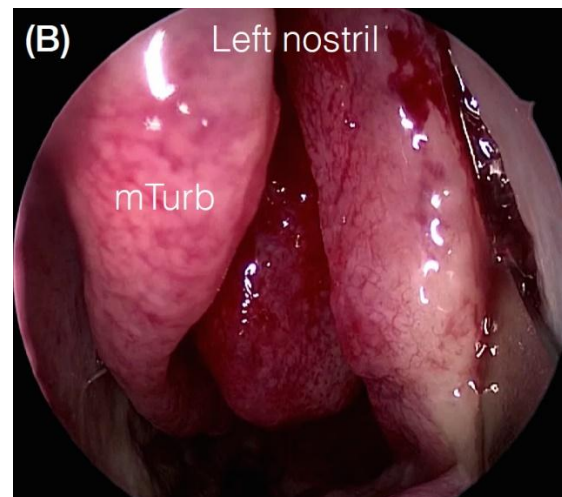
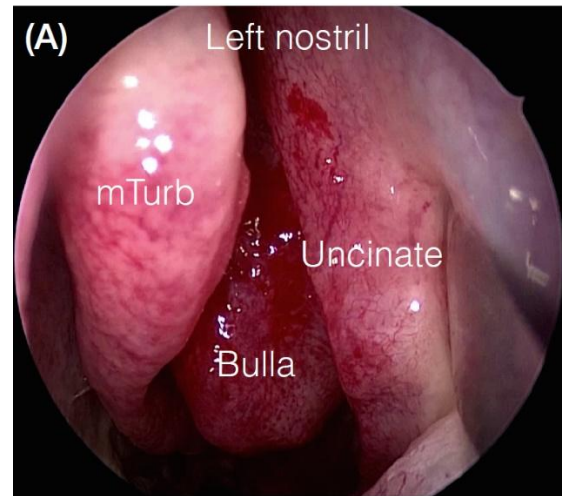
- Use a Freer elevator to incise the uncinat process (B)
- The incision is made from superiorly just below the height of the origin of the middle turbinate, to inferiorly to a level below the inferior end of the middle turbinate (B+C)

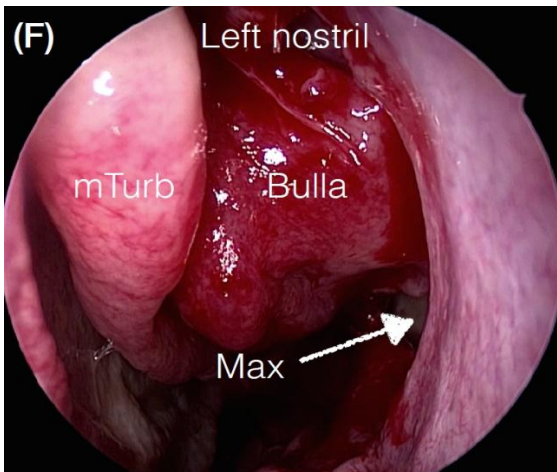
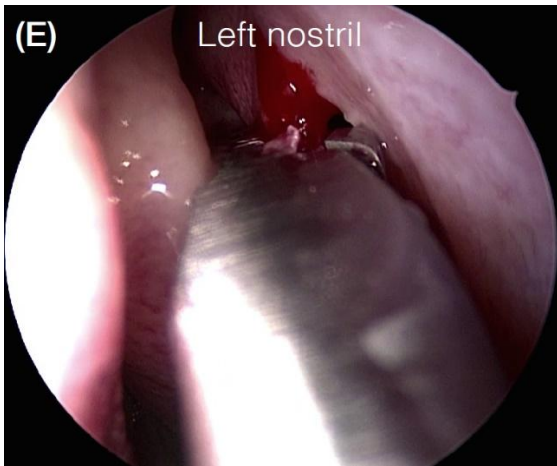
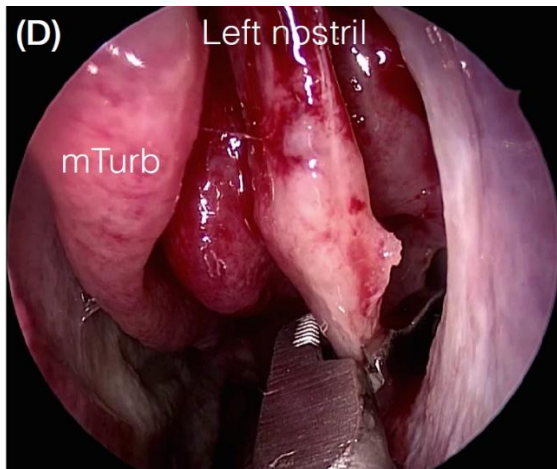
Step 5

- Use a through-cutting Blakesley to cut the uncinat process inferiorly (D) and superiorly (E)
- Remove the uncinat

Step 6

- Once the uncinat process is removed the maxillary sinus comes into view (F)





Figures 7 A-F: Gate 1: Uncinate Process - Anterograde Approach

Gate 1: Uncinate Process - Retrograde and Powered Instrumentation (Figures 8 A-F)

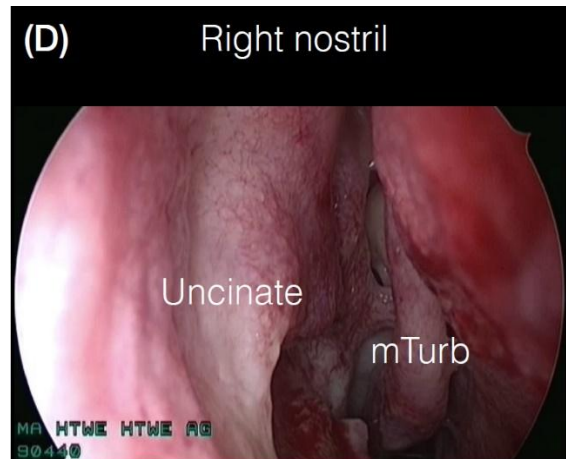
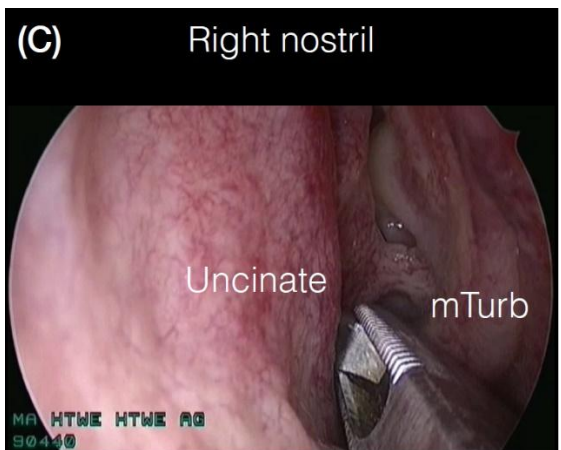
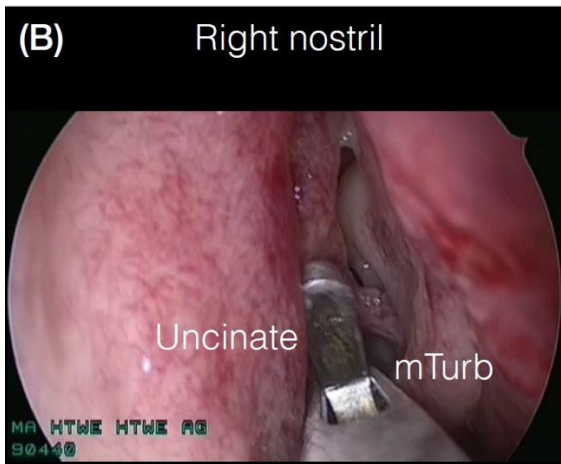
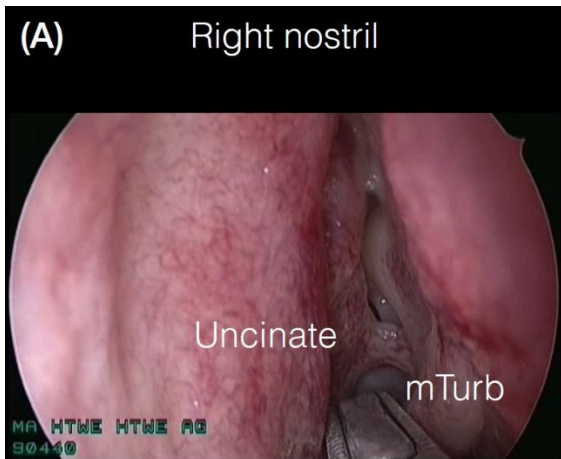
Retrograde uncinectomy using backbiting forceps

- With a narrow ostiomeatal complex there is a risk of injuring the orbit by performing an anterograde uncinectomy
- This can be avoided by using backbiting forceps, using the same steps as described above for the anterograde approach
- However, the forceps are inserted with closed prongs (A)
- Then the prongs are opened (B) and turned behind the uncinete process (C) to cut the uncinete process (D)
- It is important to be aware that the dissection should not go too far anteriorly to avoid injuring the lacrimal duct
- If resistance is felt, there is a risk of injuring the lacrimal duct

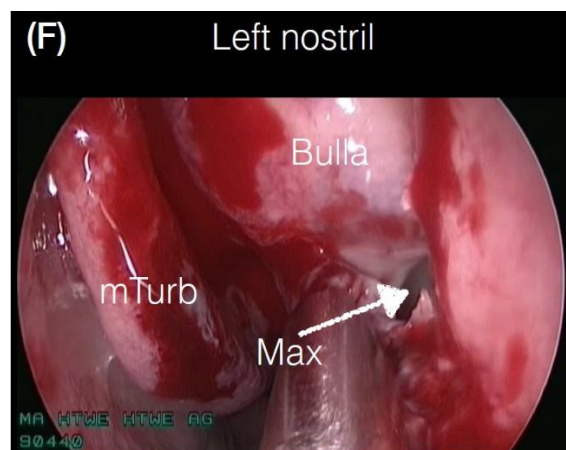
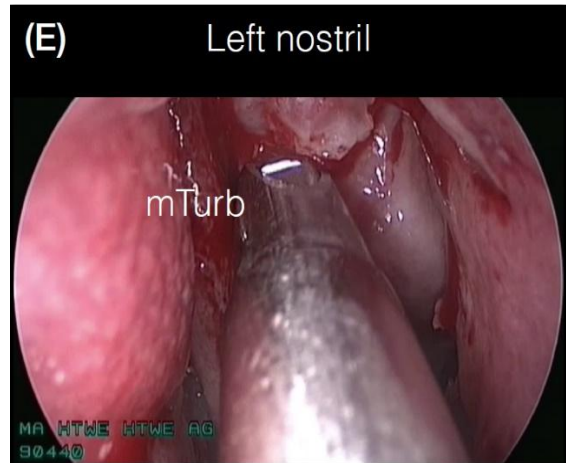
Retrograde uncinectomy using powered instrumentation

- Powered instrumentation can help to remove parts of the uncinete (E, F)
- Powered instrumentation is a very useful tool in FESS as it cuts mucosa and applies suction at the same time; this allows fast tissue removal and reduces bleeding
- Remove the uncinete process either in an anterograde fashion or with the help of backbiting forceps
- However, it should never be used blindly as it can easily cause damage to the orbit and/or skull base
- Therefore, it is vital to check the preoperative CT scans for dehiscences of the lamina papyracea and the configuration of the skull base





Figures 8 A-D: Gate 1 - Retrograde uncinectomy with backbiter



Figures 9 E, F: Gate 1 - Retrograde uncinectomy with powered instrumentation



Gate 2: Ethmoid Bulla (Figures 10 A-F)

Step 1

- Pack the nose as described before to obtain adequate haemostasis
- After the uncinectomy has been performed the ethmoid bulla can be visualised (A)

Step 2

- Enter the bulla ethmoidalis inferomedially
- This is the safest area to enter it and it is away from the orbit and the skull base (B, C)

Step 3

- Always make sure it is really an air cell (D)

Step 4

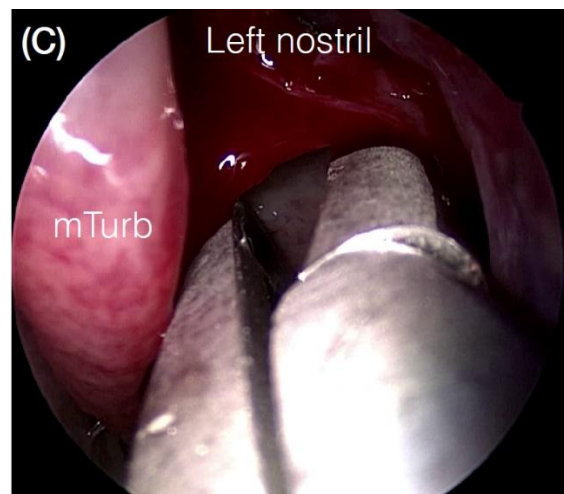
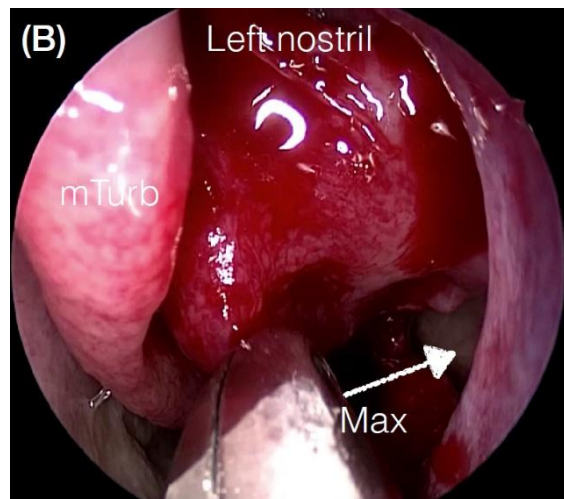
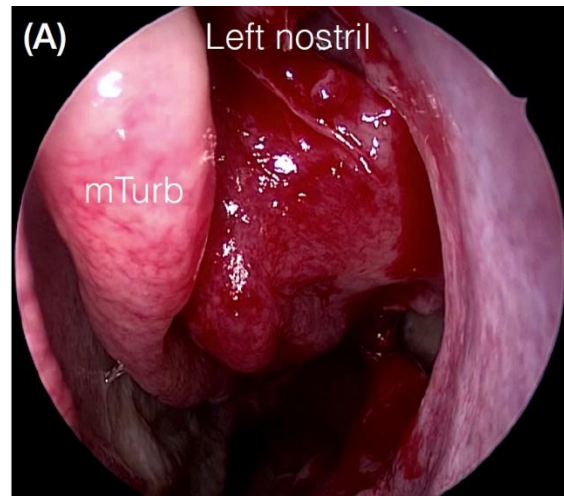
- Remove the bulla ethmoidalis with through-cutting instruments such as a through-cutting Blakesley or a microdebrider (E, F)
- This avoids tearing and stripping of the mucosa and reduces bleeding

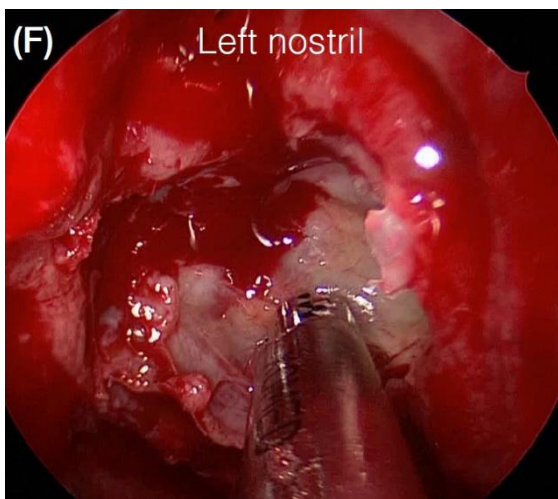
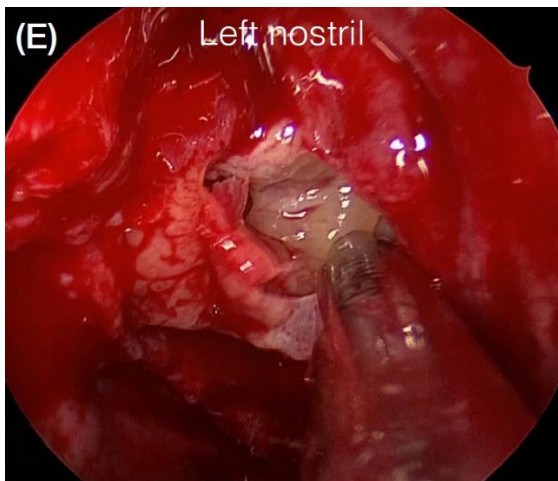
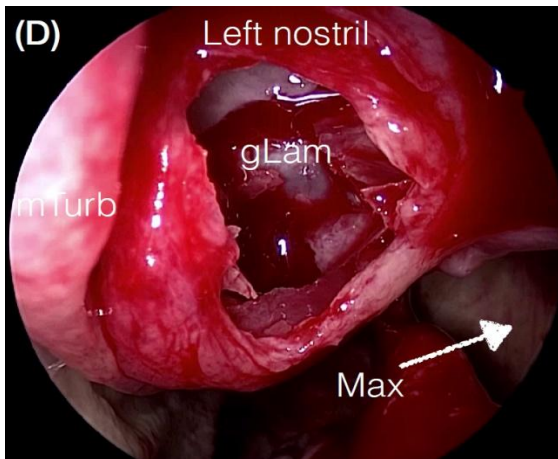
Step 5

- Do not go superior to the attachment of the middle turbinate to avoid injury to the skull base or the anterior ethmoidal artery
- Be aware not to enter the orbit laterally by injuring the lamina papyracea
- The floor and the medial wall of the orbit can be seen through the ostium of the maxillary sinus (D)

Step 6

- At the end of the dissection the next gate is visualised: the ground lamella of the middle turbinate (F)





Figures 10 A-F: Gate 2: Ethmoid Bulla



Gate 3: Ground Lamella of Middle Turbinate (Figures 11 A-F)

Step 1

- Pack the nose as described to obtain haemostasis if required
- Visualise the ground lamella of the middle turbinate (A, B)

Step 2

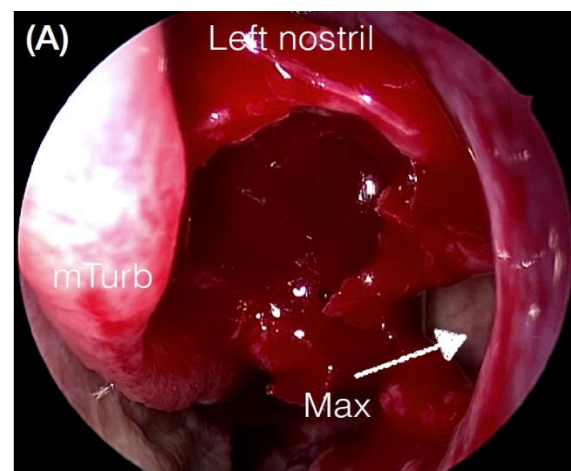
- There may be a small air space behind the posterior aspect of the ethmoid bulla
- However, the ground lamella can also be part of the posterior wall of the ethmoid bulla

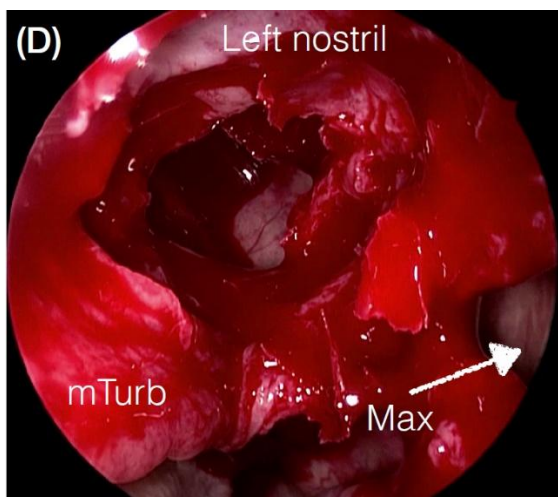
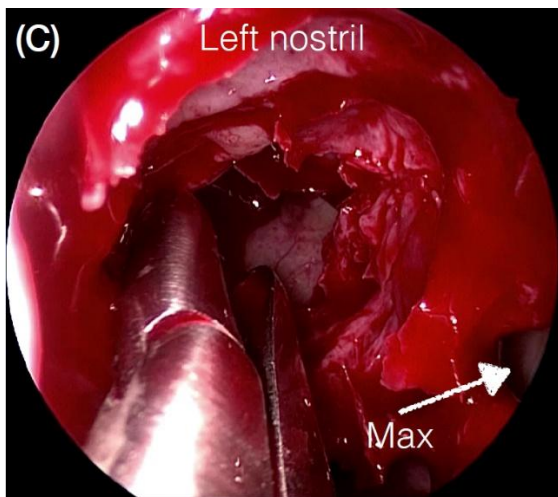
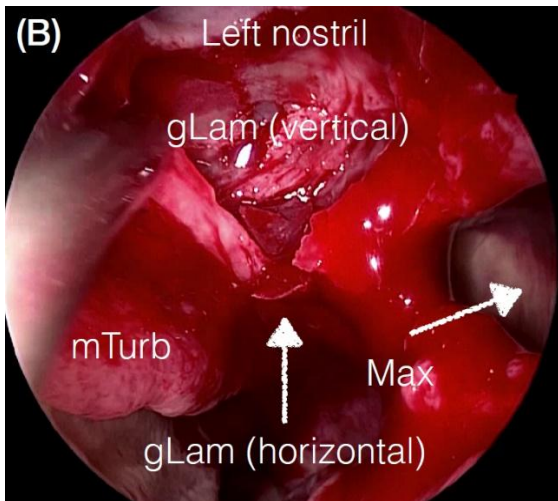
Step 3

- The ground lamella has a horizontal and a vertical segment (B)
- The posterior ethmoid is entered at the junction of the horizontal and vertical segments of the ground lamella (C)

Step 4

- To maintain a stable non-floppy middle turbinate, it is important to preserve the horizontal segment of the ground lamella (D)
- If the entire ground lamella (vertical and horizontal segments) is removed the middle turbinate is no longer stable

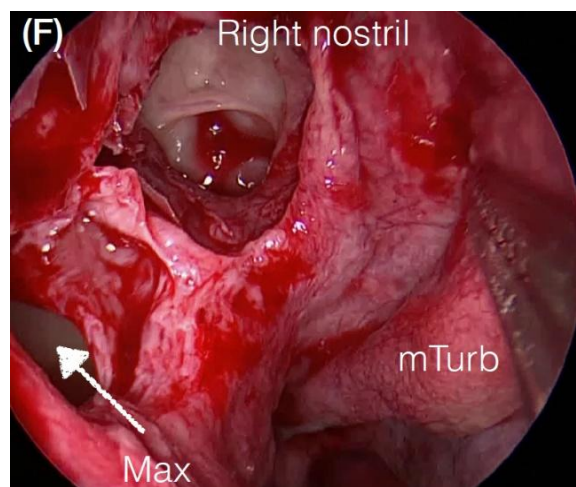
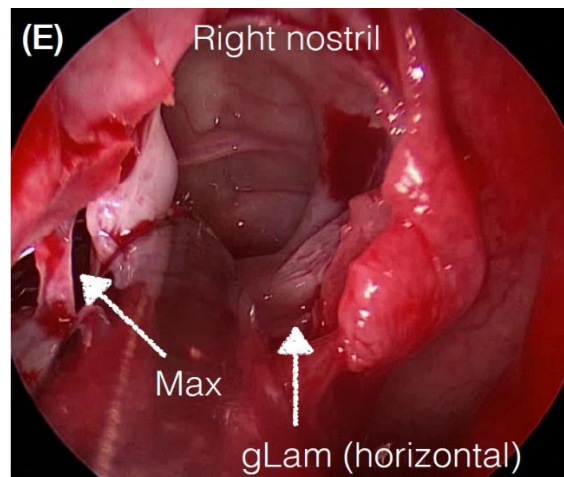




- The air cell is removed
- Vertical bony ledges can be removed with the help of a Kerrison punch

Step 6

- Important landmarks are the superior turbinate medially, the lamina papyracea laterally, and the skull base with the anterior and posterior ethmoidal arteries superiorly
- The floor of the dissection is formed by the horizontal lamella of the middle turbinate (F)
- From the CT scan it is important to be aware of the course of the optic nerve and the carotid artery - especially if an Onodi cell is present



Step 5

- The air cells of the posterior ethmoid are usually larger and fewer in number than the anterior ethmoid (E)
- Usually there is only a single air cell

Figures 11 A-F: Gate 3: Ground Lamella of middle turbinate



Video No. 5

Gate 4 - Sphenoid Sinus (Figures 12 A-F)

- Always visualise and enter the sphenoid sinus through the natural ostium between the superior turbinate and the septum
- **Do not enter the sphenoid through the posterior ethmoidal complex - this is potentially dangerous**
- Only once the sphenoid sinus is located it can be entered through the posterior ethmoidal complex

Step 1

- Study the anatomy of the sphenoid sinus
- Always check the CT scan for the course of the optic nerve and carotid artery
- (A) illustrates the sphenoid keel after the mucoperichondrium of the septum has been elevated at the posterior end of the bony septum
- The natural ostia are superior and lateral (This is just to illustrate anatomy and it is not necessary to expose the sphenoid keel to enter the sphenoid sinus in FESS)

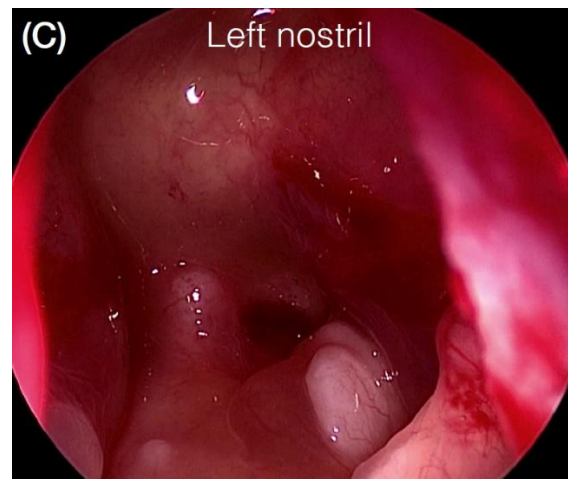
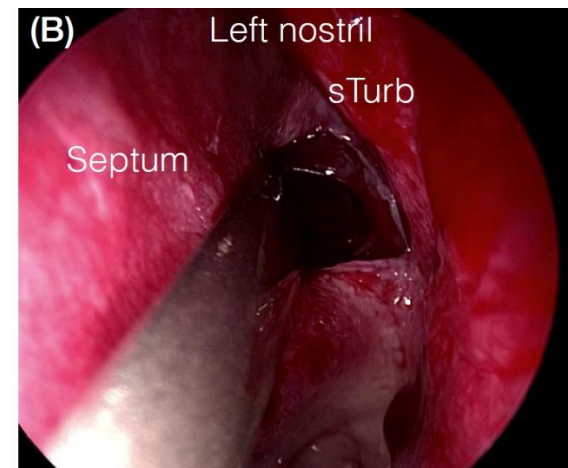
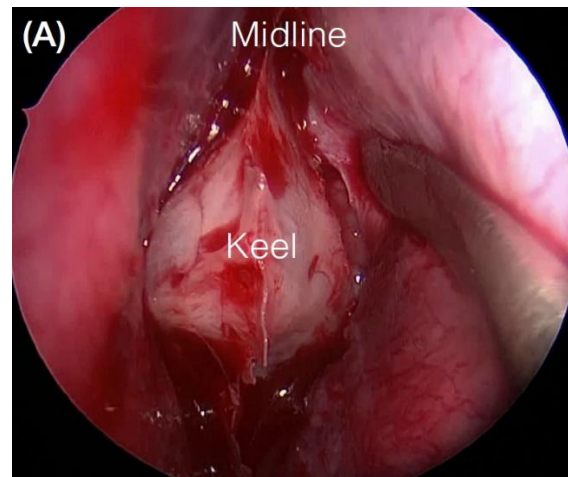
Step 2

- The natural ostium of the sphenoid sinus is located between the septum and the superior turbinate (B)
- It is important to decongest the sphenoidal recess to gain adequate access using packing soaked in either Moffat's solution or adrenaline 1:1000

Step 3

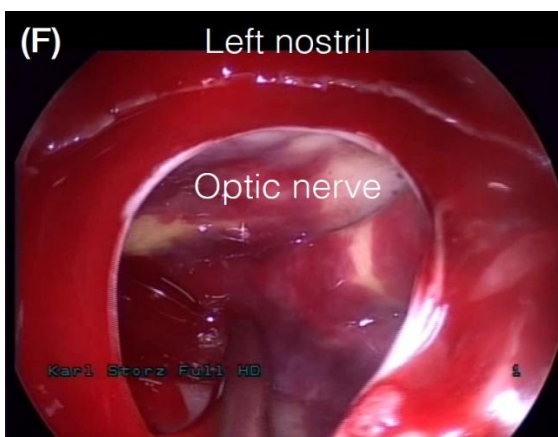
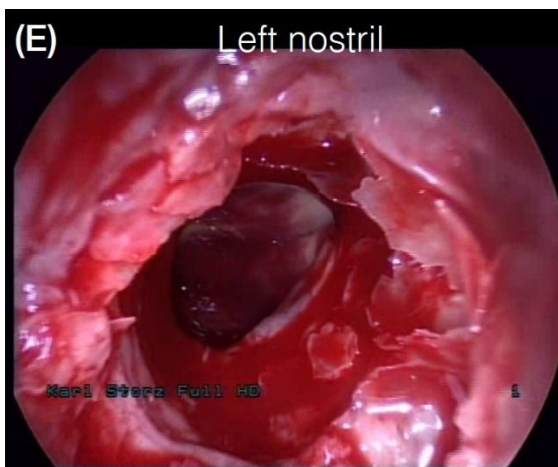
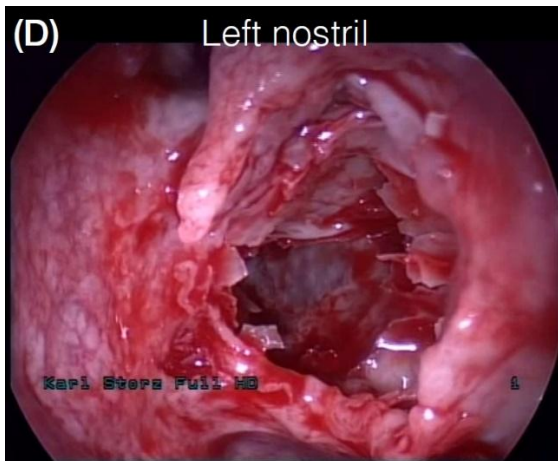
- Once the sphenoid sinus is visualised through its natural ostium (C) the extent of surgery needed can be determined

- Be aware that below the natural ostium runs a branch of the sphenopalatine artery that can bleed briskly if injured
- Its relation to the posterior ethmoidal complex can be seen



Step 4

- If there is a need to open the sphenoid sinus through the posterior ethmoidal complex this can now be done once the relations of the posterior ethmoidal complex and the sphenoid sinus are known (D-F)



Figures 12 A-F: Gate 4: Sphenoid sinus



Frontal Recess (Figures 13 A-D)

Surgery of the frontal sinus is challenging. In many cases, it is better not to touch the frontal sinus during initial surgery and to simply do an uncinectomy and anterior ethmoidectomy to clear the outflow tract of the frontal sinus.

We only highlight the main anatomical landmarks of the frontal recess. A detailed description of frontal sinus surgery is beyond the scope of this chapter.

Step 1

- An uncinectomy, anterior and posterior ethmoidectomy has already been performed (A)

Step 2

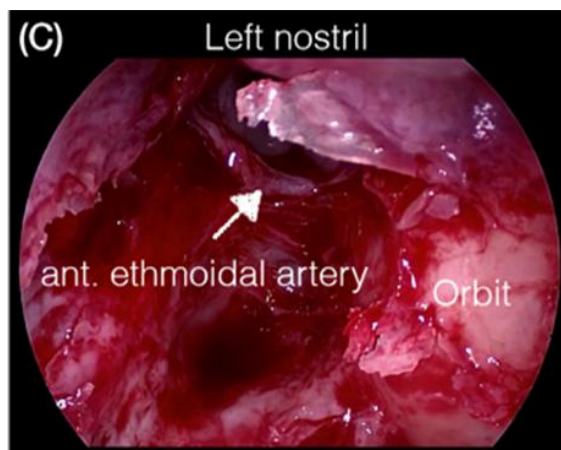
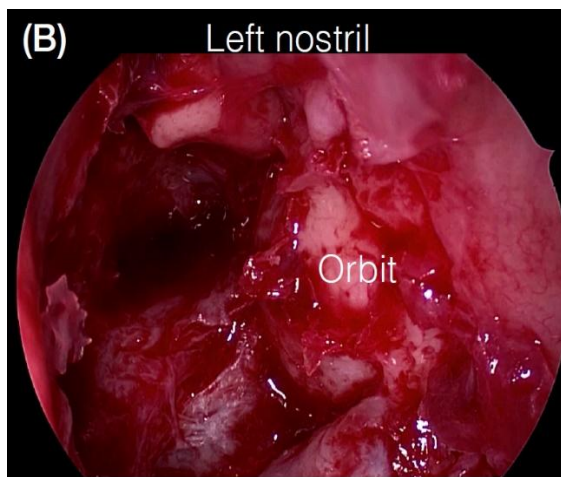
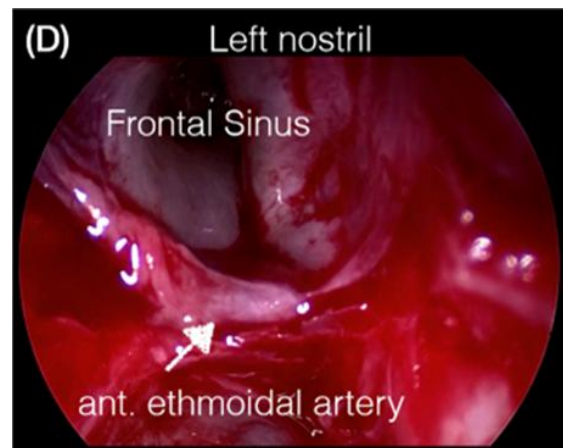
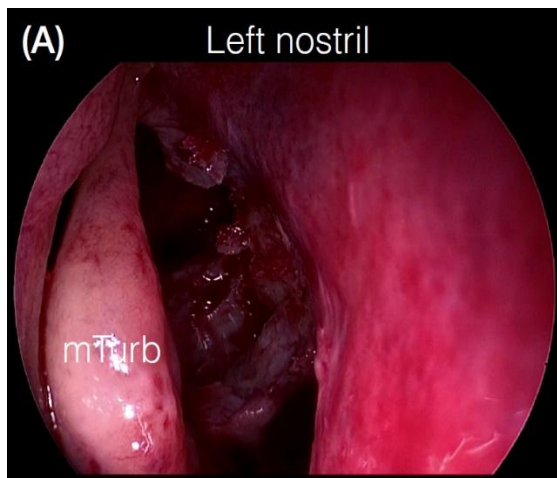
- The lateral landmark is the orbit (B)

Step 3

- This patient had an osteoma at the region of the frontal recess
- The skull base is visualised, and the anterior ethmoidal artery can be seen (C)

Step 4

- The anterior ethmoidal artery is seen posterior to the frontal recess (D)



Figures 13 A-D: Frontal Recess



Endoscopic Septoplasty (Figures 14 A-F)

Endoscopic septoplasty may be required for symptomatic septal deviation or to gain access and space to perform FESS

Step 1

- Pack the nasal cavity with 1:1000 adrenaline
- Infiltrate the nasal septum with 1:100000 - 1:200000 adrenaline
- Infiltration helps to dissect the mucoperichondrium off the cartilage in a sub-perichondrial plane (A)

Step 2

- Bipolar cautery is applied at the site of the planned incision to reduce bleeding (B)

Step 3

- Incise the mucosa with a blade without cutting into the septal cartilage (C)

Step 4

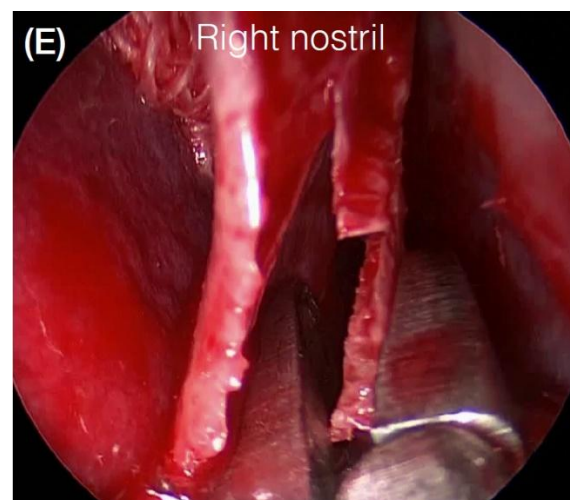
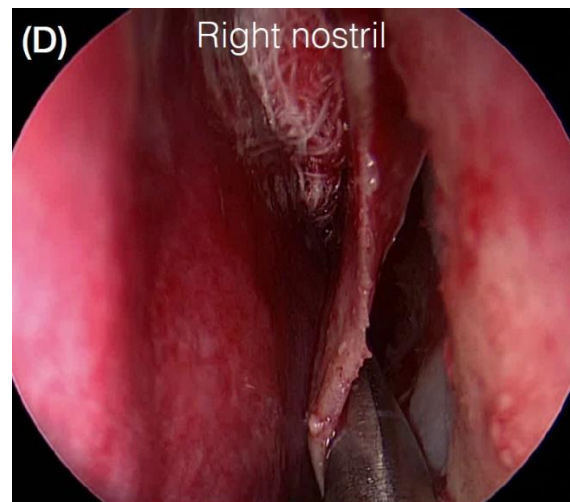
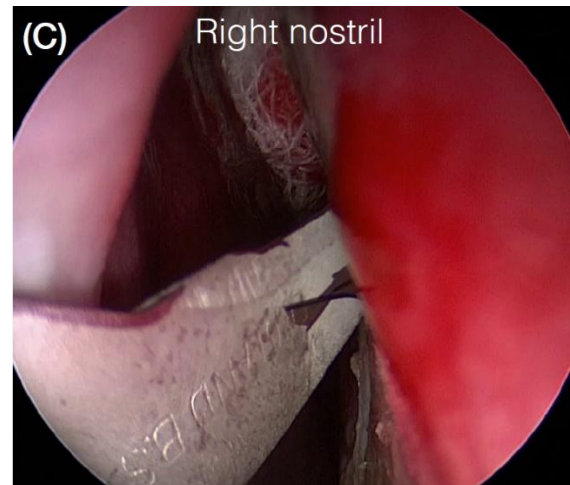
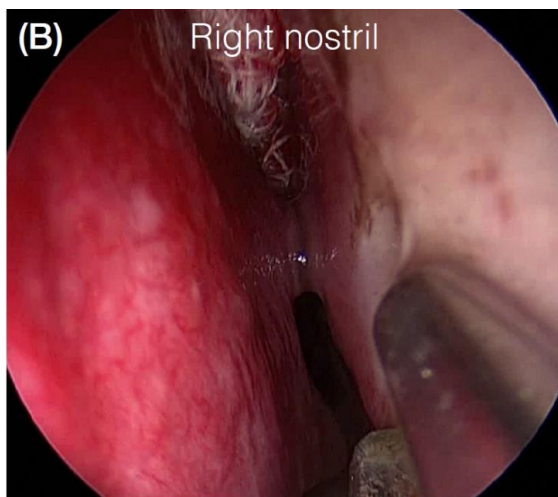
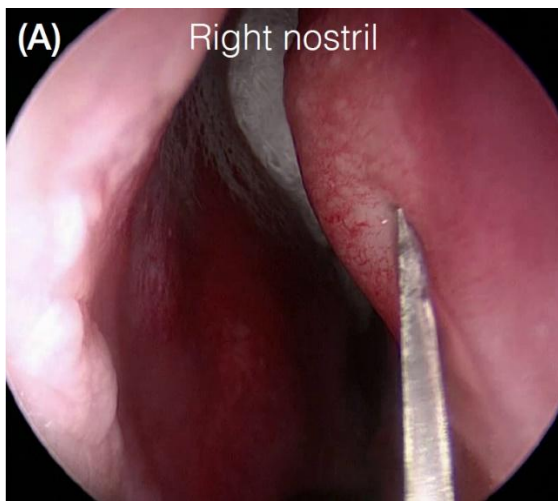
- Elevate the mucoperichondrium with a Freer elevator (D)

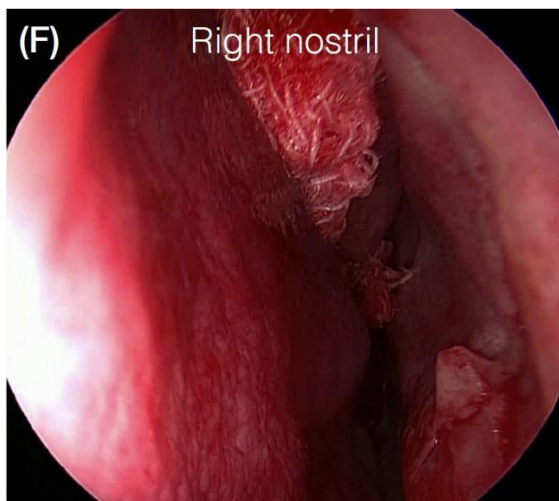
Step 5

- Remove the deviated part of the septum with a Blakesley
- Always remember to leave a dorsal strut of cartilage to maintain stability of the nose (E)

Step 6

- Replace the mucosa
- We do not routinely suture the mucosa
- Pack the nose at the end of surgery





Figures 14 A-F: Septoplasty



Concha Bullosa (Figures 15 A-D)

A concha bullosa is seen in the preoperative CT scans. It can make access to the osteomeatal complex difficult and therefore should be addressed before doing FESS if necessary

Step 1

- Pack the middle meatus with 1:1000 adrenaline

Step 2

- Puncture and split the concha bullosa (A-C)
- It is important not to disturb the medial part of the middle turbinate as this area contains important olfactory epithelium and can disturb the patient's olfaction

Step 3

- The lateral part of the middle turbinate can be removed (C)
- This can be done with through-cutting instruments or with a microdebrider

Step 4

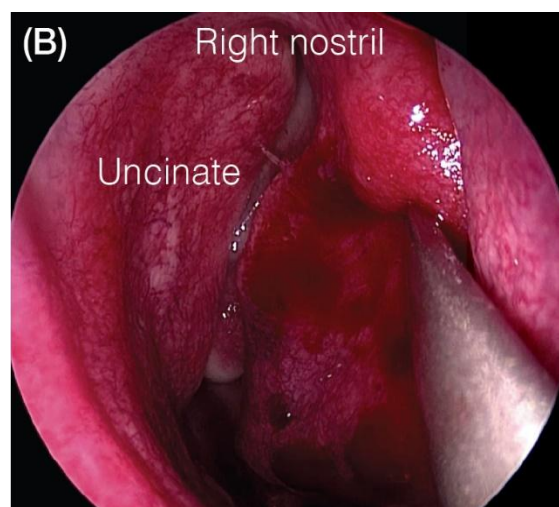
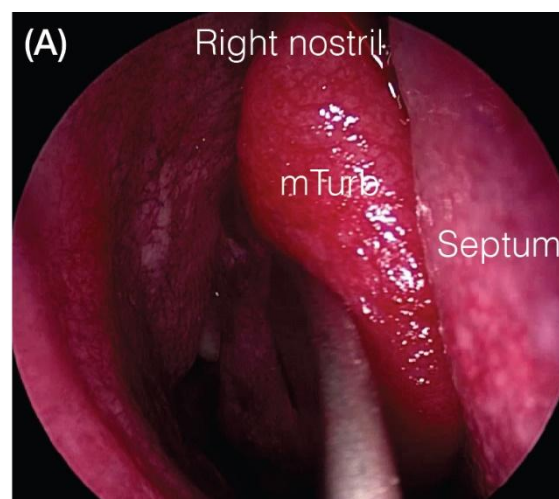
- Remember that the middle turbinate can attach to the skull base
- Therefore, the lateral part should be removed gently not to cause a CSF leak

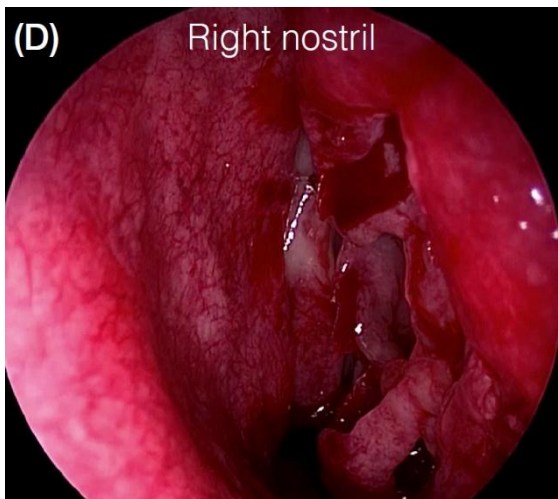
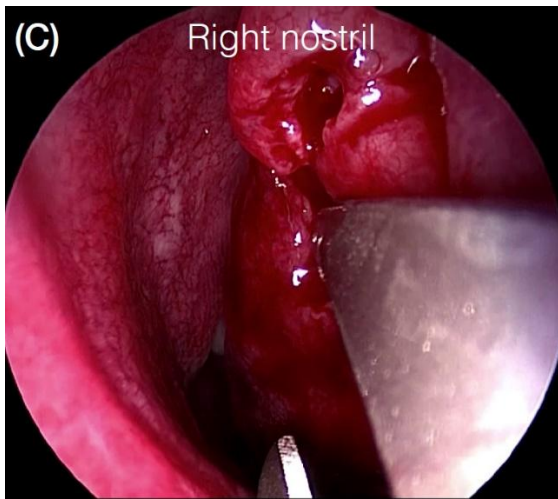
Step 5

- Always remember that the middle turbinate is an important landmark and should not be removed completely

Step 6

- Use bipolar cautery and adrenaline packs to achieve haemostasis
- When haemostasis is achieved additional surgery can be continued (D)





Figures 15 A-D: Septoplasty



Sphenopalatine Artery Ligation (Figure 16 A-F)

Minor epistaxis can be stopped by packing the nose and/or washing with warm saline. Visible shooters can be stopped by either bipolar or monopoly cautery. Significant posterior bleeding can arise from the sphenopalatine artery. Below is a step-by-step instruction to cauterise the sphenopalatine artery.

Step 1

- Pack the middle meatus with 1:1000 adrenaline-soaked gauze
- Medialise the middle turbinate
- In this case an uncinectomy had already been performed; it is not mandatory (A)

Step 2

- Elevate mucoperiosteum 1cm anterior to the posterior attachment of the middle turbinate (B)

Step 3

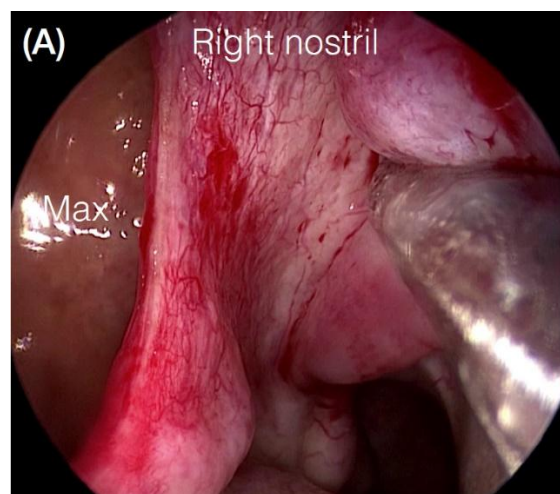
- Control bleeding during dissection by packing with 1:1000 adrenaline and/or cautery (C)

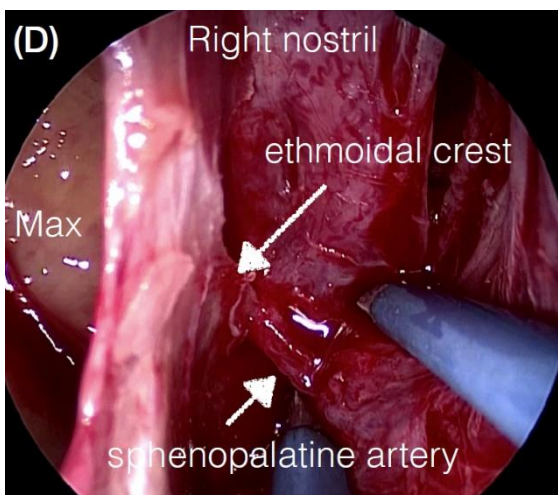
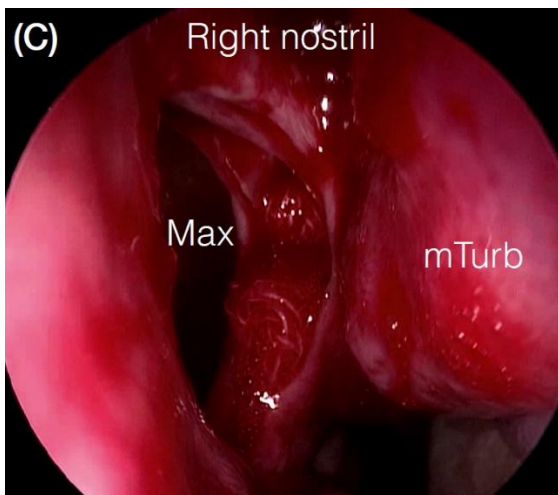
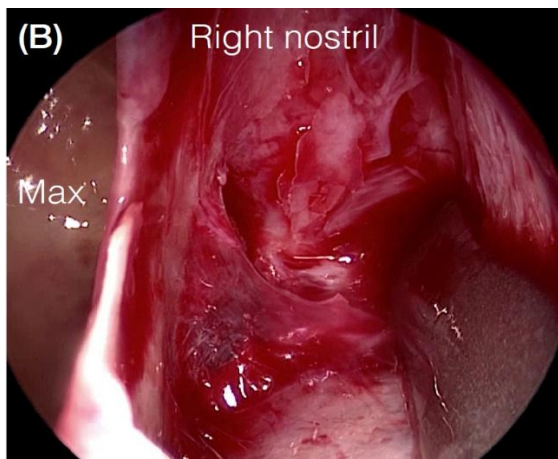
Step 4

- Identify the ethmoidal crest; this is the landmark for the sphenopalatine artery
- Remember that there may be several branches of the sphenopalatine artery
- Cauterise the vessel(s) (D)

Step 5

- Pack the area with *Surgicel* (E)
- Usually, the entire nose does not need to be packed if the bleeding is controlled by cautery (F)





Cadaveric Dissection

Precise knowledge of the surgical anatomy is the key for any surgical procedure. It is important to know key landmarks. This also holds true for FESS.

Cadaveric dissections are an excellent learning tool to gain a detailed knowledge of surgical anatomy. The embedded video shows a complete transnasal endoscopic cadaveric dissection of the paranasal sinuses, orbit, and the skull base.



List of Surgical Videos

- Video 1: Gate System of Paranasal Sinuses: <https://youtu.be/xMsiRT12Cjs>
- Video 2: Endoscopic Evaluation of the Nose: <https://youtu.be/ryp3QGeubtY>
- Video 3: Gate 1 - Uncinate Process: <https://youtu.be/9JhZgAdz4wQ>
- Video 4: Gate 2 - Ethmoid Bulla: <https://youtu.be/-vGY5WExf2A>
- Video 5: Gate 3 - Ground Lamella of the Middle Turbinate: <https://youtu.be/VAqp97XoBiA>
- Video 6: Gate 4 - Sphenoid Sinus: <https://youtu.be/P0b3-4ICbPo>
- Video 7: Frontal Recess: <https://youtu.be/q6cgnjhR4vU>
- Video 8: Endoscopic Septoplasty: <https://youtu.be/VI-YcEDoYtU>
- Video 9: Concha Bullosa: <https://youtu.be/S6MZbV3KYCU>
- Video 10: Sphenopalatine Artery: <https://youtu.be/nVs82GdDWZA>
- Video 11: Cadaveric Endoscopic Dissection of Paranasal Sinuses, Orbit, and Skull Base: <https://youtu.be/-m6HXkGUBJ8>

Authors

Yves Brand MD

Former Clinical Fellow, Department of Otorhinolaryngology, University of Malaya, Medical Centre, Kuala Lumpur, Malaysia

Chairman, Department of Otorhinolaryngology, Cantonal Hospital Graubunden, Chur, Switzerland
Associate Professor, University of Basel, Basel, Switzerland
yves.brand@ksgr.ch

Prof Dato Dr Narayanan Prepageran
Senior Consultant
Department of Otorhinolaryngology
University of Malaya Medical Centre
Kuala Lumpur, Malaysia
prepageran@yahoo.com

Editor

Johan Fagan MBChB, FCS (ORL), MMed
Emeritus Professor and Past Chair
Division of Otolaryngology
University of Cape Town
Cape Town, South Africa
johannes.fagan@uct.ac.za

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