MINIMALLY INVASIVE TECHNIQUE (MIT) IN ENDOSCOPIC SINUS SURGERY

S. K. Kaluskar¹

We as surgeons sometimes do not appreciate that the most important anatomical structure in the nose and sinuses is the mucous membrane. We are all familiar looking at the pathology on clinical examination such as deviated nasal septum, hypertrophied turbinates, polyps, granulation tissue, pus or tumors etc, but we do not think much of the mucous membrane!

The aim of any surgery is to inflict minimal trauma to the surrounding tissues resulting in less swelling, less oedema, less pain and less morbidity with optimal successful result from the patient's point of view both anatomically and physiologically. The aim of endoscopic sinus surgery is essentially a functional one to improve the function of the mucous membrane i.e. mucociliary mechanism by establishing normal drainage and ventilation through natural ostia of the sinuses. One does not need an aggressive approach with radical removal of the tissues in the sinuses so as to improve mucociliary transport following surgery. A successful outcome can also be achieved with minimally invasive technique with much less morbidity with better and quicker healing in the postoperative period for the patient.

It is important to state that minimally invasive technique is not minimal surgery, but the "invasion" into the nose and sinuses is minimal. This also enables the surgeon to preserve important surgical landmarks to avoid serious intra-orbital and intra-cranial complications which can occur during endoscopic sinus surgery.

I will discuss minimally invasive technique affecting the following structures.

1. High deviated nasal septum
2. Middle Turbinate - Concha Bullosa & Paradoxical turbinate
3. Uncinate process and Maxillary ostium reconstruction at physiological site
4. Bulla Ethmoidalis
5. Frontal recess
6. Posterior Ethmoids

7. Sphenoid sinus

1. High Deviated Nasal Septum -

A high deviated nasal septum invariably causes nasal obstruction as the normal respiratory air currents during inspiration follows a parabolic pathway into the nasal cavity with the narrow area in the region of the middle turbinate. At this level, a small deflected nasal septum in the upper part which is usually due to thickened perpendicular plate of the ethmoid bone and/or thickened cartilage causes nasal obstruction. Secondly, if there is a high deviated nasal septum, it is also very difficult to visualize middle turbinate so as to work in the agger nasi cells and ultimately into the frontal recess. It is imperative that the correction of the high deviated nasal septum be accomplished to achieve both these goals.

We can accomplish correction of the high deviated nasal septum by making a small linear incision just anterior to the deflected nasal septum following infiltration with 1% Lignocaine and Adrenaline. A small flap of septal perichondrium is elevated. A further incision is made in the cartilage and the opposite Perichondrium is elevated over the high deviated septum. A small portion of the cartilage and/or part of the perpendicular plate of the ethmoid bone is exposed. It is then gently removed without any twisting movements so as not to cause any damage to the cribriform plate of the ethmoid bone. It is extremely important that the excision of the septum in this part should not extend above the level of the attachment of the middle turbinate. Following excision of this small part of the septum, the airway in the area of the middle turbinate become quite clear and the surgeon has an easy access to the ostio-metal complex and the agger nasi cells. As the incision is small and linear in the narrow upper part of the nasal vault, no suturing is required. With good post-operative care, the incision heals satisfactorily.

2. Middle turbinate - Concha Bullosa and paradoxical turbinate

Concha bullosa is a common variant of the middle

¹Dept. of ORL, Tyrone Country Hospital, Omagh, U. K.

turbinate frequently seen in clinical practice. It is essentially a pneumatization of the middle turbinate of variable size, it may be limited to the anterior or posterior part. However, in some cases it may involve large part of the middle turbinate or in a occasional case, the entire middle turbinate is pneumatized. The concha bullosa has opening either anteriorly or sometimes posteriorly into the posterior part of the middle meatus and occasionally into the frontal recess in an extensive pneumatization.

There are various ways of dealing with this common anatomical variant which often contains disease as it is a part of the ethmoid complex. It is important to exteriorize the disease with minimal trauma to the turbinate and mucous membrane and to its attachment to the skull base. The turbinate surgery that I prefer is turbinoplasty or conchoplasty which is essentially a reconstruction of the middle turbinate. This can be accomplished by injecting the anterior surface of the middle turbinate with 1% Lignocaine and adrenaline. A linear incision is taken from just below the attachment of the middle turbinate which then follows anteriorly and inferiorly up the level of the lower part of the uncinate process. The mucous membrane is then elevated on both sides of the concha bullosa and the bony middle turbinate is excised leaving a small bony part superiorly which stabilizes the turbinate. This technique results in exteriorization of the disease from the concha bullosa. Both mucosal flaps are then apposed together and the bilateral convex concha bullosa now becomes more anatomical which is convex medially and concave laterally. This facilitates quick healing post operatively without any development of adhesions as there is no trauma to the mucous membrane. A similar technique can be used for paradoxical turbinate. However, this technique is not always possible when the mucous membrane is densely adherent to the underlying middle turbinate bone. In this situation a small wedge resection of the anterior part of about 1 cm should be performed by making two small cuts (in superior to inferior and inferior to superior direction) on the anterior surface of the middle turbinate. Not only this simple procedure "opens" the ethmoid cavity for good post-operative care, but sometimes an occult concha bullosa is also exteriorized into the nasal cavity. It is important to leave the upper and lower stump of the middle turbinate without any trauma to the mucous membrane, otherwise it may result in adhesions in the post-operative period. A good access of the ethmoid cavities in the post-operative period also allows

proper nasal douching and instillation of medication if needed.

3. Uncinectomy & Reconstruction of Maxillary Os -

Perhaps uncinete process is a misnomer as it is hardly a process but usually a thin plate of bone which extends in a superior to inferior and anterior to posterior direction parallel to the middle turbinate on the lateral wall of the nose. As the uncinate process quite often is closely applied to the medial wall of the orbit (lamina papyracea), optimum care must be taken not to traumatize the orbital periosteum or the orbital contents. If the disease is limited to the infundibulum, then a partial uncinectomy and identification of the natural ostium of the maxillary sinus is all that is needed. However in case of extensive mucosal disease, a complete uncinectomy is usually required. This can be accomplished by a curved microdebrider or back biter preferably with thru'cut forceps. Alternatively complete uncinectomy can also be performed with a sickle knife as long as the surgeon is aware of its exact anatomical position in relation to the lamina papyracea.

In vast majority of the patients i.e. 87%, the natural ostium of the maxillary sinuses is hidden behind the lower one-third of the uncinate process. It is extremely important that the natural ostium be identified, any disease which may be obstructing ventilation and drainage is excised meticulously and the edges of the natural opening are covered by mucous membrane. Surgeon must not sacrifice or expose underlying bone in the posterior part of the middle meatal antrostomy (area of "final common pathway" of the newly fashioned ostium), otherwise this may lead to formation of granulation tissues, osteitis and recurrent infection and scarred tissue which will result in inadequate drainage of the mucus from the maxillary sinus into the post nasal space. Inability to identify the natural maxillary ostium will result in poor ventilation and drainage, especially if only a "hole" is made in the lateral wall of the nose through the fontanel or an accessory ostium has been enlarged. I think it is a misconception that "larger the MMA, better the outcome"! The natural ostium of the maxillary sinus is quite small well hidden behind the lower one-third of the uncinate process, not allowing the inspiratory air currents to impinge on the mucosa of the maxillary sinus. I have seen where large MMA have been made by the surgeons, the patients have complained of uncomfortable and painful sensations on the cheek, due to inspiratory air currents now directly going into the

sinus following uncinectomy and large MMA. We as surgeons should try to preserve as much normal anatomy as possible as "nature" intended. "Remove as little as possible but as much as necessary to improve function"!

The essential difference between the natural and accessory ostium is as follows :

Natural Os

1. It is behind the lower one-third of the Uncinate process in about 87% of the time and hence not possible to examine on routine Nasal Endoscopy.
2. It is well lateral to the sagittal plane.
3. It is just at the level of lower border of the middle turbinate and the upper border of the inferior turbinate.
4. It varies in the size usually from very small to an occasional large one.
5. There is only one natural ostium as opposed to sometimes multiple accessory ostia.

The accessory ostium

1. It is situated in the anterior and/or posterior fontanel in the sagittal plane.
2. It is easily seen on routine nasal endoscopy.
3. It is present in about 10 to 40% of patients only.
4. It has characteristically "punched out" appearance.
5. It is of variable size from pin point to an almost a centimeter in diameter.
6. Sometimes it is single or multiple.

It is important to appreciate that the antroplasty or reconstruction is essentially through the natural and not the accessory ostium of the maxillary sinus

4. Bulla Ethmoidalis -

This is essentially a middle ethmoid cell which forms postero lateral boundary of the infundibulum with its own opening either on, above or behind the bulla. It often contains mucosal disease, pus, polyps etc. It is usually not appreciated that bulla extends towards the skull base in its upper part and residual disease is likely to remain in this part of the bulla if the surgeon is not aware of this anatomical fact. If during surgery of the bulla the mucous membrane is found to be healthy and normal, no further action is needed in respect of the bulla.

5. Frontal Recess -

There are multiple names given to this area by various

Endoscopic surgeons and at times it does cause some confusion to the novice. For all practical purpose, frontal recess is essentially a space, between the frontal sinus above and the nasal cavity below. Perhaps the best way of describing it is "a final Common pathway" for the drainage of the frontal sinus into the nasal cavity. I feel that, what the narrow ostiomeatal complex is to the Maxillary sinus, the frontal recess is to the frontal sinus, i.e. if we can establish a free drainage and ventilation through the frontal recess then, one does not need to "touch" the frontal sinus.

Surgical Anatomy of the frontal recess

The following structures forms the various boundaries of the frontal recess :

1. Anteriorly-Agger nasi cells or the most anterior ethmoidal air cells. These are located in front of the attachment of the middle turbinate and are almost always present in vast majority of patients. It is these cells that make the dissection in this area more hazardous due to its proximity to the lateral of the cribriform plate medially and the orbit laterally. The frontal recess usually opens into the frontal sinus in postero superior to the agger nasi cells.
2. Laterally the orbit.
3. Medially the lateral lamella of the cribriform plate - the thinnest part of the anterior skull base.
4. Anterior ethmoid artery is related posteriorly.

The two other important structures that are also related to the frontal recess are -

A) The upper part or the dome of the uncinate process which approaches the frontal recess anteriorly. The uncinate process extends superiorly and may attach to the skull base, lateral surface of the middle turbinate or laterally to the lamina papyraccia forming sinus terminals in majority of the patients. The type of attachment of the uncinuate process superiorly determines the drainage of the frontal recess into the nasal cavity either into the maxillary sinus or into the middle meatus.

B) Sometimes the upper part of the bulla ethmoidalis.

C) Occasionally anterior extension of the ground lamella.

A high resolution CT scan of the area of the agger nasi cells is mandatory before embarking upon surgery in this area as there is a high risk of damage to the skull and/or orbit. Sometimes a reconstructed sagittal CT scan is also

of utmost value to understand the intricate anatomy in this "crowded" area. Through cut forceps aided by image guided surgery is of great value in this situation. In addition to the detailed images on the CT scans one also needs the ability to use angled telescopes in this area. My choice of telescope for this purpose is 70 degree, as it allows simultaneous viewing of agger nasi cells in relation to the cribriform plate. One has to remember that more the acute angle of the telescope, the more the optical distortion and foreshortening of the operative field which must be taken into account during surgery in this area. The surgery of the frontal recess is a challenging one and the understanding of the intricate surgical anatomy of this area is of utmost importance.

6. Posterior Ethmoids -

Inflammatory diseases affecting posterior ethmoids usually forms a part of the entire ethmoid complex disease. Isolated inflammatory disease of the posterior ethmoids is extremely rare, and that is not surprising, as the mucociliary clearance from these cells is relatively simpler directly into the superior meatus compared to the mucociliary clearance of the anterior ethmoids into the narrow stenotic areas of the middle meatus.

It is important to remember that the posterior ethmoid cells are usually two to three large pyramidal shaped cells as compared to the large number of smaller anterior ethmoidal cells. These are separated from the posterior ethmoids by the constant anatomical structure of ground or basal lamella. Perhaps the most important anatomical relation to the posterior ethmoid is the skull base. This forms the roof of these cells which is usually thick and must be identified and kept in mind by the surgeon every time the instrument and/or suction is advanced into the nasal cavity. The second most important structure in relation to the posterior ethmoid is the optic nerve which could be vulnerable especially in the presence of a Sphenothmoidal cell (Onodi cell). In the presence of mucosal disease either in terms of thickening, polyps or bleeding in this area during surgery these structures are at risk and utmost care should be taken to avoid injury. The same principle of minimal invasive technique applies to these cells that only a gross disease or polyp should be removed carefully without stripping the underlying mucous membrane and no attempt is made to excise every thickened mucosa and polyp with the exposure of the underlying bone. It is also important to preserve the lower most horizontal part of the ground lamella, not only as a

vital surgical landmark but also to keep the stability of the middle turbinate. If the entire ground lamella is removed, there is a danger of making middle turbinate floppy and with laterisation may end up with scar tissue formation and impaired drainage of the ethmoid cavity. Needless to say that the thorough understanding of the CT anatomy of this area is vitally important before embarking upon surgery of the posterior ethmoids.

7. Sphenoid sinus -

As posterior ethmoids, inflammatory disease of the sphenoid sinus is usually a part of the entire inflammatory process of the sinuses. However, isolated inflammatory disease of the sphenoid sinus is encountered from time to time in clinical practice. It is important to remember that there are several important anatomical structures including internal carotid artery and the optic nerve in the sphenoid sinus. Once again, the aim of the sphenoid surgery is to simply exteriorize the disease from the sphenoid sinus and never to attempt complete excision of any thickened mucosa or polyp from the sinus. The important anatomical landmarks for sphenoid surgery are-

1. Superior turbinate
2. Posterior part of the septum
3. Posterior end of the middle turbinate
4. Upper border of the posterior choana.

There are various ways in which the surgeon can approach the sphenoid sinus disease

1. Trans ethmoid - following ethmoidectomy
2. Trans nasal - between middle turbinate and the septum
3. Trans septal - usually for pituitary surgery through sphenoid sinus
4. Trans nasal following excision of the posterior end of the middle turbinate

It is my usual practice not to enter the sphenoid sinus in its upper part through its natural ostium, as it is nearer to the skull base in a further narrowed area. The thin skull base in this area is at a risk especially in the presence of bleeding, polyps etc. If the sphenoid is involved in a inflammatory disease process as a part of the entire ethmoid complex disease, the trans-ethmoidal approach is most - useful, especially when the lower most part of the ground lamella has been preserved. This gives a better orientation of the position of the sphenoid sinus in relation to the posterior ethmoids. The sphenoid sinus is not a continuation of the posterior ethmoids but is infero medial to the posterior ethmoids. In case of isolated disease of

the sphenoid sinus, my preferred approach is trans nasal which causes minimal morbidity and trauma to the patient. A truly fibre transmissible laser such KTP/532 is a very useful tool in this situation. The surgeon can simply vaporize the thin anterior wall of the sphenoid sinus and exteriorize the disease. In any approach to the sphenoid sinus, entry into the sinus through the thick lower anterior wall should be avoided, as this will only result in excessive trauma and bleeding from the posterior branch of the sphenopalatine artery.

Much controversy exists whether one should join the sphenoidotomy opening to the natural ostium of the sinus in a similar fashion as is being done for the accessory and natural ostium of the maxillary sinus. I usually do not do this, and from the follow up of these patients, there does not appear to be a problem in the post operative period of recirculation of the mucus in sphenoid sinus.

Vast majority of patients suffering from chronic inflammatory disease of the sinus has a great potential to recover from the diseased mucosa once the ventilation and drainage through the natural ostium has been established. We have observed these changes on long term follow up (in excess of 12 years) of our patients. Patients suffering from " mucosal disease" are the most intractable ones and fortunately these are very small in number. A diligent postoperative care and follow up is mandatory following functional endoscopic sinus surgery. Perhaps surgeon should play a part of being " Nature's Assistant".

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