Evaluation of Olfactory Fossa Depth Using Computed Tomography at a Tertiary Care Centre, Tamil Nadu

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Abstract

Introduction: Endoscopic sinus surgery is the well customary approach for managing the sinonasal disease. The olfactory fossa is a vulnerable part to be located in sinus surgery as it has a risk of anterior skull base injury. The anatomical knowledge of nose and para nasal sinuses which have been observed by computed tomography images plays a major role in surgical modality. Hence this study was an attempt to evaluate the depth of Olfactory fossa using CT images. Material & Methods: In the Radiology department, a convenient sampling method was used to conduct a retrospective record-based observational study. In 101 scans, a single radiologist evaluated the depth of the olfactory fossa and classified the images using the Keros classification. SPSS software was used for data analysis. Results: Right and left OF's average depths were 5.13 ±0.980 and 5.15± 1.007, respectively. The right side of the OF had Type II, I, and III OF in proportions of 96%, 3%, and 1%, respectively, according to the Keros classification. According to the Keros categorization, 95%, 4%, and 1% of the OF had Type II, I, and III OF on the left side, respectively. In 27.7% of the images, the OF is asymmetrical. Asymmetry and depth of the Olfactory Fossa were not related to gender. Conclusion: To minimise iatrogenic consequences during procedures, the depth of the olfactory fossa must be measured. Type II Keros was the most frequent variety of OF seen. Type III is the least common, but it is also more prone to injury.

KeywordsOlfactory fossa, Keros, Asymmetry, Gender, Retrospective study

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INTRODUCTION

Endoscopic sinus surgery is the well customary approach for managing the sinonasal disease. The surgeon should be well aware of anatomical structures and vulnerable landmarks before performing surgery for a better outcome and reduction of complication rates since the paranasal sinuses are close to the orbital spaces and the brain. (1) The anatomical knowledge of nose and para nasal sinuses which have been observed by computed tomography images plays a major role in surgical modality. The olfactory fossa is a vulnerable part to be located in sinus surgery as it has a risk of anterior skull base injury. (2)

The orbital plate of the frontal bone closes the roof of the ethmoid bone, which is open superiorly. This plate is indented with ethmoidal air cells, each of which is a fovea ethmoidalis. The medial wall of the roof, which runs from the middle turbinate to the cribriform plate, and the lateral wall of the olfactory fossa or niche are both formed by the thin, lateral cribriform lamella, one of the thinnest sections of the cranial base. During sinus surgery, the olfactory fossa, which has a variable depth and is frequently asymmetrical, is at risk. (3)

The olfactory nerve and bulb are located in the olfactory fossa. It is located in the anterior cranial fossa's most infero-medial portion. The perpendicular plate is located beneath the crista Galli, which creates the longitudinal limb above the horizontal limb. The primary component of the roof of the ethmoid bone labyrinth that divides the ethmoidal air cells from the anterior cerebral fossa is called the fovea ethmoidalis (FE). It medially articulates with the cribriform plate's lateral lamella (LLCP). The angle at which FE and LLCP unite determines the form of the fovea. Since the LLCP is the thinnest bone, functional endoscopic sinus surgery leaves it most susceptible to iatrogenic injury. (4)(5) This little bone plate, which is mostly vertical, joins the fovea ethmoidalis to the lateral wall of the cribriform plate. (6)

The various heights of the cribriform plate's horizontal level were defined by Keros' in 1962. Depending on the length of the LLCP, there are three different types of olfactory fossa depth according to Keros' classification. (7) The following are the three forms of olfactory fossa: The lateral lamella is short and the ethmoid roof and cribriform plate seem to be almost in the same plane in Type I, which is 1-3 mm deep. Type II (the most frequent) is 4 to 7 mm deep, with a longer lateral lamella. It is 8-16 mm deep in type III, and the ethmoid roof is much higher than the cribriform plate. (2) The ethmoid roof and cribriform plate are nearly in the same plane in Keros type I, and the OF is flat. In type II the OF is deeper and the lateral lamella is higher than in type I. The ethmoid roof is much higher than the level of the cribriform plate in type III, and the lateral lamella is larger with a deeper OF. The riskiest form of relationship for endoscopic sinus procedures is type III, which is why Keros type III is referred to as a dangerous ethmoid since there is a significant likelihood of penetration into the LLCP. During procedures like FESS, asymmetry in the depth of the OF or the height of the ethmoidal roof is also linked to a higher risk of cerebral penetration. (8)

The ethmoid roof structure may show asymmetries in the height and angulation between sides in the same person. Fewer than 50% of people have symmetrical lateral lamella of the cribriform plate, according to certain research, and this asymmetry is linked to flattening of the fovea ethmoidalis with angulation of the lateral lamella of the cribriform plate, which could cause surgical challenges. (9) In addition to aiding in the diagnosis of sinonasal disorders, computed tomography (CT) has also helped to characterise the anatomy of the paranasal sinuses. When planning endoscopic nasal procedures, coronal images can be particularly useful as maps for evaluating the anatomy, which can vary greatly even between the two sides of the same person. They can highlight potential trouble spots. (10)

Patients undergoing endoscopic sinus surgery are evaluated pre-operatively using a CT scan of the nose and paranasal sinus. Critical in ESS, the asymmetries of the ethmoidal fovea, olfactory fossa, and structural abnormalities of the lateral lamella may lead to potentially fatal effects such as bleeding, CSF leak, and intracranial problems. (11) The larger height of LLCP, the greater risk of iatrogenic damage during endoscopic sinus surgery according to Keros. So, this study is an attempt to determine olfactory fossa depth using

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computed tomography images.

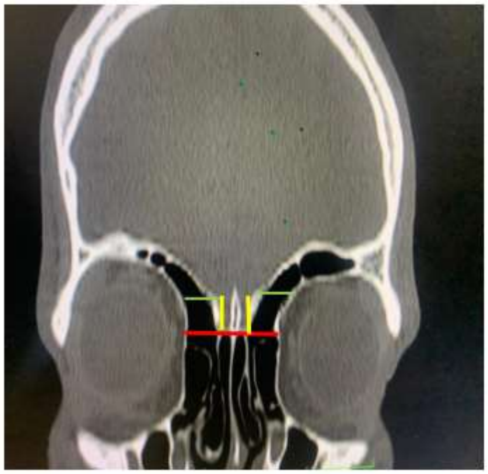

FIG 1. DEPICTION OF OF MEASUREMENT OF OLFACTORY FOSSA DEPTH

MATERIAL AND METHODS

In the department of radiology at the Karpaga Vinayaga Institute of medical sciences and research centre, Madhuranthagam, a retrospective record based observational study was carried out based on CT images of patients who underwent CT Brain/PNS. Patients between the ages of 18 and 65 were included in the contrast- and non-contrast-enhanced CT Brain/PNS pictures. The study excluded images of patients with paranasal sinus/facial bone fractures , mass lesions in PNS, congenital facial anomaly. By applying the formula n = 4pq/d2, the sample size was determined. The sample size was determined to be 100 utilising a 72 percent proportion of type II OF depth based on Keros categorization (Patil et al study), 10 percent absolute accuracy, and 80 percent power. From October 2021 to November 2021, CT scans were obtained from the records department using a convenient sampling strategy.

Olfactory fossa depth was assessed by a single radiologist using a coronal section of CT images of patients who underwent CT Brain/PNS. With the patient in the supine posture, Siemens SOMATOM (16 slice configuration) computed tomography was used. The patient was laid out in the supine position, and a volumetric axial CT scan was performed with slices that were 3 mm thick from the frontal sinus to the floor of the maxillary sinus using the parameters of 130 kV, 145 mAs, and 3.5 seconds of scan duration. Images were obtained in all planes using multiplanar reconstruction and 1 mm thin slices spaced 0.5 mm apart.

By drawing three lines from the coronal portions at the section of maximal depth, the OF depth was computed. Line A is formed by connecting the bony borders of the orbital foramina with a horizontal line (inferior). The vertical line connecting the lateral lamella and fovea ethmoidalis with line A to form line B. Line C is formed by connecting the lateral bony margin of the cribriform plate to line A. According to Keros, the depth of the olfactory fossa was divided into three categories: Type I (1–3 mm), Type II (4–7 mm), and Type III (≥8 mm). Asymmetry was defined as a difference in the depth of OF between the two sides of more than or equal to 1 mm. (3)

The SPSS software 23 version was used to evaluate the data, which were entered in MS Excel 2015. Quantitative variables were analysed using mean and standard deviation, whereas qualitative variables were analysed using proportions. Chi-square and independent T-test were used to evaluate the test of significance. A P-value less than 0.05 is regarded as significant

RESULTS

Records were used to evaluate the patients' CT pictures, and 101 images were included in this study. The patients' average age was 36.19±13.485 years. The survey comprised 60.4 percent the men and 39.6 percent of women. Olfactory fossas on the right and left sides, respectively, had mean depths of

5.13 ± 0.980 and 5.15 ±1.007. Figure 2 shows the OF depth based on the Keros classification on the right side. According to the Keros categorization, the right side of the OF had Type II, I, and III OF in proportions of 96%, 3%, and 1%, respectively.

Figure 2: OF depth based using Keros classification (Right side)

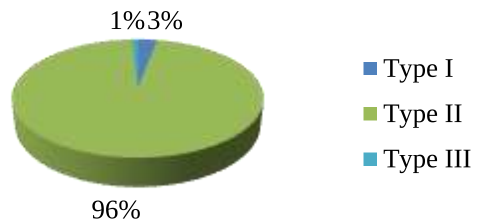

Figure 3 shows the OF depth based on Keros classification on the left side. 95%, 4% and 1% of the OF had Type II, I, and III OF based on Keros classification respectively on the left side.

Figure 3: OF depth based on Keros classification (Left side)

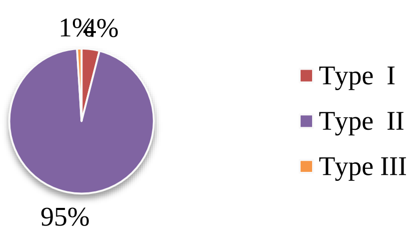

Table 1 shows the association between gender and olfactory fossa depth. There was no association between gender and olfactory fossa depth on both sides.

Table 2 shows the association between gender and types of olfactory fossa depth on the right side. There was no association between gender and types of olfactory fossa depth on the right side. Table 3 shows the association between gender and types of olfactory fossa depth on the left side. Gender and the different types of olfactory fossa depth on the left side did not relate.27.7% of OF were asymmetrical and the rest of them were symmetrical. Figure 4 shows symmetry of OF.

Figure 4: Symmetry of OF

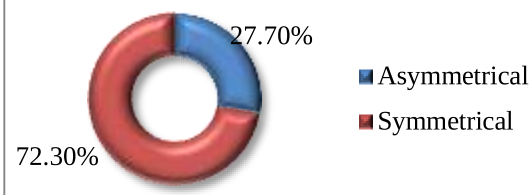

Table 4 shows the association between gender and symmetry. There was no relationship between gender and olfactory fossa symmetry.

Fig. 5 TYPE II KEROS

FIG 6. TYPE III KEROS

DISCUSSION

Based on the findings of this research, Type II OF was the most prevalent type on both sides. The proportion of asymmetrical OF was just 27.7%. Olfactory fossa depth and symmetry on both sides did not associate with gender.

According to Shrestha et al(2)., the most prevalent type of OF observed in both the right (87.1%) and left (85.1%) sides of 101 Nepalese individuals with a mean age of 33.72 ±15.15 was Type I. This result was varied from our study results might be due to population characteristics.

Elwany et al(1) among the Egyptian population found that the common type of OF was type II in men and type I in women on both sides. On both the right and left, there were statistically significant differences in the depth of the olfactory fossae among men and women. But our study shows that the commonest type among men and women was type II and no significant difference between olfactory fossa depth and gender. Another study by Shama et al(12) of the adult population in Egypt also revealed that type I Keros was the most prevalent at 56.5%, followed by type II (40.5 percent). Only 3% of the adult Egyptian population surveyed had Keros type III. This variation could be due to population characteristics.

In a study conducted in Turkey, Karatay E. et al.(13) showed that 30.85%, 66.75%, and 2.4% were classified by Keros as having type I, type II, and type III, respectively. The commonest OF type was type II by Karatay E. et al similar to our study results. Statistics show a substantial difference in mean OF depth between genders, which might suggest that the sampling size may be the cause of inconsistent results compared to our study. In another hospital-based study conducted in Turkey, Kaplanoglu H et al.(14) discovered 500 CT images of the paranasal sinuses contained 13.4% Keros Type I, 76.1 % Keros Type II, and 10.5 % Keros Type III OF which also shows a similar type of OF compared with our study results.

In a hospital-based study including 600 Iranian individuals, Moradi M et al.(15) discovered that 38.3 percent of the cases showed asymmetry, and they were divided into three categories: 36.7 percent Keros type I, 50.5 percent Keros type II, and 12.8 percent Keros type III. These results were similar to our study results as the common type was Keros type II as same as our study results.

In a study conducted in Qassim, Almushayti Z. A. et al.(3) established their findings that the average depth of the right olfactory fossa (OF) was 5.1 mm with a standard deviation of 1.756 and the left side's was 5.28 mm with a standard variation of 1.66. Out of 296 OF, type 1 was present in 28.4%, type 2 in 63.5, and type 3 in 8.1 percent, all according to the Keros categorization. These results are also similar to our study results, that the mean depth was slightly higher on the left side and the commonest type of OF was Keros type II.

A study by Adeel M et al.(16) found that among 77 Pakistani population, keros type I was found in 29.8%, type II in 48.7%, and type III in 21.4% of CT images of paranasal sinuses. The most common type of OF was type II Keros as compatible with our findings.

Type II is the most prevalent Keros type, followed by type I Keros type, and type III Keros type is the least common on both sides, according to a study by Murthy V. A. et al.(11) at Kuppam, India using 100 CT images. Based on the Keros type, 23 percent of the participants in this study exhibited asymmetric olfactory fossa on the right and left sides, whereas the remaining 77 percent did not. Murthy V A et al study exhibited the same findings as our study results.

As per Patil DT et al (17), 21.6 percent of the South Indian population in the research had type I Keros on their right side, 72.82 percent had type II, and 5.57 percent had type III. Type I, II, and III OF were found on the left side at 11.5 percent, 83.62 percent, and 4.88 percent, respectively. As related to our study results the commonest OF was type II on both sides

Keros' type II (74.5%) was the most prevalent, followed by type I (18.5%) and type III (7 %) according to a study by Pawar A. et al.(18) at Western Maharastra In 11.5 percent of cases, there was an asymmetry in the depth of the olfactory fossae. As far as type and asymmetry were concerned, there was no evident gender predilection. In comparison to our analysis, Pawar et al's study yielded comparable findings.

According to a study by Salroo et al (19), the average height of the lateral lamella among Kashmiris was 5.08mm, and the OF of 29%, 61%, and 10% of patients, respectively, were classified as Keros I, Keros II, and Keros III. As compared with our study results the common type of OF was type II.

According to Babu et al(8) research in Kerala, the average OF depth was 5.26±1.69 mm analysed among 1200 patients. Type I OF was discovered in 17.5 percent of people, type II in 74.6 percent, and type III in 7.9 percent. As compared with our study results Type II was the commonest OF. The mean depth of OF between males and females was statistically significant, but not between right and left sides which shows the contrast results might be due to the larger sample size considered in Babu et al research. In 75% of the individuals, there was asymmetry in OF depth between the two sides which also shows contrasting findings compared with our study.

CONCLUSION

As many studies imply that the common type of OF encountered was Type II. There was near one-fourth of OF exhibited asymmetrical olfactory fossa. Gender was not associated with olfactory fossa depth. Olfactory fossa depth needs to be assessed to reduce iatrogenic complications during surgeries. Although type III is a rarest one, it is more prone to injuries. Keros's categorization offers an objective evaluation of the anterior skull base anatomy and aids in directing the surgeon during FESS to raise the procedure's safety profile. It will make it easier to recognize any surgery-related issues. As a result, the surgical strategy can be properly planned and the anticipated difficulties can be avoided.

LIMITATIONS

This study includes only 101 images, for generalising results larger sample size can be included. CT images were assessed by a single radiologist, there might be inter-observer variation.

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Tables

Table 1: Association between gender and olfactory fossa depth

VARIABLE		OLFACTORY FOSSA DEPTH RIGHT SIDE Mean ± SD	OLFACTORY FOSSA DEPTH LEFT SIDE Mean ± SD
GENDER	Male	5.17±0.877	5.22±0.935
	Female	5.07±1.128	5.05±1.11
	p-value	0.626	0.406

Table 2: Association between gender and types of OF depth based on Keros classification (Right side)

VARIABLE		Type I	Type II	Type III	Total	p-value
GENDER	Male	1(1.6%)	60(98.4%)	0	61	0.282
	Female	2 (5%)	37 (92.5%)	1 (2.5%)	40	
	Total	3 (3%)	97 (96%)	1 (1%)	101	

Table 3: Association between gender and types of OF depth based on Keros classification (Left side)

VARIABLE		Type I	Type II	Type III	Total	p-value
GENDER	Male	2 (3.3%)	59 (96.7%)	0	61	0.417
	Female	2 (5%)	37 (92.5%)	1 (2.5%)	40	
	Total	4 (4%)	96 (95%)	1 (1%)	101	

Table 4: Association between gender and symmetry

VARIABLE		Symmetrical	Asymmetrical	Total	p-value
GENDER	Male	13(21.3%)	48 (78.7%)	61	0.075
	Female	15 (37.5%)	25 (62.5%)	40	
	Total	28 (27.7%)	73 (72.3%)	101	