

Assessment of Olfactory Fossa Depth based on Keros Classification using Computerised tomography (Ct) in Age Groups of Both Genders

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Author's Contribution

¹ Conception of study

¹ Experimentation/Study conduction

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Abstract

Objective: To assess Olfactory fossa depth based on Keros classification in different age groups of both genders using computerized tomography (CT).

Material and Methods: This was a cross-sectional study done at Ziauddin University, Clifton, Karachi. The sample size was 270 adults including 160 males & 110 females. The assessment of the depth of the Olfactory fossa was carried out by measuring the height of lateral lamella of a cribriform plate on CT images.

Results: Olfactory fossa from both sides of 270 patients were classified according to Keros classification. We found Type II to be the most frequent on both sides of the olfactory fossa in both genders. No significant difference in depth of olfactory fossa was found when compared in different age groups.

Conclusion: The present study shows that the vast majority of the population comes under type II & type III Keros classification, thus emphasizing the need for pre-operative radiological assessment. The Association of right & left olfactory fossa depth in different age groups was found to be insignificant.

Keywords: Keros classification, Paranasal sinuses, Olfactory fossa, Radiological assessment.

Introduction

Endoscopic sinus surgery (ESS), at present, is the preferred treatment not only for diseases like chronic rhinosinusitis but for many other diseases such as nasal polyposis & mucocele. It is also preferred for the treatment of tumors in sellar and parasellar regions, along with optic nerve decompression.¹ Since the sinuses are surrounded by important structures like orbits, brain, and some cranial nerves, Surgeons are expected to be mindful while operating in the sinonasal region since it has a lot of variations. Anatomical orientation is one of the key factors which can directly affect the results of ESS and its complications.²

Therefore, a sound understanding of anatomical landmarks & associated variations will help surgeons to operate securely. However, evaluation of preoperative CT scan remains equally important while traversing through the paranasal sinus region to minimize the risk to patients.³

Computed tomography (CT) scan is considered a benchmark in preoperative evaluation of the paranasal sinuses (PNS).⁴

Though ESS is frequently performed, it has lots of complications. Some of them are cerebrospinal fluid leak, ocular/orbital injury, and intracranial injury.⁵ Almost, all of them are associated with ethmoid bone & fall under the category of major complications.

The ethmoidal cells are separated from the anterior cranial fossa by ethmoidal roof. The fovea ethmoidalis which is a part of the frontal bone forms the roof of the ethmoidal labyrinth. This fovea ethmoidalis connects with the lateral lamella of the cribriform plate.⁶ Lateral lamella is the structure that is most vulnerable to damage because perforation may occur during surgical maneuvers.⁷⁻⁹

There are two reasons for which ethmoid roofs have critical importance. Firstly, it is most susceptible to iatrogenic leakage of cerebrospinal fluid.¹⁰ Secondly, the structure which can be injured is the anterior ethmoidal artery, and damage to it can cause uncontrollable bleeding into the orbit. While performing ESS, injury in the intracranial region is likely to occur where the position of the roof is comparatively low.^{1,11,12}

An olfactory fossa is an interstice between the cribriform plate & fovea ethmoidalis. It is here where the olfactory bulb is lodged. The cribriform plate is generally at a lower level than fovea ethmoidalis. Fovea ethmoidalis connects medially with the lateral lamina of the cribriform plate (LLCP).¹³ This lateral

lamella is the thinnest & most vulnerable in terms of complication during ESS. Anterior ethmoidal artery traverses through LLCP to enter the olfactory fossa. There are variations present in the relationship of the anterior ethmoidal artery with the roof of the ethmoid therefore it is at risk during ESS.¹⁴

The height of the lateral lamella of the cribriform plate is used to determine the depth of the olfactory fossa.

In 1962, Keros proposed a classification¹⁵, which was based upon CP position in relation to the roof of the ethmoid. There is a significant application of this classification in ESS. As per this classification, type I ranges from 1- 3mm. In this type, the LL is short and a significant part of frontal bone protects the ethmoid roof making the sinus less dangerous to operate within. Type II ranges from 4 - 7mm, so the ethmoid roof is formed by a considerable portion of the LL. And lastly, type III has a range of 8 - 16mm. The LL becomes thin forming a greater component of the ethmoid roof. Keros type III is therefore considered to be the most vulnerable type and has a considerable risk for trauma.¹⁶ Proper knowledge of anatomical variations of ethmoid bone has been proved to help avoid complications that may occur during ESS. With this background, the present study was undertaken to assess the depth of the olfactory fossa on CT.

Materials and Methods

This is a cross-sectional study that was done at the radiology department of Ziauddin university hospital, Clifton Karachi. The duration of the study was 5 months that is January 2017 till May 2017 after the approval from the ethics review committee, with a sample size of 270 individuals. Males and females between 21 - 60 years of age were included. Patients with sinonasal tumor, chronic rhinosinusitis, prior sinus surgery, facial fractures, nasal polyposis, and congenital craniofacial anomalies were excluded.¹⁷

The study population comprised adults coming for CT of the head & brain who didn't have a bony abnormality of sphenoid and ethmoid sinuses or adjacent structures. CT scan was performed & depth of the olfactory fossa was assessed by measuring the height of lateral lamella of a cribriform plate(LLCP) on 16 slices of Toshiba Alexion in which the scanner's X-ray beam was rotated around the head which created a series of images from different angles. Sequential axial images were obtained and processed to form volume data. From volume data, multiplanar reconstructions were made in axial, coronal, and sagittal planes. 3D volume-rendered images in the bone algorithm were

also constructed. All images were evaluated in both coronal and axial planes.

Analysis was performed to categorize the height of the lateral lamella of the cribriform plate.¹⁸ The coronal views of CT films were analyzed in bony windows and the results were reported in a data sheet.

The following anatomical landmarks were used for measurement:

- The point of the Infraorbital nerve
- The medial ethmoid roof point (MERP) (which corresponded to the medial end of the ethmoid roof that articulates with the LLCP)
- Cribriform plate point

Vertical height from the MERP and the vertical height from the CP to the horizontal plane through the infraorbital foramen was measured on each side. (Figure 1)

The LLCP was calculated by subtracting CP height from MERP height (MERP-CP=LLCP)¹⁹

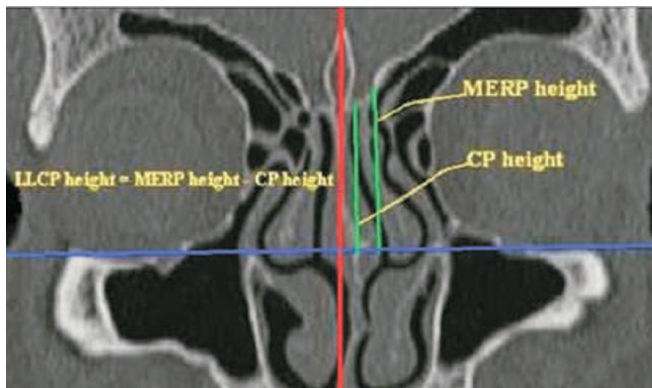


Figure 1: showing LLCP measurement in a coronal paranasal sinus CT cross-section¹

Type I Keros included measurements between 1 and less than 4 mm. Measurements between 4mm to 8mm were considered type II Keros. A depth of 8 mm and more were included in Keros type III. This was done to overcome the limitations in original Kero's classification in which the measurements between 3 and 4 as well as between 7 and 8 mm were not described.²⁰

For statistical analysis, SPSS version 23 was used. Quantitative variables include mean; olfactory fossa depth. Qualitative variables include Keros type of olfactory fossa depth.

Means and standard deviations were calculated for quantitative variables and compared using the independent sample t-test for two groups and the Analysis of variants (ANOVA) for three or more groups.

A Chi-square test was used to compare qualitative variables.

A P-value less than 0.05 is taken as significant.

Results

CT scans from 270 patients were analyzed. 160 males and 110 females were included. The sample ranged from a minimum of 20 years to 60 years. The olfactory fossa depth of the right and left sides were recorded separately for each subject.

We observed the association of right and left olfactory fossa depth in different age groups.

We found an insignificant difference in mean right olfactory fossa depth among different age groups. The mean depth was least in the 4th decade and progressively increased in the 6th decade. (Table 1)

A similar pattern was noted in the mean left olfactory fossa depth of different age groups. (Table 2)

Table 1: Association of right olfactory fossa depth with age

Age Group (years)	N = 270	Mean	Std. Deviation	P value
21-30	90	6.129	1.8738	0.23
31-40	73	5.922	1.6078	
41-50	39	6.174	1.9961	
51-60	68	6.543	1.8552	

Table 2: Association of left olfactory fossa depth with age

Age Group (years)	N = 270	Mean	Std. Deviation	P value
21-30	90	5.864	1.8509	0.448
31-40	73	5.747	1.5370	
41-50	39	6.085	1.8018	
51-60	68	6.200	1.9882	

We classified our study subjects according to Keros classification. The distribution of Keros for left and right sides were observed according to gender. Keros type I was found to be 19 (11.88%) in males and 15(13.64%) in females respectively. The greatest frequency of both genders fell in Keros type 2 i.e. 115 (71.88%) males and 72 (65.45%) females respectively. Type III Kero's was found to be 26 (16.25%) in males and 23 (20.91%) in females. The difference between the genders was insignificant (p-value 0.515). Figure 1

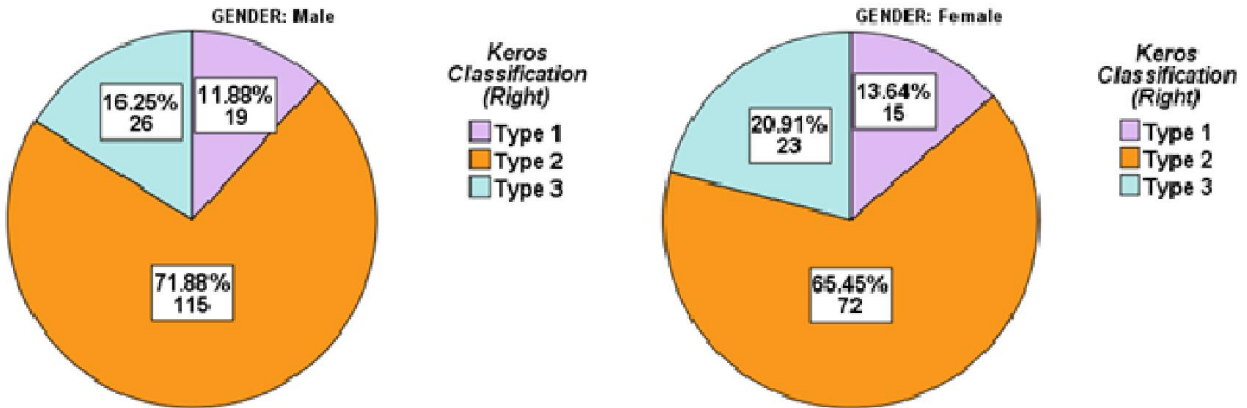


Figure 1: Frequency of subjects according to Keros classification (right side) according to gender. P-value 0.515

For the left side, Keros type I was found in 20 (12.50%) males and 12(10.91%) females. However, type II was higher in both males 120 (75%) and females 77 (70%), and type III 20 (12.50%) in males and 21 (19.09%) in females. The difference between the genders was insignificant (p-value 0.329). Figure 2

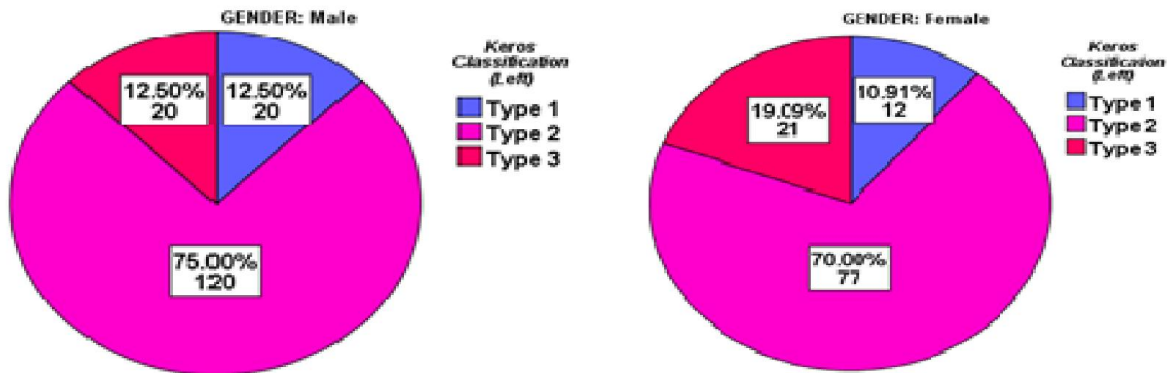


Figure 2: frequency of subjects according to Keros classification (left side) according to gender. P-value 0.328

Discussion

Due to the close association of vital structures like the optic nerve and anterior ethmoidal artery, endoscopic sinus surgery has become a procedure with serious complications.²¹ In order to minimize the complications, Computed tomography has an immense contribution as far as diagnosis and evaluation of sinonasal disease is concerned.²²

In our study, we analyzed both the right & left olfactory fossa of 270 adult males and females in different age groups. This is the first study documenting the mean depths of olfactory fossa in different age groups on both sides. The insignificant p-value in different age groups on both sides indicates that there are equal chances of damage to vital structures surrounding the olfactory fossa in all age groups. This is of prime significance for surgeons

performing ESS as no significant difference lies between different age groups. Further studies are required to understand the age-related morphometric changes.

The comparison of the frequency of the different type of Keros on the right & left sides in males and females indicate that Keros type II was found to be the most frequent in both genders on both sides. Our results are in accordance with a few other studies^{1,8,23,24} who also reported the highest frequency of type II Keros on both sides in both genders. Elwany et al report a higher frequency of type II Keros on both sides in the male gender only.²² However, frequencies of Keros type I & III on both sides in gender differ from our study. Adeel et al reported the lowest frequency of Keros type III on both sides in males only⁸ & Kaplanoglu et al reports the lowest frequency of type III on both sides in females only.¹ While some studies reported the lowest frequency of type III on both sides in both

genders.²²⁻²⁴ Our study shows Keros type III to be the second-highest.

Considerable variation exists as far as the frequency of type I Keros is concerned. Adeel et al observed Type I is to be the least on both sides in females only, while Kaplanoglu et al observed type I to be the least on both sides in males only. However, our study reports the least frequency of type I Keros on both sides in both genders. For some studies type, I remain to be the second-highest on both the sides in both genders^{23, 24}, for others type I remains to be second highest in males only.^{8,22} Such variation may be due to racial differences and also could be due to the fact that Keros classification is ambiguous in the ranges of 3-4mm and 7-8mm.

According to the present study, the majority of individuals are falling in the high-risk category of Keros which necessitates the need for pre-operative evaluation through CT.

Conclusion

It is concluded that the majority of the studied population was present in the categories of Keros type II and type III which indicates the necessity for pre-operative radiologic evaluation. However, no significant difference was found in the mean of both right and left olfactory fossa depth among different age groups in our sample. This finding can be of clinical relevance when planning ESS in patients belonging to different age groups.

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