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Evaluation of Olfactory Fossa Keros Classification Using CT scans, A Hospital-Based Study

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Abstract

Background and objectives: Prior to any surgery for sinonasal diseases, a preliminary scanning of the paranasal sinus is required to validate that the surgical approach is satisfactorily planned and to avoid complications connected to the anatomy of this area. We intended to assess the olfactory fossa depth using paranasal sinus CT images to identify the types and prevalence of Keros classification in our population.

Methods: From December 2021 to December 2022, cross-sectional research was carried out at the Department of Radiology of Erbil Teaching Hospital, Erbil/ Iraq. Eighty participants (46 men and 34 women) received paranasal sinus CT scan to assess their paranasal sinuses and adjacent bone structures. Using the Keros categorization technique, the penetration of the olfactory fossa was determined and categorized into three types, described as type I (1 to 3 mm), type II (4 to 7 mm), and type III (8 to 16 mm).

Results: The average penetrations of the left and right olfactory fossa were 6.27±2.19 mm and 5.7±2.03 mm, respectively. Based on the Keros categorization, most of the cases (103) were of type II (64.3%). The right side for both genders was of Keros type II in 63.7%. The association of the right side and the Keros classification was statistically significant (p value = 0.006).

Conclusion: For both genders, Keros type II was more predominant. The Keros categorization and the gender variables with respect to the left and right sides respectively, differed significantly.

Keywords: CT scan, Keros Classification, Olfactory Fossa

Introduction

Chronic sinonasal problems are one of the most common diseases in otolaryngology that require different treatment options including surgical interposition.[1] In the current years, endoscopic sinus surgery has turned out to be a prominent treatment option for diseases of the nose and paranasal sinuses (PNS). Although associated issues are significantly less common when compared to conventional treatments, difficulties might still occur.[2] Throughout the surgery, information about specific anatomical details and definition of the nose and paranasal sinuses components are significant, such as

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the olfactory fossa (OF) type and height on each side, anatomical defects in the side lamella, the frontal ethmoid artery flow, and the irregularity of the ethmoidal fovea.[3] To avoid major surgical difficulties, in-depth anatomical knowledge is seen as essential, particularly regarding the skull base. As a result, for every patient, the anatomical detail and variations of paranasal sinuses should be properly inspected and diagnosed before surgery. Keros classification is an established method for determining the depth of the nasal roof/ olfactory groove height and should be evaluated prior to surgery because failure to do so could result in numerous potentially significant complications which could be fatal as well.[3,4] Accordingly, before surgery, a computed tomography scan (CT scan) preoperative examination is necessary.[4] According to gender and ethnicity, anatomical changes such as irregularities in the ethmoidal fovea, the olfactory fossa, and anomalies in the side lamella are critical during surgery.[5] Published investigations on the Keros categorization performed by hospitals before surgery indicated variations in the rates of the categories.[6,7] Olfactory fossa penetrations or depth is categorized into three types according to the Keros classification,[8] and they are defined as (A) 1 to 3 mm for Keros type I, (B) 3 to 7 mm for Keros type II, and (C) 7 to 16 mm for Keros type III, and the deeper the olfactory fossa, the more liable complications to develop during surgery .This study was done to determine the prevalence of different types of olfactory fossa according to Keros classification and we aimed to determine the correlation of each type to both age and gender, along with side difference, due to the paucity of research in this area in our settings.

Materials and methods:

From December 2021 to December 2022, this cross-sectional research was conducted at the radiology department of the Erbil Teaching Hospital in Erbil City, Iraq's Kurdistan region. This study was approved by the local ethical committee of the College of Medicine, Hawler Medical University. Sample size: A convenient sample size of 80 patients was included. Age of 18 years and older, having sinonasal and paranasal sinus disorders that needed clinical evaluation in both genders, and accepting to participate in the research were included. Criteria for elimination included cases with a history of trauma, para-nasal surgery, benign or malignant tumors of the sinonasal tract, abnormal olfactory fossa morphology, juvenile patients, and refusal participants. All the cases underwent native CT scan (Siemens 64 slice, AD definition Germany) using 0.6mm slice thickness. Olfactory fossa penetrations were determined using the Keros classification,[8] and they were defined as 1 to 3 mm for Keros I, 3 to 7 mm for Keros II, and 7 to 16 mm for Keros III (Figure 1 "A and B "). For statistical evaluation, the obtained data were analyzed and programmed in SPSS (V.24) statistical software that is used for discrete applications, including social sciences. The analysis methodology has examined the data with the utilization of descriptive statistics, as several significant parameters were measured, including frequencies (F), percentages (%), and score means. At a probability value (P-value) ≤ 0.05, the substantial correlation between the demographic data and the Keros category was determined using the Chi-Square statistical approach.

Results:

Eighty-six patients were interviewed for participation; six patients were excluded (2 patients who were under the age of 15, and 4 who declined to take part). The socio-demographic features of the entire research group are summarized in Table (1). The outcomes have shown that the majority of cases were male and constitute 57.5 %; with regard to age, most of them were between 19 and 29 years old and represented 27.5%.

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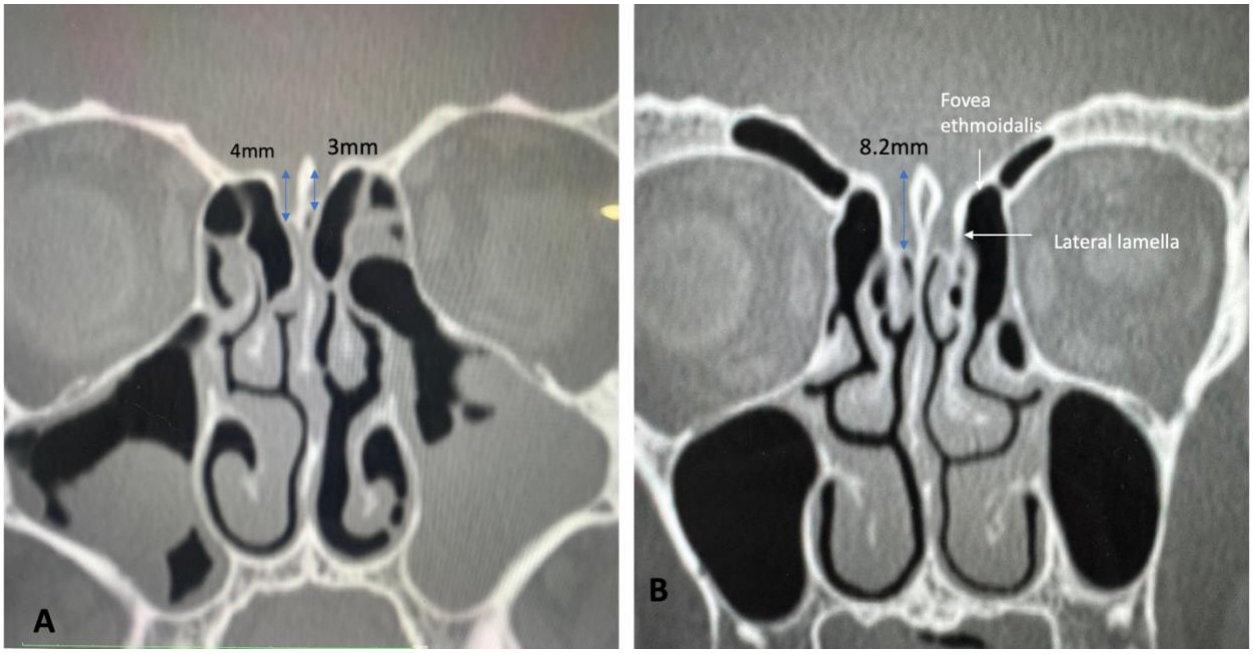

Figure (1): CT scan coronal plane for two distinctive patients: patient (A) displays Keros type I on the left side and Keros type II on the right side. (B) Another patient with Keros type III on the right side.

Table (1): Features of the research sample's demography

Gender	Male	Female	Sum
No. (%)	46(57.5)	34(42.5)	80 (100)
Age(year)	Frequency	Percentage	
19-29	22	27.5	
30-39	16	20.0	
40-49	11	13.7	
50-59	11	13.7	
60-69	8	10.0	
70 and above	12	15.0	
Sum	80	100	

Table (2): Mean and standard deviation variation of the depths of both left and right olfactory fossae**.**

Depth		
Side	Left (mm)	Right (mm)
Number	80	80
Mean	6.2763	5.7450
Standard deviation	2.19189	2.03730

Based on the analyzed results of Table (2), the left olfactory fossa had an average value of 6.27mm with a standard deviation of 2.191mm, whereas the right olfactory fossa had an average depth of 5.7mm and a standard deviation of 2.037mm.For the 160 olfactory fossae, type I was found in 27 cases (16.87%), type II in 103 cases (64.3%), and type III in 30 cases (18.7%) as per the Keros categorization. These results identified that 64.3% of the patients fell into the second type Table (3).

Table (3): Allocation of the olfactory fossa based on side and Keros categorization

	Left	Right	Sum
Keros type	Number (%)	Number (%)	Number (%)
Type I	11(13.8)	16 (20.0)	27(16.87)
Type II	52(65.0)	51(63.8)	103 (64.3)
Type III	17(21.3)	13(16.3)	30 (18.7)
Sum	80(100.0)	80(100.0)	160(100)

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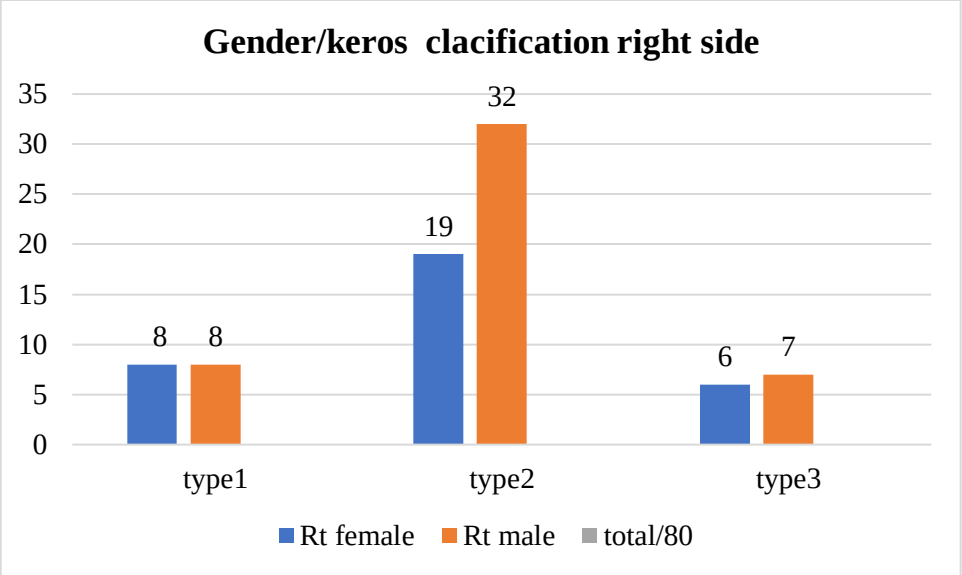

Figure (2): Gender/keros calcification of the right side

The Keros categorization for the 80 patients' olfactory fossae is displayed on the right side in Figure (2). Type I was found in 16 cases (20%), while type II and III were 51 cases (63.7%) and 13 cases (16.2%), respectively. On the right side, type II males and females were more prevalent, as the difference was statistically substantial (P value = 0.006).

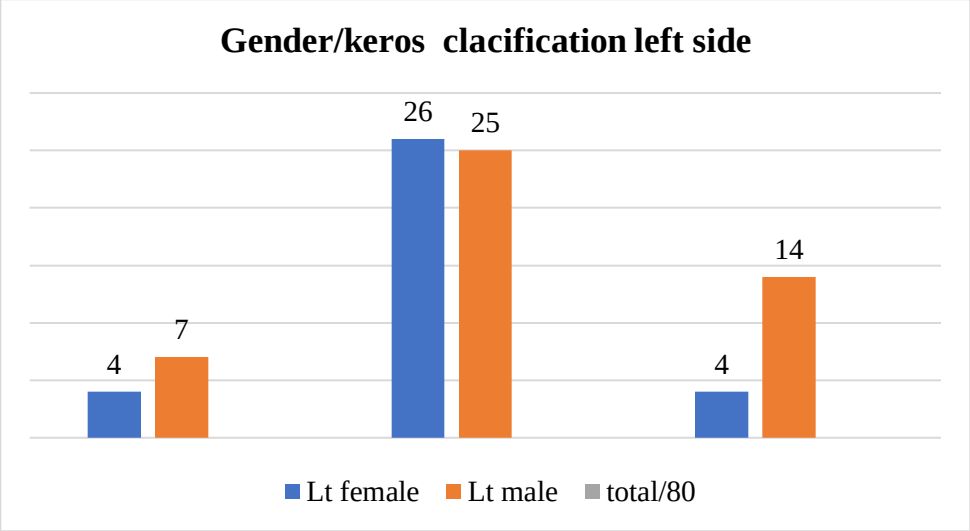

Figure (3): Gender/Keros Calculation for the Left Side

In Figure (3), the left side of the olfactory fossae has been identified, where Keros type I was 11 cases (13.7%), while Keros types II and III were 51 cases (63.7%) and 18 cases (22.5%), respectively. Based on both gender distributions (male and female), type II was the most predominant on the left side. Furthermore, substantial variations between the Keros classification and the gender variable were noticed on the left side (P value = 0.009).

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Discussion

The use of computed tomography is the gold standard for radiological assessment of the paranasal sinuses, whether it is used to diagnose sinonasal abnormalities or to evaluate patients before and after surgery.[9] The results of the study showed that there were 57.5% more men than women in the sample size. Published literature also reveals that more women than men undergo paranasal surgical procedures, although most of the differences are not statistically significant.[4,10] Most of the sample size was between the ages of 19 and 29 years, which was roughly in line with a study by Sar H. et al in which the most prevalent age groups (41.3%) were 14 to 29 years.[4] A depth of 5.7±2.03 mm was an average value for the right olfactory fossa, whereas the left one had an average value of 6.27±2.19 mm, and this was in disagreement with the study conducted by Babu et al.[2] The mean depth did not differ statistically significantly between the right and left sides, although it did between males and females. This difference could be due to the difference in sample size and methods of conducting the CT scan. The present investigation indicates that Keros type II is the most prevalent type, followed by types III and I, respectively. It is shown that 67% of the patients had the second Keros type on both sides, with the right side being more common than the left. These results were in good agreement with what was found by Murthy A. et al [10] where a potential investigation was done in a rural tertiary hospital in India where the Keros type II classification was 68% and the Keros type III classification was 13%. Furthermore, the distributions of both the right and left sides were of the second Keros classification type, with a 70%. In contrast to the current study, other investigations on other populations found that most of the patients had Keros type I subsequent to type II and then type III.[11] For the right side, there were substantial discrepancies between the variable gender and Keros classification; this is consistent with research done among Saudis, which found that type 2 was more prevalent in females on the left side than it was in males on both sides.[12] Anatomical diversity between individuals and across nations should be suspected and accounts for the variance in results between researchers. Significant variations were noticed on the right side between the Keros categorization and the variable gender. In the present investigation, the variation between the average depths of females and males on the right side was statistically significant. However, Naidu L et al. conducted a study on South African populations at high risk of olfactory fossa injury and concluded that there are no significant statistical variations in Keros category symmetry based on sex.[7] In contrast, Pawar et al. found a substantial distinction between the male's right and left Keros types.[13] Variations found in this study highlight the necessity for preoperative examination of the depth of the OF to determine injury risk, prevent iatrogenic damage and its associated consequences, and carry out successful paranasal surgeries. Similarly, because of its impartiality, dependability, risk identification, and usefulness, the Keros grouping is utilized for the initial evaluation of the depth of the current study. According to the current study, the prevalence of 18.7% of Keros type III classification among the studies sample makes significant number of our population being vulnerable to olfactory region complication during FESS procedure particularly on the right side, however due to the limitations imposed by the sample size, more investigations are required to determine the exact prevalence of this type in a large number of cases , and to extend the study on other geographic groups to expand anatomical and surgical understanding of the area.

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Conclusion

Current research demonstrates that both sexes are more likely to have Keros type II. Additionally, on both the left and right sides, respectively, there were substantial differences between the gender factors and the Keros classification. Further study using Keros classification in Kurdish populations with a larger sample size is needed.

Conflict of Interest

None

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