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Original Research Article

Assessment of depth of olfactory fossa in pre-functional endoscopic sinus surgery computed tomography scan of paranasal sinuses

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ABSTRACT

Background: To evaluate the olfactory fossae depth according to the Keros' classification on pre functional endoscopic sinus surgery (pre-FESS) and determine the incidence and degree of asymmetry in the height of the ethmoid roof in the population of western Maharashtra.
Methods: Retrospective analysis of 200 multidetector CT studies (400 sides) of paranasal sinuses performed in between January to August, 2017.
Results: According to the Keros' classification, the incidence of different types of olfactory fossae was as follows: type I: 18.5%, type II: 74.5% and type III: 7%. Asymmetry in the ethmoid roof height was found in 11.5% of cases.
Conclusions: Keros' type II was the commonest followed by type I and type III. There was asymmetry in the depth of the olfactory fossae in 11.5% cases. There was no significant gender predilection as far as type and asymmetry were considered.

Keywords: Computed tomography, Pre–functional endoscopic sinus surgery, Olfactory fossa, Lateral lamella

INTRODUCTION

Computed tomography is routinely performed for the evaluation of the paranasal sinuses prior to functional endoscopic surgery. Endoscopic sinus surgery is based on the work of Messerklinger. It emphasizes in the importance of establishing drainage pathways and preserving the mucosa of the sinuses.[1] This approach was termed functional endoscopic sinus surgery by Kennnedy et al.[2] High resolution CT scan of paranasal sinuses (PNS) provides excellent bony anatomic details and soft tissue mapping for surgical planning.[3] Various anatomical variants detected on pre–FESS CT scan help to decide the optimal surgical approach and to minimise intra-operative complications. Most of major complications are related to surgical manipulation of the ethmoidal and frontal sinuses.[4,5] In this article, we evaluate the depth of olfactory fossa in the population of western Maharashtra, as no such study has been undertaken so far. This is important as several reports have shown diverse configurations of the ethmoid roof in various ethnic populations.[6-8]

METHODS

Our study was a retrospective cross sectional observational study performed on 200 patients (males: 116, females: 84) done at our hospital between January to August 2017. All patients who underwent CT scan for suspected pathologies of the paranasal sinuses were included in this study. Patients with previous history of trauma to base of skull, sinonasal tumour, sinonasal polyposis, previous surgery of the ethmoid sinuses or the base of the skull, severe rhinosinusitis were excluded as these pathologies disturbed the visualization of the skull base. Also patients under the age of 18 years were excluded due to lack of mineralisation of the skull bones.

CT scans were performed on 16-slice GE ACT REVOLUTION 16. Technique used was: tube voltage: kVp 120; 120–150 mA; field of view: 150 mm; high resolution: 1.0 mm contiguous axial slices. The CT images were analyzed using bone window settings on OsiriX software. For each CT scan images set, a multiplanar view created by the software was used to determine the best coronal cut showing clearly the cribriform plate and the lateral lamellae. All the CT images were interpreted by the same radiologist. The following were the established anatomical points which were identified and used for measurements.

1. Fovea ethmoidalis
2. Cribriform plate
3. Lateral lamella

The measurement of both right and left lateral lamellae in the CT scan was recorded.[9] The height of the lateral lamella was measured to determine the depth of the olfactory fossa. A line was drawn parallel to the highest point of maxillary sinus. Perpendicular lines were drawn upto the inferior and superior margin of the lateral lamella (Figure 1). Difference between these lines denoted the depth of the olfactory fossa. The olfactory fossae were then grouped according to Keros'classification. The distribution was then analysed according to gender and laterality.

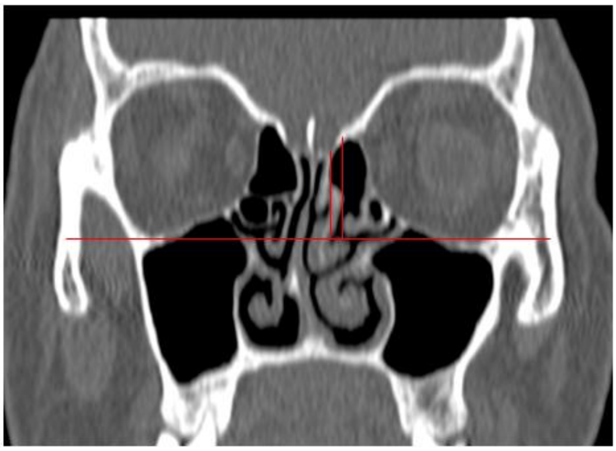

Figure 1: Depth of the olfactory fossa is calculated by measuring the difference between lines drawn from superior and inferior margins of lateral lamella perpendicular to a line parallel to the roof of maxilla.

Frequency tables were calculated to size the proportion of Kero's type in both right and left olfactory fossae. For observing the age and sex wise difference in the distribution of Kero's type of olfactory fossa, chi- square test, independent sample t-test and one way ANOVA (Fischer's exact) were used as tests of significance. Difference between the mean depth of the right and left olfactory fossa was seen separately in males and females and to study any statistically significant difference, paired sample t-test was used as the test of significance.

RESULTS

The incidence of types of olfactory fossae (Table 1) and sex wise distribution of the olfactory fossae (Table 2).

Table 1: The incidence of types of olfactory fossae.

Keros' type	Right (%)	Left (%)	Total (%)
I	44 (22)	30 (15)	74 (18.5)
II	144 (72)	154 (77)	298 (74.5)
III	12 (6)	16 (8)	28 (7)
Total	200	200	

Table 2: Sex wise distribution of the olfactory fossae.

	Males		Females	
Keros' type	Right	Left	Right	Left
I	18	8	26	22
II	78	80	67	63
III	20	28	4	4

Type I olfactory fossa was found in 74 patients (18.5%), of which 44 (22%) were found on right side and 30 (15%) on the left side. Type II olfactory fossa was found in 298 patients (74.5%), of which 144 (72%) were found on right side and 154 (77%) on the left side. Type III olfactory fossa was found in 28 patients (7%), of which 12 (6%) were found on right side and 16 (8%) on the left side. The sex–wise distribution of the depth of olfactory fossae I is provided in Table 2. There was statistical significant difference in the depth of the olfactory fossa on right and left side in males (p=0.039), the right sided fossa being deeper than the left. No such statistically significant difference was found in female patients.

Table 3: Asymmetry in the depth of the olfactory fossae.

Types	Number	Percentage (%)
Same subtype	177	88.5
Asymmetry	23	11.5
Higher subtype on right	14	60.8
Higher subtype on left	9	39.2

Although minor variations in dimensions were present in nearly all patients, most of them fell in the same subtype of the Kero's classification (n=177/200). Asymmetry for the anatomical subtype to fall in different categories was found in 23 patients. Of these, the right olfactory fossa was of a higher subtype in 14 patients (60.8%) and left olfactory fossa was of a higher subtype in 9 patients (39.2%) (Table 3).

DISCUSSION

Nowadays, endoscopic sinus surgery (ESS) is a common operation which is not only indicated for the management of chronic rhinosinusitis that resists medical treatment, but also for a number of other conditions such as nasal polyposis, mucocele, choanal atresia, sellar and parasellar tumors, optic nerve decompression, management of epistaxis and epiphora caused by lower lacrimal duct obstruction.[10] The complications that occur with endoscopic sinus surgeries are many. They can be divided into minor and major complications. Minor complications occur in 1.1–20.8% of functional endoscopic sinus surgery cases.[11] Major complications, although rare, occur in 0–1.5% of such operations. They include cerebrospinal fluid leak, ocular injury (herniation of orbital fat, extra-ocular muscle injury, ocular motility dysfunction, optic nerve injury, and periorbital hematoma or periorbital emphysema) and intracranial injury (brain or major blood vessels injury).[12] Hence an understanding of the anatomy of the paranasal sinuses and the common variants in this region is necessary. Among all the surgical complications that occur with endoscopic sinus surgery, ethmoidectomy was the most hazardous procedure in a study done by Dessi et al.[13] Several studies, highlight the relevance of the evaluation of the ethmoidal roof and its value in the prevention of endoscopic surgery complications.[14-16] According to Gray et al and Souza et al, in the skull base, iatrogenic lesions occur commonly in the lateral lamella of the cribriform plate.[17,20]

The roof of the ethmoidal labyrinth is formed by the fovea ethmoidalis, which is extension of the orbital plate of frontal bone, separating the ethmoidal cells from the anterior cranial fossa.[14,15,18] Medially, the fovea ethmoidalis attaches to the lateral lamella of the cribriform plate, which is part of the ethmoid bone. In adults, the olfactory fossa is a depression in the cribriform plate that is bounded medially by the perpendicular plate and laterally by the lateral lamella. It contains olfactory nerves and artery.

The depth of the olfactory fossa is determined by the height of the lateral lamella of the cribriform plate. In 1962, Keros, defined height and classified the depth of the olfactory fossa into 3 types: Keros type I (<3 mm), type II (4-7 mm) and type III (8-16 mm).[16] Depending on the Keros type, a variable segment of the lateral wall of the olfactory fossa will be exposed during the dissection of the frontoethmoidal region. The Keros type III olfactory fossa is the deepest and most vulnerable to iatrogenic injury. Type I olfactory fossa, being shallow is the least vulnerable to iatrogenic injury and relatively safe for performing FESS.

Various studies conducted by Paber et al, Souza et al, Shama et al, Erdem et al and Solares et al have showed that various ethnic populations have shown diverse configurations of the olfactory fossa.[19-23] So knowledge of the configuration and symmetry of olfactory fossae in the ethnic population of a particular geographical area is necessary. Our study has showed that type II (74.5%) olfactory fossa was the commonest in the population of western Maharashtra. This was followed by type I (18.5%) and type III (7%). In our study the fact that most patients had higher prevalence of Kero's type II makes them more susceptible to the risk of operative complications. This is in concurrence with the study done by Salroo et al for the north Indian population.[24] Also there was statistically significant asymmetry in the depth of right and left olfactory fossae in males, right being deeper, which is in concurrence with the previous studies. There was no statistically significant asymmetry in females in our study.

As described in the initial study performed by Kero's, the ethmoid roof configuration may present asymmetry in the height and angulation between sides in the same individual.[16] Souza et al and Shama et al have demonstrated that the lateral lamella of the cribriform plate is symmetrical in less than 50% of individuals, and this is also in many cases related to flattening of the fovea ethmoidalis, angulation of the lateral lamella of the cribriform plate, causing intra-operative difficulties and complications.[20,21]

CONCLUSION

Development and refinement of CT scan imaging has allowed detailed assessment of the sinonasal diseases and characterization of paranasal sinus anatomy. Understanding the complex anatomic relationship of ethmoid roof and its variability is crucial to avoid potential intracranial complications during endoscopic sinus surgery. So evaluation of the depth of the olfactory fossae and presence of ethmoidal roof asymmetry represents a significant aspect in tomographic studies, and should be included in the routine description of tomographic reports.

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