FUNCTIONAL ANATOMY OF THE UNCINATE PROCESS AND ITS ROLE IN ENDOSCOPIC SINUS SURGERY

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ABSTRACT : *Background : A basic step of Functional Endoscopic sinus surgery - the most modern and revolutionary surgical treatment for chronic and recurring sinusitis, is removal of uncinat process to expose the infundibulum. The purpose of this study is to explore the functional role of uncinat process with special reference to endoscopic sinus surgery.*

Methods : A fixed dose of sterile methylene blue was sprayed into the nasal cavities of post endoscopic sinus surgery cases, 20 without uncinat process preservation and 20 with uncinat process preservation. The area of staining/deposition of the stain in the ethmoidal cavity and the maxillary sinuses was endoscopically observed.

Results : deposition of methylene blue was consistently found to be occurring in a larger area of the ethmoidal cavity including the maxillary sinus in post endoscopic sinus surgery cases without uncinat process preservation.

Conclusion : Uncinat proces probably acts as a protective wall by directing the allergen bearing and contaminated inspired air away from the sinuses and facilitating ventilation of the sinuses in the mucocilliary pretreated expiratory phase. Injudicious removal of the uncinat process especially in cases with allergic rhinosinusitis should thus expose the sinus mucosa to contaminated air.

Key Words : Uncinate process, Endoscopic sinus surgery.

INTRODUCTION

Uncinate process and bulla ethmoidalis are very constant anatomical structures in the lateral wall of the nasal cavity [Prades et al, 1993 ; Caliot et al, 1990]. The hiatus semilunaris which is situated between the above two, leads to a narrow passage called infundibulum. The frontal sinus, the maxillary sinus, anterior and middle group of ethmoids

drain into the nasal cavity through the infundibulum. This complex microarchitectural pathway comprising of the frontal recess, the maxillary osteum and the infundibulum is referred to as "osteo-meatal complex" by Messerklinger. Even subtle mucosal disease in this area causes obstruction to the drainage of the anterior group of sinuses causing chronic sinusitis. This is the basis of functional endoscopic

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Fig. I : Endoscopic photographs showing post-operative endoscopic sinus surgery cavities, a) without uncinete process preservation, b) with uncinete process preservation.
[Key : CM = middle turbinate, UP = uncinete process.]

Fig. II : Endoscopic photographs showing the extent of stained area in post-operative nasal cavities, a) without uncinete process preservation, b) with uncinete process preservation.
[Key : CM :=middle turbinate, MMA = middle meatal antrostomy, UP = uncinete process]

sinus surgery as described by Messerklinger, wherein infundibulotomy forms an integral step by removal of the uncinete process [Stammberger and Posawetz, 1990; Kennedy et al, 1985; Rice, 1989].

Even though uncinete process is a very constant anatomical feature, its function is poorly understood and evaluated. It probably plays a key role in the ventilatory anatomy of the middle meatus and thus of the sinuses, by directing the contaminated inspired air away from the sinuses and the more sterile expired air into the sinuses. The present study is aimed to evaluate this possible functional role of the uncinete process and its significance in endoscopic sinus surgery.

MATERIALS AND METHODS

20 patients [group I] who underwent conventional functional endoscopic sinus surgery as described by Stammberger [Messerklinger's technique] and 20 patients [group II] who underwent uncinete process preserving endoscopic sinus surgery, were selected for the study. In the latter group, infundibulotomy was done from behind by removal of the bulla ethmoidalis aided by 70 and 90 Hopkin's rod nasal endoscopes. Frontal recess clearance and middle meatal antrostomy was done without disturbing the uncinete process or the agger nasi cells. We call this approach as " trans-bullar approach", which is intermediary between Messerklinger's antero-posterior approach and Wigand's postero-anterior approach [an ongoing study].

The patients age and sex in both the groups were balanced. All the cases were operated by the senior author[DRN]. Cases with synechia and deviated nasal septum were excluded from the study. The extent of ethmoid exentration in the two groups were same i.e., anterior ethmoidectomy.

All patients underwent middle meatal antrostomy with frontal recess clearance. The only difference between the two groups was that the group I had uncinete process resected and group II had uncinete process preserved [Figure I]. Two of the cases in the group II had perforation of the uncinete process, which was closed by rotating the posterior part of the uncinete process after freshening the edges of the perforation. A merocel^R pack was used to stabilize the flap in position. We call this procedure as "uncinoplasty".

After decongesting the turbinates using cottonoid strips soaked in 4% lignocaine with 1:10,000 adrenaline, a fixed dose and concentration of sterile methylene blue was sprayed by the senior author [DRN], from the anterior nares of patients, on the 15th post operative day after thorough cleaning of the operated cavity. Decongestion was done to avoid the influence of the size of the inferior turbinate in the deposition of the stain in the middle meatus. 2 puffs of the stain were sprayed on each side using a sprayer, during quiet respiration. A nasal endoscopy was done immediately after the spray and the site and extent of the stained area were noted and the results were compared between the two groups. The type of the uncinete process found preoperatively was noted down from the case records. The extent of stained area in different types of uncinete process was analysed in the group II.

RESULTS

The extent of the stained area in the operated ethmoidal cavity, maxillary sinus, middle turbinate and uncinete process [when preserved] noted in the two groups are as shown in table I. This clearly demonstrates that uncinete process resection was associated with more deposition

Table - I

Extent of stained area	Group I n=20	Group II n=20	p value
Ethmoid cavity	20	6	<.001
-lateral wall	14	4	<.01
-posterior wall [ground lamella]	20	6	<.001
superior	10	0	<.01
inferior	16	6	<.01
-roof	8	0	<.01
Maxillary sinus	12	3	<.01
Uncinate process	-	20	
Middle turbinate [ant.end]	20	20	

Table - II

Type of Uncinate process [Group I+II]	No.	Percentage
Normal	25	62
Medially turned		
-mild	5	13
-gross	2	5
-gross +UP perforation	2	5
Laterally turned	2	5
Anteriorly turned	4	10

of the stain in the ethmoidal cavity and to some extent in the maxillary sinus also [Fig.II]. The deposition of the stain in the maxillary sinus was also determined by the position and the size of the maxillary antrostomy. More anterior, more medial and large antrostomies had more stain deposited in the maxillary sinus. In the uncinat process preserved group, maximum staining occurred on the uncinat process and the anterior end of the middle turbinate rather than the operated ethmoid cavity. Only laterally turned uncinat process and anteriorly turned uncinat process were associated with minimum staining in the postero-inferior part of the ethmoid cavity. In two cases of the group II, the maxillary sinus was minimally stained, where the maxillary ostium was medially placed. One of the patients in whom inferior and posterior part of the uncinat process was resected to identify the maxillary

ostium, had deposition of the stain in the maxillary sinus and posterior wall of the ethmoids. The incidence of various types of uncinat process seen preoperatively in both the groups are shown in table II. The UP was found to prevent entry of the stain into the ethmoid cavity in both the cases who underwent uncinoplasty.

DISCUSSION

The evolution of functional endoscopic sinus surgery [FESS] has revolutionized the management of cases of chronic and recurring sinusitis. This surgery introduced by Messerklinger and popularized by Stammberger and Kennedy, consists of removal of the uncinat process to open up the infundibulum followed by exentration of the anterior group of ethmoidal cells, middle meatal antrostomy and frontal recess clearance. Various anatomical and pathological abnormalities are found in this region which are responsible for persistent infection in the ethmoid and the their dependent major sinuses. FESS had shown to facilitate better mucociliary drainage of the sinuses [Stammberger and Posawetz, 1990; Kennedy et al. 1985].

Eventhough our experience with FESS in cases with chronic rhinosinusitis has been good, it has been found to be troublesome and less effective in cases associated with nasal allergy and immunocompromised states like diabetes etc., who had persistent or increased postnasal discharge. It was postulated that the cause of failure of FESS in above cases was increased exposure of allergens and bacteriae into the operated ethmoid cavity as a consequence of the removal of uncinat process [Nayak et al].

The efficacy of FESS in cases with allergic rhinosinusitis is not impressive in the medical literature. Nishioka et al [1994] found that polyp recurrence was higher following FESS in allergic patients. Levine [1990] reported better results in cases with chronic sinusitis compared to those with polyposis. Shambaugh Jr [1995] views the new sinus operations with great skepticism. Davis et al [1991] observed extended post operative recovery times and decreased antrostomy patency rates in patients operated upon during a period of high antigen exposure.

The above facts prompted us to analyze the functional role of the uncinat process, which is not found to date in the medical literature. Our results of this study clearly demonstrates the protective role of the uncinat process in preventing deposition of the stain in the ethmoid cavities

in majority of the cases and hence it probably also prevents exposure of allergens and bacterial elements into the anterior group of the sinuses. Similarly the anterior end of the middle turbinate also plays a this important role. Even clinically, we have found that in treating cases of chronic sinusitis associated with nasal allergy, endoscopic sinus surgery with uncinat process preservation has given better results than the conventional FESS [Nayak et al].

Embryologically, it has been found that the uncinat process arises from the medial surface of the lateral cartilaginous capsule and is first identifiable by 10 weeks. The uncinat process and the infundibulum are present in a rudimentary form by 11 to 12 weeks and that the prolongations from the space lateral to the uncinat process progress to form the maxillary and the ethmoid sinus [Bingham et al, 1991; Arredondo et al, 1996; Wake et al, 1993]. Bolger et al [1990], studying the coronal CT scans of the patients with maxillary hypoplasia, found that the severity of the maxillary hypoplasia was directly proportional to the severity of the hypoplasia of the uncinat process. Less hypoplastic maxillary sinus had normal uncinat process and the infundibular space whereas more hypoplastic maxillary sinus had more hypoplastic or even an absent uncinat process. Studying the CT features, Wake et al [1993] found uncinat process abnormalities to be the most frequent association [83%] of maxillary sinus hypoplasia. Kosko et al [1996] reporting 5 children with acquired maxillary hypoplasia following endoscopic sinus surgery, attribute this to activation of bone formation within the maxilla and removal of pneumatization centers due to sinus inflammation and surgical trauma. Considering the development of the uncinat process and its association with maxillary sinus hypoplasia, we feel that the removal of the uncinat process is more responsible for the acquired hypoplasia of the maxillary sinus.

The function of uncinat process is not known and is presumed to be a vestigial remnant in the process of its development. Even though the mucociliary clearance of the mucosa of the uncinat process is studied, the actual function of the uncinat process has not been yet studied. Uncinat process is a very constant anatomical structure seen in the lateral wall of the nasal cavity [Prades et al, 1993 ; Caliot et al, 1990] and we presume that it subserves some function rather than being just a vestigial remnant.

Quoting Wolfdorf's observations, Kennedy et al [1985] stated that the anterior ethmoids were more prone to the

deposition of the allergens and the bacteriae due to its topographical situation making it more prone to pathological changes like mucosal odema and polypoidal changes. The microarchitectural pathways of mucociliary drainage of the anterior group of sinuses [osteomeatal complex], which are situated in the anterior ethmoids are thus prone to get obstructed by the pathological mucosal changes, consequently causing sinusitis in the dependent major sinuses. Moreover, the anterior ethmoids are more prone to anatomical changes, causing increased risk of developing osteomeatal complex disease [Stammberger and Posawetz, 1990; Kennedy et al, 1985]. Thus anterior ethmoidectomy forms an integral component of FESS.

The frontal recess and the maxillary sinus ostium and to some extent bulla ethmoidalis also, are norrii<!!y hidden behind the uncinat process. Considering Wolfdorf's observations, it can be easily understood that removal of the uncinat process will make the bulla ethmoidalis. maxillary ostium and the frontal recess exposed to the inspiratory contaminated air.

The sinuses are ventilated in the expiratory phase [Grooves and Gray, 1995] and this air is pretreated by the mucociliary system of the respiratory tract making it more sterile. This preferential ventilation of the sinuses in the expiratory phase is probably due to the position of the uncinat process in the lateral wall which directs the expired sterile air stream into the sinuses [Fig.III]. Thus there is considerable alteration of the ventilatory pathways in post-FESS cases, in whom the operated ethmoid cavity and

Fig. III : Illustration showing the hypothetical ventilatory airflow in the middle meatus during the inspiratory and the expiratory phases. Left side : Post -FESS without uncinat process preservation and in the right side, post-FESS with uncinat process preservation. [Key : UP= uncinat process, CM = middle turbinate]

the maxillary sinuses are ventilated by the contaminated inspired phase rather than the pretreated expired phase.

This study amply demonstrates the protective role of the uncinate process and the anterior end of the middle turbinate in preventing the deposition of the insufflated stain into the operated ethmoid cavity. Thus in reality it probably protects the deposition of the particulate allergens and the bacteriae in the ethmoidal cavity including the frontal recess and maxillary sinus.

CONCLUSION

The uncinate process has definite functional role in the ventilatory physiology of the nasal cavity and the sinuses rather than being just a vestigial remnant. It protects the anterior group of sinuses from the allergen and bacterial deposition by being a barrier and also probably by directing the contaminated inspiratory airflow away from the sinuses. It also probably facilitates the ventilation of the sinuses in a more sterile expiratory phase. Injudicious removal of the uncinate process during endoscopic sinus surgery, especially in cases associated with nasal allergy can cause persistent or even worsening of the mucosal disease in the ethmoid cavity and its dependent major sinuses. In such cases, we feel, infundibulotomy should be performed from behind by removal of the bulla ethmoidalis, preserving the uncinate process and thus its protective role.

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