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Endoscopic Sinus surgery

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Evolution of Endoscopic sinus surgery

Introduction of nasal endoscopy is credited to Alfred Hirschmann. He in 1901 attempted to view the nasal cavity . It was in the following year M. Reichert performed the first endoscopic sinus surgery using an endoscope to manipulate the maxillary sinuses through the oroantral fistulae.

Maltz promoted the use of endoscope for diagnostic evaluation of the sino nasal cavity in 1950. He initially promoted its use for diagnostic purposes. It became widely used as a diagnostic tool in 1961. Maltz also coined the term sinuscopy.

Professor Harold Hopkins invented the rod lens system for rigid endoscope in 1950. It was brought into clinical practice in 1961.

Harold Hopkins the inventor of Rod lens system

In the 1970's many rhinologists were using these endoscopes to perform endonasal and sinus surgeries. Walter Messerklinger of Austria was the foremost. In his path breaking work he demonstrated the importance of osteomeatal complex in the middle meatus as a key structure in the pathogenesis of maxillary, ethmoidal, and frontal sinusitis. He in fact introduced the concept of functional endoscopic sinus surgery.

The aim of Fess is to resect the inflamed structures and other obstructing anatomical structures that interfere with the physiologic mucociliary clearance function. This concept was a radical change when compared to the highly destructive surgical procedure prevalent at that time (stripping of the entire sinus mucosa). The combination of invention of rod lens system, better understanding of the mucociliary clearance mechanism and almost universal availability of CT scans have made FESS a logical choice in the management of chronic rhinosinusitis. The principles of FESS was first published in 1985.

Photograph showing Messerklinger and Stamberger together

With the advent of FESS evolution of surgical instruments used for the procedure began. Initially Fess was performed using grasping forceps. These grasping instruments caused more trauma to the nasal mucosa than needed. Areas of exposed bone lead to chronic inflammation, scarring and occasional mucocele formation. Even if these exposed bony areas are covered by regenerating nasal mucosa, it did not have normal mucociliary activity. Through cutting forceps minimized unnecessary mucosal damage.

45 degree through cutting forceps

Microdebrider:

This instrument was originally developed for orthopaedic procedures. This was modified for nasal use. This instrument was first used for nasal surgery by Setliff and Parsons in 1996. This equipment used disposable bladed which reduced the risk of mucosal stripping. Since the blades are used only once the cutting surface is maintained at its original sharpness. These blades are connected to the suction and irrigation apparatus. The continuous irrigation and suction ensured good visibility even bleeding areas. Being powered instruments, they were prone for severe complications if orbit is entered inadvertently.

Burrs can also be attached to Microdebrider. This is very useful in operating on patients with chronic rhinosinusitis when removal of bone is necessary. This is really useful when surgery is performed to remove intranasal tumors, since it is important to remove underlying bone in tumors to provide adequate clearance.

Image showing Microdebrider

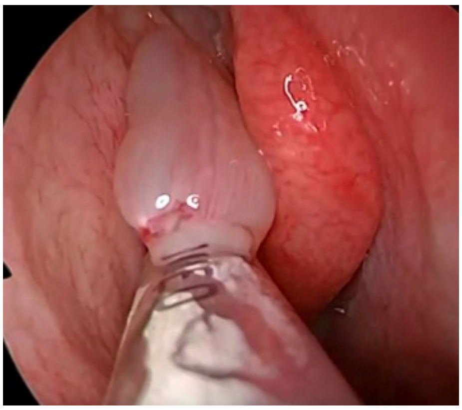


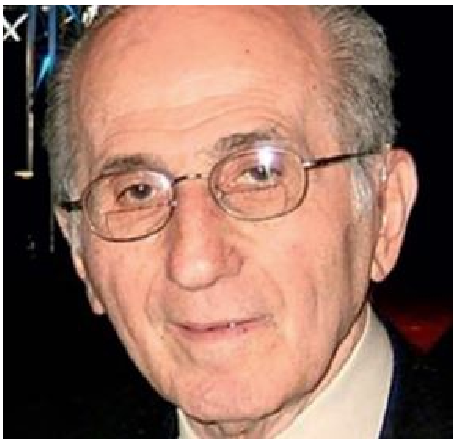
Image showing Microdebrider blade in action.   The suction effect at the tip of the blade holds the tissue close to the cutting surface, while the rotating blade shielded on one side cuts through the polyp

Visualization:

This is a huge plus in endoscopic sinus surgery. Currently in adults 4 mm endoscopes are used. These endoscopes provide excellent High Definition images. The standard endoscope length is about 18 cm's. They are available in 0 degree, 30 degree, 45 degree and 70 degree. Endoscopes with varying degrees of visualization helps the surgeon to visualize every nook and corner of the nose and sinuses during endoscopic sinus surgery. The image produced is dependent on the quality of the endoscope, light source and the camera. Technical improvements in the camera and monitor have improved the quality of images.

A 2.7 mm endoscope is used for pediatric cases. Small diameter of these scopes enable them to be used in children.

It should be stressed that at the beginning the brilliance of the invention of rod lens system was not recognized immediately. The first presentation of the telescope was performed at a urology meeting in Rio de Janeiro in 1961. It was Dr George Berci of United States who brought together the genius Hopkins with the instrument maker Karl Storz.

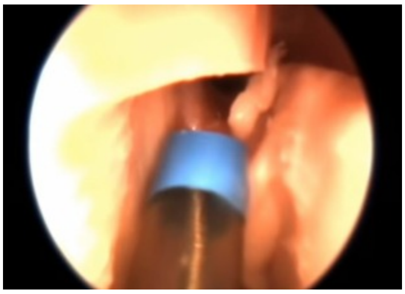


George Berci who was responsible for rigid endoscopes to see the light of the day

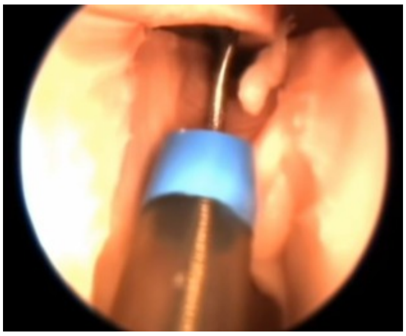
Karl Storz who manufactured the rigid endoscopes with rod lens system

Developments in the field of CT imaging has improved our understanding regarding the pathophysiology of chronic rhinosinusitis. With the introduction of high resolution CT imaging the accuracy of the radiographic images have improved leaps and bounds. Computer interactive imaging and Image guidance during surgery have managed to reduce intra operative complications by avoiding injury to vital structures.

Balloon sinuplasty developed in 2002 is a novel method in endoscopic surgery introduced by Lanza and Kennedy in 2006. The sinus ostium is entered in an atraumatic fashion via a catheter based balloon and the ostia is dilated by inflating the balloon. This enlarges the ostium without excessive trauma to mucosa.



Balloon introducer seen being introduced into the frontal sinus ostium



Balloon probe seen being pushed into the frontal sinus ostium

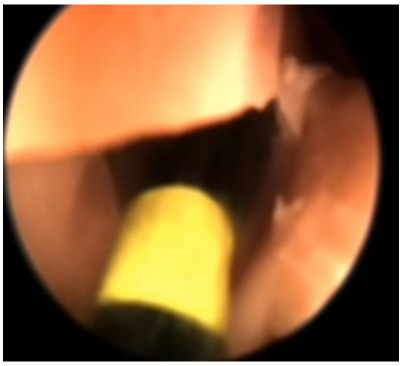


Image showing balloon being dilated enlarging the frontal sinus ostium

Indications & Contraindications of Endoscopic sinus surgery

Main indications for Endoscopic sinus surgery are:

1. Recurrent / chronic maxillary, frontal or sphenoidal sinusitis that is unresponsive to conservative management
2. Nasal polyposis
3. CSF leak repair
4. Benign & malignant tumors of nose and paranasal sinuses
5. Olfactory disturbances
6. Pituitary tumors
7. Skull base tumors
8. Orbital decompression
9. Optic nerve decompression
10. Orbital infections

Contraindications for Endoscopic sinus surgery include:

1. Acute infections involving nose and sinuses
2. Intracranial complications following sinus infections
3. Incomplete access to the pathology via the endoscopic approach

The main aim of surgical treatment of chronic maxillary rhinosinusitis is to restore the normal mucociliary clearance of the diseased sinuses. This is achieved by opening and widening the opening of sinus ostium, clearing it of swollen / diseased mucosa as well as removing obstructing or diseased structures in the anterior ethmoidal region.

The diseased mucosa of the maxillary sinus itself is not removed, because it would heal spontaneously after the function of osteomeatal complex has been removed. The extent of surgery is always dependent on the extent of the disease.

Anesthesia in Endoscopic sinus surgery

Endoscopic sinus surgery is always performed under general anesthesia which is administered via oro tracheal intubation. Currently Total intravenous anesthesia is administered (TIVA). What ever be the type of anesthesia hypotension during the entire course of surgery is desirable. Hypotension will ensure that bleeding during the entire process of surgery is minimized.

TIVA is defined as a technique of general anaesthesia which involves use of intravenous drugs to anaesthetize the patient without the use of inhalational agents. In fact chloral hydrate was the first anaesthetic agent to be introduced intravenously way back in 1870. Introduction of Propofol in 1986 gave a new lease of life to TIVA.

It was Sigismund Elsholtz who first attempted intravenous anaesthesia in 1665. Real advance in intravenous anaesthesia took place during 1921 when Daniel and Gabriel Bardet published their experiences using somnifaine. Fredet and Perlis combined somnifaine with subcutaneous injection of morphine to supplement the effects of somnifaine. To begin with a Vann's 10 ml syringe was used for this purpose. To facilitate continuous intravenous infusion Abel's syringe was used.

The current popularity of TIVA has been attributed to the pharmacokinetic and pharmacodynamics properties of Propofol and opioids. These drugs are ultra-short acting and hence suitable for continuous infusion. With the advent of advanced computer based drug administration system intravenous drug administration has become safer and predictable. The currently available intravenous drug delivery system allows the anaesthetists of vary the depth of anaesthesia by just controlling the infusion rate of the drug. This is in fact similar to that of conventional inhalational systems currently available.

Advantages of TIVA:

1. Recovery is smooth and predictable

2. No post-operative vomiting

3. There is no pollution

4. Allows high dose of oxygen to be inspired

5. There is virtually no bowel distention

6. Reduced requirement for muscle relaxants

7. Intraocular pressure is reduced

8. Malignant hyperthermia is virtually unknown

9. Controlled hypotension is possible

10. Produces adequate amnesia

11. Produces adequate analgesia

12. Less neuro humoral response

Drug pharmacokinetics:

This is actually the use of mathematics to describe how body handles a certain drug. This is in a nutshell a calculation of the mathematical relationship between the administered dose of drug and the resulting observed changes in its plasma concentration. This is very important in deciding which drug / drug combinations can be safely used to administer TIVA.

Goals of TIVA:

1. Smooth induction

2. Reliable and titratable maintenance of anaesthesia

3. Rapid emergence out of the effects of infused drug as soon as the infusion is terminated

Drug combinations used in TIVA:

1. Propofol with remifentanil

2. Propofol with sufentanil

3. Midazolam with sufentanil (used in patients susceptible to hyperthermia)

Only flip side to TIVA is the expense involved. The newer drugs are highly expensive and coupled with the cost of computerized delivery system adds to the cost.

Target controlled infusion:

This is the basis of TIVA. This system calculates the drug concentration, the delay in the transfer of blood brain barrier. Drugs like Propofol affects its own pharmacokinetics, probably by decreasing cardiac output and also by decreasing hepatic blood flow. Target controlled infusion is performed using a syringe pump.

Figure showing syringe pump

Important functions of syringe pump include:

1. Bolus - This gives the ability to rapidly increase plasma concentration of the drug administered

2. Flow rate - The pump should be able to function accurately even at low flow rates

3. Alarms - Facilitates identification of improper positioning of syringe in the pump

4. Tight syringe fitting - This prevents syringe from moving when the pump is in action

5. Battery indicator

Precautions that should be taken while using syringe pump:

1. High concentration of drugs that run at slow speed should be avoided

2. The syringe pump should be connected close to the patient

3. Vasoactive drugs should not be combined with the primary drug

4. Pump should not be placed above the level of the patient

Otolaryngological surgeries where TIVP is preferred:

1. Functional endoscopic sinus surgery

2. Thyroid surgeries where recurrent laryngeal nerve monitoring is needed

3. Advanced endoscopic surgical procedures involving skull base where hypotensive anaesthesia is needed to control bleeding

Propofol:

This drug is GABA receptor agonist. This drug produces deep state of unconsciousness within 30 seconds of administration of loading dose (1.5-2.5 mg/kg body weight). It is also known to cause respiratory depression in 90% of patients. Effects of this drug wanes within 5 minutes of administration due to redistribution of the drug. This drug causes lower incidence of post-operative vomiting. Liver plays a vital role in elimination of Propofol.

Opioids:

Commonly used opioids in TVIP include:

Morphine

Fentanyl - 100 times more potent than morphine

Remifentanyl - Short half life

Sufentanyl - Ultra short half life

Currently only Remifentanyl / Sufentanyl is being used.

The anesthetist should pack the throat around the endotracheal tube with roller gauze / bandage. This will prevent aspiration of blood and secretions from the oral cavity.

Surgical Steps

A 4 mm 0 degree nasal endoscope is used for this surgery. As a preliminary step the nasal cavity should be examined thoroughly. It is better if a 30 degree 4 mm scope is available. The same can be sued for the purpose of diagnostic endoscopy.

Prior to anesthesia the nasal cavity of the patient is packed with roller gauze dipped in 4% xylocaine with 1 in 100,000 adrenaline. It should be ensured that the quantity of xylocaine used should not exceed 7 ml as this is the maximum tolerated dose. The roller gauze should be squeezed dry before insertion into the nasal cavity. One pack is inserted into the floor of the nasal cavity, the next one is used to pack the middle meatus and the third one should be used to pack the roof of the nasal cavity. Insertion of these packs decongest the nose thereby increase the intranasal space for the surgeon. It also reduces the bleeding during the surgical procedure. Packing should be performed at least 15 minutes before administration of general anesthesia. These nasal packs should be removed before intubation as it would interfere with ventilation of the patient.

Endoscopic examination:

First pass: This involves examination of inferior meatus and nasopharynx. The following aspects should be borne in mind during the first pass.

General view of the nasal cavity is obtained. One should look out for any septal deviations, presence of spurs and their size. Presence of mucous discharge is also noted. The color of nasal mucosa is also noted.

The endoscope is passed along the floor of the nose into the nasopharynx. The following structures are examined:

Opening of ET on both sides

Walls of nasopharynx

Upper surface of soft palate and uvula

The endoscope should be rotated to visualize the opposite side ET opening.

The endoscope is slightly withdrawn to examine the margins of choana and posterior ends of turbinates.

The endoscope is slowly withdrawn to examine the inferior meatus for the opening of nasolacrimal duct and Hasner's valve. Slight pressure over the lacrimal sac may express a drop or two of lacrimal fluid through the nasolacrimal opening.

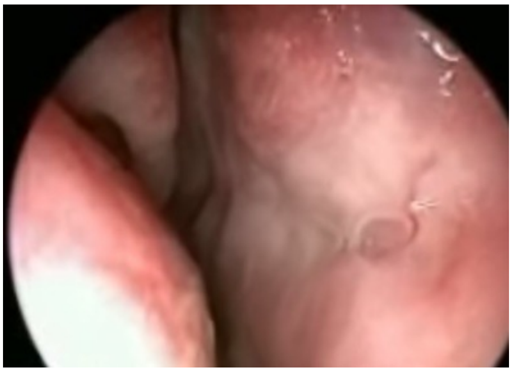


Image showing the First pass

Image showing the Choana

Image showing ET orifice

Second Pass:

During this pass the following structures can be examined.

Sphenoethmoidal recess

Superior meatus

Openings of sphenoid sinus and posterior ethmoid cells

In this step the endoscope is passed medial to the middle turbinate in order to examine the posterior portion of the middle turbinate, sphenoethmoidal recess, superior turbinate and meatus, opening of posterior ethmoidal cells in the superior meatus and opening of the sphenoid sinus in the posterior wall of sphenoethmoidal recess between the nasal septum and the superior turbinate.

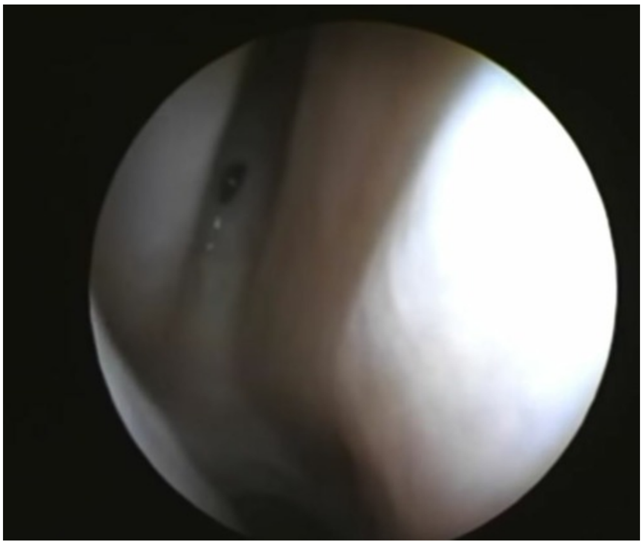


Image showing sphenoid ostium

Third pass:

During this pass the middle meatus is examined in detail. The endoscope is passed from the front into the middle meatus. The middle meatus need to be medialized to create space. The following structures can be examined:

Uncinate

Bulla

Hiatus semilunaris

Frontal recess

Uncinectomy

This is the first step in middle meatal antrostomy. Removal of uncinate opens up the middle meatus. The incision is placed over the anterior end of uncinate process, which feels softer to palpation with sickle knife when compared to the hardness of the lacrimal bone that lies anterior. The incision can be given in either both inferior to superior or from superior to inferior direction.

Sickle knife seen being used to incise the uncinate process

After the incision the uncinate is medialized and removed using a Blakesley forceps. Small tags especially the inferior portion of the uncinate can be removed using a 45 degree Blakesley forceps. The free edge of the uncinate process should be grasped for total removal. It can be removed by a medial turn of the forceps towards the nasal septum. Only after removal of uncinate process the middle meatus opens up.

Swing door technique for uncinate removal:

This is another method for uncinate removal. Back biting (reverse cutting) is used for this purpose. As a first step the inferior free margin of the uncinate process overlying the maxillary sinus ostium is cut.

Image showing back biting forceps cutting the inferior margin of uncinate process

An incision is made in the superior margin of uncinate to form a flap. The hinged uncinate (on its anterior margin) can be moved with an elevator or ball probe. An angled true cut forceps is used to grasp the free edge of the uncinate process in order to remove it. This step is followed by submucosal removal of the horizontal process of the uncinate and subsequent trimming of the mucosa to fully visualize the maxillary ostium. Once the uncinate process is removed the natural ostium of the maxillary sinus can easily be identified.

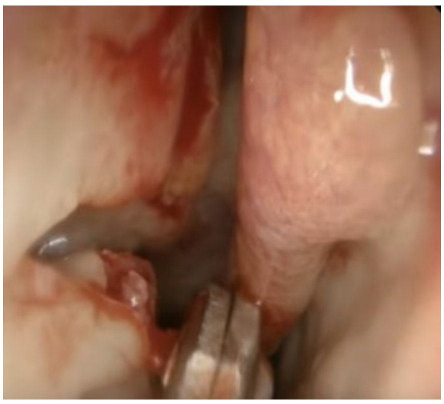


Image showing back biting forceps biting into the superior portion of uncinate process

Image showing the status after Uncinectomy. Note the maxillary sinus ostium

Image showing horizontal portion of uncinate process being removed. This enlarges the natural maxillary sinus ostium.

Image showing widened maxillary sinus ostium

Once the natural ostium is identified an ostium seeker can be placed through the ostium and then pushed posteriorly gently to widen it. A Microdebrider if available can be used to enlarge the ostium.

Simmens classifies maxillary sinusotomy as follows:

Infundibulotomy:

This is uncinectomy alone. The mucosa around the natural ostium is preserved. The superior attachment of the uncinate can be left intact, particularly if it is attached to the skull base or middle turbinate to avoid potential complications like CSF leaks or adhesions around frontal recess area.

Type I maxillary sinusotomy:

In this type the natural ostium of the maxillary sinus is enlarged posteriorly by more than 1 cm. If an accessory ostium is present, then this should be combined with the natural ostium to avoid recirculation phenomenon. Recirculation phenomenon is a common cause of failure in endoscopic sinus surgery. This occurs when secretions transported out of the natural maxillary ostium return back to the sinus via a surgically created accessory ostium. To correct this the intervening band of mucosa should be taken down ot enlarge the antrostomy and to eliminate the cause of the recirculation.

Type II maxillary sinusotomy:

Antrostomy is opened 2 cm's posteriorly and inferiorly.

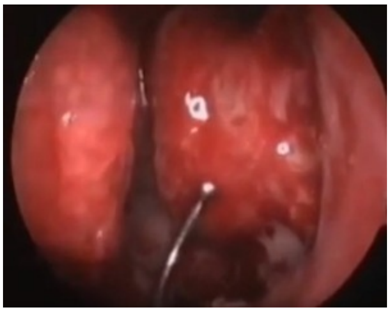
Type III maxillary sinusotomy:

Antrostomy is opened up to the posterior wall of the maxillary antrum, anteriorly to the lacrimal sac and inferiorly to the base of inferior turbinate.

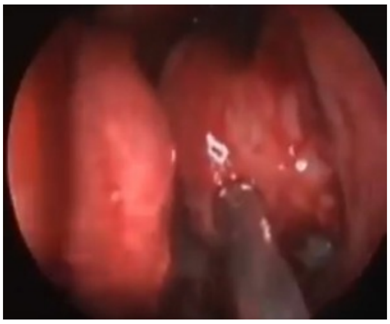
Anterior Ethmoidectomy

The lateral attachment of the ethmoid bulla represents the second lamella. One can use a straight curette and a 45 degree Blakesley forceps for performing anterior Ethmoidectomy. The bullla ethmodalis is opened by placing the straight curette behind the bulla into the retrobullar recess or into the bulla from below (in the absence of this recess) and breaking it down by moving the instrument towards the surgeon.

Other anterior ethmoidal air cells can similarly be opened. After fracturing these air cells the bone fragments are removed with a 45 degree Blakesley forceps. Loose tissue can be removed by grasping it with a forceps and rotating medially. No tissue should be pulled. Basal lamella of the middle turbinate comes into view.



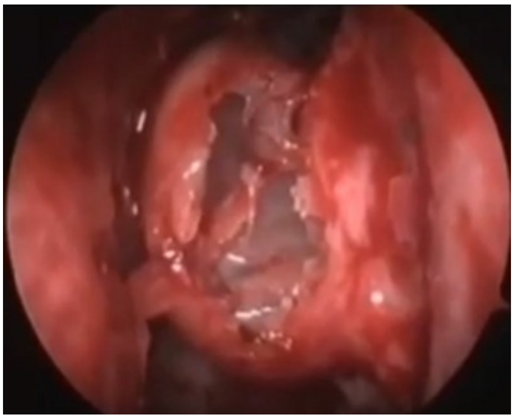
Bulla seen being punctured with a ball probe



Opening in the bulla being widened by passing a suction through the opening made by the ball probe

Lateral wall of the bulla is formed by lamia papyracea. It should not be breached during the surgery.

Blakesley forceps seen being used to open up the Bulla



View of the field after opening the bulla. Posterior wall of bulla is formed by basal lamella which needs to be breached to enter the posterior ethmoid air cells

Basal lamella (Ground Lamella):

This is the lateral insertion of the middle turbinate to the lamina papyracea. It is posterior to the bulla ethmoidalis and separates the anterior from posterior ethmoidal air cells. It represents the third lamella described by Messerklinger.

The basal lamella is opened at the level of superior aspect of the maxillary sinus ostium, pointing the suction tip medially towards the septum. This will be in line with the sphenoid ostium. The basal lamella is entered using a straight suction tip.

A straight curette is passed through the opening in the basal lamella and is enlarged. The opening is enlarged first superiorly and then laterally towards the lamina papyracea.

The medial aspect of the basal lamella is removed with a kerrison punch. This area should not be pulled as the middle turbinate would be avulsed / fractured if done. The basal lamella is opened until the entire free edge of the superior turbinate is visible.

Posterior Ethmoidectomy

Posterior ethmoid cells can be reached after breaching the basal lamella. Posterior ethmoidectomy is performed from anterior to posterior in a stepwise fashion. The surgeon should work up to the sphenoid face and skull base.

The sphenoid ostium is a valuable landmark. The inferior border of the sphenoid ostium is seen at the level approximately horizontal to the superior border of the maxillary ostium medial to the superior turbinate. Sphenoid face represents the posterior limit of the ethmoidectomy.

Once the sphenoid ostium is identified the posterior and superior limits of the dissection can be identified. Lamella of the superior turbinate is broken using a straight suction tip so that the sphenoid ostium will be visible directly from the middle meatus via the ethmoidectomy.

A straight curette is used to break down the posterior ethmoidal cells working posterior to anterior and away from the skull base. The fovea ethmoidalis can be clearly seen at this stage.

The dissection is continued from posterior to anterior direction with the skull base in full view during the entire phase of dissection. Frontal sinus outflow tract now need to be identified. A ball probe can be carefully inserted into the frontal sinus drainage pathway.

After the surgery is completed, the nasal cavity is packed with merocel pack. This packing not only controls post operative bleeding but also prevent adhesion formation.