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Evaluation of Olfactory Fossa Depth Using Computed Tomography in A Tertiary Center: A Retrospective Study

Shrestha R[1], Gautam M[1], Shrestha N[2]

[1]Department of Radiology and Imaging, Nobel Medical College and Teaching Hospital, Biratnagar, Morang, Nepal
[2]Kharanitar Hospital, Kharanitar, Nuwakot, Nepal

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ABSTRACT

Introduction:

Endoscopic sinus surgery is a widely utilized surgical method for addressing chronic sinonasal diseases. To prevent major postoperative problems, an anatomical understanding of its variants is necessary. Our study aims to determine the occurrence and classification of different Keros types by analyzing paranasal sinus CT scans and retrospectively evaluating the depth of the olfactory fossa in our population.

Methods:

This is a retrospective single-centre analytical study on 254 patients who had undergone a non-enhanced paranasal sinus CT scan for 1 year after ethical approval from the Institutional Review Committee of Nobel Medical College Teaching Hospital. The statistical program SPSS version 25 was used to conduct the statistical analysis.

Results:

The average depth of the right olfactory fossa (OF) was 4.4±1.44 mm on the right side and 4.5±1.5mm on the left side. According to the Keros classification, out of a total of 254 patients, 38 patients (15%)were classified as Keros I, 193 patients (76%) as Keros II, and 23 patients (9%) as Keros III for the right lateral lamella. 44 (17.3%), 180 (70.9%), and 30 (11.8%) patients were classified as Keros I, II, and III respectively, for the left lateral lamella.

Conclusions:

A preoperative CT scan of the paranasal sinus is useful in assessing the architecture of the anterior skull base and making sure the surgical approach is properly planned.

Keywords: *Endoscopy; Paranasal Sinuses, Retrospective Studies, Skull*

Correspondence to: Dr. Robinson Shrestha
Department of Radiology and Imaging
Nobel Medical College and Teaching Hospital
Biratnagar, Morang, Nepal
Email: *iamrabba@gmail.com*

INTRODUCTION

The olfactory fossa (OF), which is visible as a dip in the anterior cerebral fossa, has an ethmoid bone structure called the cribriform plate that acts as its floor. This thin bone plate serves as a barrier between the nasal cavity and the anterior cerebral fossa. The medial and lateral boundaries of OF are formed by crista galli and the lateral lamella of the cribriform plate of the ethmoid, respectively. Olfactory bulbs and tracts are present in OF.[1]

The depth of the olfactory fossa is determined by the size of the lateral lamella of the cribriformplate. After studying 450 cadaveric skulls, Keros categorized the olfactory fossa into three types based on the level of the ethmoid roof. In Keros Type I, the depth of the olfactory fossa rangesfrom 1 to 3 mm, in Type II, it ranges from 4 to 7 mm, and in Type III, it ranges from 8 to 16 mm. The term "dangerous ethmoid" was coined by Kainz and Stammberger and initially referred to olfactory fossa depth, specifically resembling Keros type III, which is associated with a higher risk of complications during procedures. Multidetector computed tomography (MDCT) is consideredthe gold standard for assessing the anatomy and conditions of the paranasal sinuses and nasal cavity. It enables simultaneous visualization of bone, soft tissue, and air.[2,3,4,5,6,7]

The depth and asymmetry of the olfactory fossa are important considerations during endoscopic sinus surgery (ESS), which is a commonly used surgical technique for treating chronic sinonasal disorders. Given the close proximity of the paranasal sinuses to the orbital spaces and the brain, it is crucial for surgeons to be knowledgeable about sinonasal anatomy and any variations that may exist. Therefore, this study aimed to evaluate the depth and asymmetry of the olfactory fossa, providing valuable information for surgeons performing ESS.[8,9]

METHODS

This retrospective single-center analytical study was done in the Department of Radiodiagnosis, Nobel Medical College, Biratnagar. Ethical approval was taken from the Institutional Review Committee (IRC No: 6/6/2022). The study population was all the patients aged 18-90 years who attended the Department of Radiodiagnosis of Nobel Medical College, Biratnagar and underwent non-contrast CT PNS over a period of one year. Patients with neoplastic lesions of PNS, fracture/trauma to the PNS, and congenital abnormalities of the face were excluded from the study.

CT scan images were obtained with a single multi-detector 128-slice CT scanner (Siemens SOMATOM Definition AS, Germany). Only coronal images were used for the study. 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 the maxillary sinus at the level of bony boundaries of infraorbital foramina. Perpendicular lines were drawn up to the inferior and superior margins of the lateral lamella. The difference between these lines denoted the depth of the olfactory fossa as shown in Figure 1.

The convenience consecutive sampling method was used. The data were then statistically analyzed using the Statistical Program for Social Science (SPSS) Version 25. Quantitative variables were analyzed using measures such as mean and standard deviation, while categorical variables were examined through frequency and proportion.

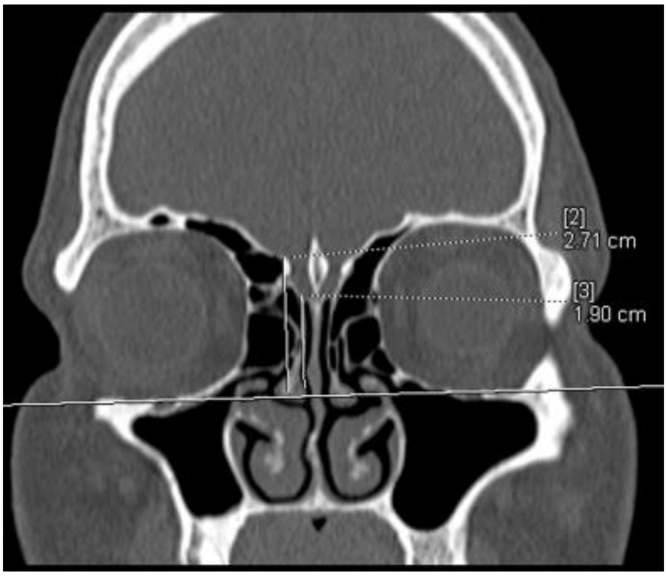

***Figure 1:** Measurement of olfactory fossa depth*

RESULTS

Two hundred fifty-four CT scans were analyzed, 151 (59.4%) were males, and 103 (40.6%) were females. The mean age of patients was 39±16.32 (SD) years. The mean OF depth on the right side was 4.4±1.44 mm and on the left side was 4.5±1.5 mm. The mean OF depth in females on the right side was slightly less than that of males (4.3±1.48 mm as compared to 4.5±1.41 mm) while that on theleft was slightly more than that of males (4.5±1.53 mm as compared to 4.4±1.49 mm) (Table 1). The difference between right and left was statistically insignificant.

Table 1: Distribution of study population according to side and sex

Total	Right (mm)		Left (mm)	
	Female	Male	Female	Male
	103	151	103	151
Mean	4.303	4.574	4.551	1.5352
Std. Deviation	1.4857	1.4134	4.474	1.4950

Each CT scan was counted as two cases (right and left) for a total of 508 cases. On both sides (right and left), Eighty-two cases (16.1%) were Keros I, 373 (73.4%) Keros II, and 53 (10.5%) Keros III (Table 2). Thirty-eight (18.5%) females were classified as Keros I, 145 (70.4%) were classified as KerosII and 23 females (11.1%) were classified as Keros III. Fourty-four males (14.6%) were classified as Keros I, 228 (75.5%) were Keros II, and 30 (9.9 %) were classified as Keros III (Table 3). 68 subjects (26.8%) showed different Keros types bilaterally.

Regarding the classification of Keros in types I, II, and III, it was found that there is no significant association between gender and the side (p-value > 0.05 in all types).

Table 2: Distribution of study population according to side and Keros type

Type	Right	Left	Total both sides
Type I	38 (15%)	44 (17.3%)	82(16.1%)
Type II	193 (76%)	180 (70.9%)	373(73.4%)
Type III	23 (9%)	30 (11.8%)	53(10.5%)
Total	254	254	508

Table 3: Distribution of study population according to sex and Keros type bilaterally

		I	II	III	Total
Sex	Female	38 (18.5%)	145 (70.4%)	23 (11.1%)	206
	Male	44 (14.6%)	228 (75.5%)	30 (9.9%)	302
Total		82	373	53	508

DISCUSSION

Regarding the treatment and care of the paranasal sinuses, the use of endoscopy can pose a risk of perforation during surgical procedures. To prevent iatrogenic complications, it is crucial to evaluate the ethmoid roof using CT scans, as emphasizedin several studies. Studies conducted in different countries have revealed that ethnic populations exhibit diverse configurations of the olfactory fossa. Therefore, it is important to have an understanding of the configuration and symmetry of the olfactory fossae specific to the ethnic population residing in a particular geographical area.[8, 10, 11,12,13]

Our study has shown that type II (74.5%) olfactory fossa was the commonest. This was followed by type I (18.5%) and type III (7%). This is in concurrence with the study done by Salroo et al. for the north Indian population. This is also in agreement with studies conducted among the Saudi, Jordanian, Indian, Brazilian, and Turkish populations.14 Many Indian studies also reported Keros Type II as the common OF type. Studies by Babu et al. and Salroo et al. reported Keros II in 61%, 74.6% Keros I in 29%, and 17.5% in Kashmir and Kerala. Unlike our findings, the research conducted on the Egyptian and Filipino populations revealed that the majority of participants examined were categorized as Keros type I, followed by type II, and finally type III.[13,14,15]

Regarding gender, Type II olfactory fossa was common in both males and females followed by Type I and Type II. In our study, the mean OF depth on the right side was 4.4±1.44 mm, and on the left side was 4.5±1.5 mm. A study by Shama and Montaser conducted on Egyptians revealed mean OF depth on the right side of 4.87±1.71mm and 4.91±1.66mm on the left side. Furthermore, various studies have indicated that the average depth is lower on the right side compared to the left side. Our study showed 68 subjects (26.8%) have different Keros types on both sides. In a study by Pawar et al., 11.5% of the subjects showed asymmetry in Keros types. Therefore, there is no consistency in the anterior skull base depth, and frequent anatomical variation can be observed.[11,16,17,18]

Endoscopic sinus surgeries can result in a range of complications, which can be classified as minor or major. Minor complications are observed in 1.1-20.8% of cases. Major complications, while rare, occur in 0-1.5% of such surgeries, and can include bleeding, cerebrospinal fluid leakage, ocular injury, ocular infection, and intracranial injury (involving the brain or major blood vessels). Thus, possessing a thorough comprehension of the structure of the paranasal sinuses and common anatomical variations in this region is crucial in preventing such complications.[19,20]

The major limitations of our study are the small sample size, taking measurements by a single radiologist and since all participants in the study were adults aged 18 and above, the findings may not be applicable or representative of children or adolescents.

CONCLUSION

This study has shown that the majority of the participants were under Keros Type II, followed by Type I and Type III. Adequate data on the variability of the anatomy of the olfactory area are very helpful in the preoperative workup of patients with diseases of the nose and paranasal sinuses. Inadequate attention to the anatomy of this area can lead to damage of the cribriform plate and subsequent major and minor complications. We recommend a larger sample size and more than one radiologist to take the measurements to increase the reliability of the results.

CONFLICT OF INTEREST

None

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None

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