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Anatomical Variation of Olfactory Fossa on Computed Tomography of Paranasal Sinuses

Madeeha Shahid, Rashid Mahmood, Hidayat Ullah*, Muhammad Atif Sheraz, Muhammad Imran Ibrahim***, Farzana Zulfiqar Ali*****

Combined Military Hospital, Sialkot/National University of Medical Sciences (NUMS) Pakistan, *Federal Medical and Dental College, Abbottabad Pakistan, **Armed Forces Institute of Radiology & Imaging/National University of Medical Sciences (NUMS) Rawalpindi Pakistan, ***Combined Military Hospital/National University of Medical Sciences (NUMS) Rawalpindi Pakistan

ABSTRACT

Objective: To determine the frequency of anatomical variation of olfactory fossa among the adult Pakistani population by Keros classification on computed tomography (CT) of paranasal sinuses.

Study Design: Cross-sectional study

Place and Duration of Study: Department of Radiology, Combined Military Hospital, Rawalpindi Pakistan, from May 2019 to Mar 2020.

Methodology: A total of 65 patients of either gender were included. Patients with previous trauma or surgery of the skull base or paranasal sinuses, malignant diseases of the sinuses and congenital anomalies were excluded. All the included patients in the study underwent CT paranasal sinuses. Measurements of the olfactory fossae followed by grouping as per Kero's classification were done, and CT findings were recorded.

Results: The patients included in the study ranged from 18 to 65 years, with a mean age of 33.09±10.86 years and 72.3% of patients 18 to 40 years of age. Of 65 patients, 36(55.4%) were males, and 29(44.6%) were females. The mean CT depth of the olfactory fossa was 6.34 ±4.03mm. Type-I olfactory fossa by Keros classification was found in 17(26.2%), Type-II in 35(53.8%) and Type-III in 13(20%) of patients.

Conclusion: This study concluded that Keros Type-II is the most common anatomical variation of olfactory fossa among the adult Pakistani population on CT of paranasal sinuses with an intermsediate risk of intracranial complications during endoscopic sinus surgery involving this region.

Keywords: Anatomical variation, Computed tomography of paranasal sinuses, Olfactory fossa.

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INTRODUCTION

Paranasal sinuses anatomy has become the focus of attention with the introduction of functional endoscopic sinus surgery (FESS), and multi-detector computed tomography (CT) scan imaging.[1] Frequently occurring anatomical variants need to be recognized to decrease risks in surgery.[2] The combination of CT with nasal endoscopy provides the maximum information.[3]

Endoscopic sinus surgeries can also have minor and major complications like any other surgery. The latter, although rare, occur in up to 1.5% of such surgeries.[4,5] These include eye injury (extra-ocular muscle injury, herniation of orbital fat, optic nerve injury, ocular motility dysfunction, periorbital emphysema or hematoma), cerebrospinal fluid leak, and injury to the brain or intracranial vessels.[6] Among different endoscopic sinus surgical procedures, ethmoidectomy is more often followed by compliations and the evaluation of the ethmoidal roof has a pivotal role in reducing the complications of endoscopic surgery.[7]

Correspondence: Dr Hidayat Ullah, Associate Professor of Radiology, House No. 490, Street 19, Sector A, Askari-14, Rawalpindi Pakistan

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The lateral lamella of the cribriform plate of ethmoid bone and fovea ethmoidal are the most susceptible portions of the skull base as these are susceptible to iatrogenic injuries during functional endoscopic sinus surgery.[8]

The configuration of the olfactory fossa shows diversity depending on different ethnic groups.[9] Therefore, knowing the prevalent type of olfactory fossa in a particular ethnic group and geographical location, along with the details of its anatomy and symmetry, is important. Such studies have yet to be conducted in the past in our country. One of them showed the frequency of Type-I by Keros classification is 29.8%, that of Type-II is 48.7%, and that of Type-III is 21.4%.[10]

We planned this study to know the overall depth of the olfactory fossae and to evaluate its variation in Pakistani adults using computed tomography. Reporting the Keros type in CT scan findings of paranasal sinuses will help the surgeon understand the anatomy and avoid inadvertent iatrogenic injuries.

METHODOLOGY

The cross-sectional study was carried out at the Diagnostic Radiology Department, Combined Military

Hospital, Rawalpindi Pakistan, from May 2019 to August 2019 and from December 2019 to March 2020 after it was approved by the institutional ethical committee (No. ERC19721). Calculation of the sample size was done with the help of OpenEpi sample size calculator using a confidence level of 95% and required absolute precision of 10%.[10] The sample size calculated was 65 patients. Patients were included by non-probability, consecutive sampling.

Inclusion Criteria: Patients of either gender aged 18 to 65 years, coming for the evaluation of any paranasal sinuses pathology were included after getting informed written consent.

Exclusion Criteria: Patients with previous trauma or surgery of the skull base or paranasal sinuses, malignant diseases of the sinuses and congenital anomalies were excluded.

Axial CT scan of the paranasal sinuses was carried out with 128 slice multi-detector CT by GE Optima using helical scan mode, 120 kV, 250-400mA, rotation time 0.5sec, FOV 240mm, slice thickness 0.5-0.75 and beam pitch-1. Coronal and sagittal reformat images with bone window settings were also obtained. The olfactory fossa's maximum depth was measured in direct coronal scan images by drawing a horizontal line through the uppermost parts of the maxillary sinuses. Vertical lines were drawn from this line to reach the inferior and superior margins of the lateral lamella. The depth of the olfactory fossa was calculated by finding the difference between these two lines. Grouping of the olfactory fossae was then done per Keros' classification, and a depth of 1-3mm was labelled as Type I, 4-7mm as Type-II and 8-16mm as Type-III.[11] The exact measurement was rounded to the nearest whole number in mm. These CT findings were recorded on a proforma.

The Statistical Package for Social Sciences version 21.00 was used to analyse the data. Quantitative variables were expressed as Mean±SD and qualitative variables were expressed as frequency and per-centages. The Chi-square test was applied to see the association of anatomical variation with age & gender. The *p*-value of ≤0.05 was considered significant.

RESULTS

A total of 65 patients were included in the study, aged 18 to 65 years. The mean age was 33.09±10.86 years. The study population had 47(72.3%) patients between 18 to 40 years of age and 18(27.7%) patients between 41 to 65 years of age. Of 65 patients, 36(55.4%) were males, and 29(44.6%) were females. The mean CT depth of the olfactory fossa was 6.34±4.03mm. Frequency of Type-I by Keros classification was found in 17(26.2%), that of Type-II was 35(53.8%), and that of Type-III was 13(20%) patients (Table-I). Anatomical variation of olfactory fossa did not show any significant relation (*p*-value 0.559) with age and gender (Table-II).

Table-I: Frequency of Anatomical Variation of Olfactory Fossa among adult Pakistani Population by Keros Classification on CT of Paranasal Sinuses (n=65)

Keros Classification	n(%)
I(1-3mm)	17(26.2)
II(4-7mm)	35(53.8)
III(8-16mm)	13(20)

Table-II: Association of Anatomical Variation of Olfactory Fossa by Keros Classification with Age and Gender (n=65)

Age(years)	Anatomical Variation of Olfactory Fossa by Keros Classification n(%)			*p*-value
	I (1-3mm)	II (4-7mm)	III (8-16mm)	
18-40 years	14(21.6)	24(36.9)	9(13.8)	0.559
41-65 years	3(4.6)	11(16.9)	4(6.2)	
Gender				0.673
Male	9(13.9)	21(32.3)	6(9.2)	
Female	8(12.3)	14(21.5)	7(10.8)	

DISCUSSION

At present endoscopic sinus surgery (ESS) is quite frequently carried out. Conditions for which this surgery is performed include resistant chronic rhinosinusitis, nasal polypi, mucocele, tumours in and around the Sella, and for decompressing optic nerve.[11,12] Because of the anatomical complexity of the region, complications are often encountered in endoscopic sinus surgery. Some 1.1% to 20.8% of the patients undergoing ESS develop minor complications, which include bleeding, narrowing or obstruction of the ostium, loss of localizing sense, loss of sensation in teeth and lip, infection and relapse. In 0 to 1.5% of cases, however, major complications may occur, including eye injury (extra-ocular muscle injury, herniation of orbital fat, optic nerve injury, ocular motility dysfunction, periorbital emphysema or hematoma), cerebrospinal fluid leak, and injury to the brain or intracranial vessels.[13,14] Knowledge of the exact anatomy of the olfactory fossa and adjacent structures is essential to reduce the risk of these complications.[15,16]

Our study showed that the most frequently found olfactory fossa among the adult Pakistani population is Keros Type-II, being present in 35(53.8%) patients,

while Keros Type-I was seen in 17(26.2%) and Keros Type-III in 13(20%) patients. This was in accordance with a past study, who also concluded that type olfactory fossa was the most frequently found in 70% of the 450 skull specimens they studied.[17] The frequency of type-I and type-II was 12% and 18%, respectively. The findings of Elwany *et al*. also corresponded with our results which found that type-II olfactory fossa was most frequently found in the Egyptian population being present in 56.8% of the cases while type-I was present in 42.5% of the cases. Type-III was found only in 1.4% of the cases.[18] Similar results were obtained by Souza *et al.* who showed that Keros Type-II was found in 73.3% of the 200 CT-scans he had studied in Brazil, followed by Type-I and Type-III seen in 26.3% and 0.5% of the cases respectively.[19] In United States. However, the findings were quite different, where Solares *et al.* found Type-I to be present in 83% of the 50 CT-scans he had evaluated. Type-II and-III were found in 15% and 2%, respectively.[20] The findings of these studies support the hypothesis that the prevalent anatomy of the ethmoidal roof and, thus, the configuration of the olfactory fossa is different in different populations.

In one study, Keros Type-II olfactory fossa was more frequently found in men than women (p<0.001).[21] Elwany *et al.* also showed that Type-II olfactory fossa was more frequent in men. In contrast, Keros Type-I was more often found in women.[18] Our study did not show any significant relation between olfactory fossa type and gender. The mean CT depth of the olfactory fossa in our study was 6.34±4.03mm. Erdem *et al.* showed almost similar results, with the depth of olfactory fossa being 6.1±2.2mm.[22]

Our study offers this opportunity to show the most frequent Kero type in our study population. However, our study was limited by a small sample size and one institution. Therefore, more studies with a bigger sample size and diverse study population are required to generalize the findings of this study.

CONCLUSION

This study concluded that Keros Type II is the most common anatomical variation of olfactory fossa among the adult Pakistani population on CT of paranasal sinuses. Considering the importance of preoperative determination of the type of olfactory fossa, we recommend that CT of paranasal sinuses be done routinely in every patient before endoscopic sinus surgery to detect any anatomical variations. This will help the surgeon define more precise surgical techniques and guidelines for preventing complications related to anatomical variations.

Conflict of Interest: None.

Author's Contribution

Following authors have made substantial contributions to the manuscript as under:

MS & RM: Study design, drafting the manuscript, data interpretation, critical review, approval of the final version to be published.

HU & MAS: Data acquisition, data analysis, data interpretation, critical review, approval of the final version to be published.

MII & FZA: Critical review, concept, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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