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Computerised tomographic profile of ethmoid roof on basis of keros classification among ethnic Kashmiri's

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ABSTRACT

Background: The purpose of this study was to evaluate the ethmoid roof on computerized tomography of nose and paranasal sinuses of Kashmiri people and distribute them on basis of KEROS classification.
Methods: Cross sectional descriptive study, the randomly selected paranasal sinus computed tomography (PNS CT) scans coronal cuts .Total of One hundred PNS CT scans done at the SMHS Hospital from April 2015 to September 2015 were reviewed, and selected for study. The bilateral heights of the lateral lamellae of the cribriform plate were obtained, independently coded, and classified according to keros.
Results: The mean height of the lateral lamella among Kashmir's was seen to be 5.08mm and 29% of patient's CT PNS were classified as Keros I, 61% were classified as Keros II and 10% were classified as Keros III. There was significant difference in the distribution of Keros classification between the right and left lateral lamella. There was no significant difference in the height of the lateral lamella (t-test: p=0.98 on right side & p =0.89 on left side) and the distribution of Keros classification (Fisher's Exact test: p = 0.823) among younger (1-14 year) and older (>14 year) Kashmiri age groups. There is significant difference in the height (t-test: p=0.03 on right side and p=0.03 on left side) and the distribution of Keros classification is statistically insignificant (Fishers Exact Test: p=0.11) between Kashmiri females and males.
Conclusions: Preoperative assessment of ethmoid roof anatomy and keros level is mandatory for alerting the surgeon of the potential iatrogenic injury during endoscopic sinus surgeries to minimize the grave complications during ESS.

Keywords: Tomography, Ethmoid roof, KEROS, Kashmir

INTRODUCTION

The evolution of modern functional endoscopic nasal and paranasal sinuses (FESS) surgery has been revolutionized by English physicist Hopkins. The technique of systemic explorations of lateral nasal wall was first developed by Messeklinger in the late 60s and 70s.[1] With the advance of Endoscopic Sinus Surgeries (ESS), dreaded complications like orbital or skull base penetration are being encountered commonly. A definite anatomic knowledge and familiarity of constant landmarks and variations along with a preoperative CT evaluation guides rhinologists to securely traverse through paranasal sinus region with minimal risk to patients. The thin lateral lamella of cribriform plate and low Ethmoid Skull Base (ESB) are potential anatomical variants that can lead to iatrogenic injuries in the form of direct penetration trauma to the Dura, serious intracranial and intra-cerebral complications during ESS. The roof of the ethmoidal labyrinth is formed by the fovea ethmoidalis, an extension of the frontal bone orbital plate, primarily separating the ethmoidal cells from the anterior cranial

fossa. Medially, the fovea ethmoidalis attaches to the lateral lamella of the cribriform plate (LLCP) that is part of the ethmoid bone, corresponding to a very thin bone structure, much thicker than the fovea ethmoidalis, offering lower resistance to perforation during surgical procedures Keros first described the differences in the level of the lateral lamella of the ethmoid. This classification depends on the length of the lateral lamella of the cribriform plate. In Keros I, the olfactory fossa is 1 to 3 mm deep, the lateral lamella is short, and the ethmoid roof is almost in the same plane as the cribriform plate. In Keros II, the olfactory fossa is from 4 to 7 mm deep, and the lateral lamella is longer. In Keros III, the olfactory fossa is 8 to 16 mm deep, and the ethmoid roof lies significantly above the cribriform plate. The Keros III classification poses the highest risk for intracranial entry during endoscopic sinus surgery (ESS) (Figure 3).[1,2] Asymmetry in the anterior of the skull base and especially in the ethmoid roof is important for ESS. If asymmetry is present, the height of the ethmoid roof varies, and the fovea ethmoidalis of the two sides may be at different levels. The shape of the contour of the fovea is determined by the angle at which the fovea ethmoidalis joins with the cribriform plate. The fovea ethmoidalis may be straight or in the shape of a broken wing if the joint angle increases. In the anterior coronal plane the ethmoid roof is lower medially at its articulation with the LLCP. It rises from medial to lateral in a "gullwing" configuration. Intracranial complications appear more frequently on the side in which the ethmoid roof is low.[2,3]

There is a paucity of descriptive studies on the Keros classification among ethnic Kashmiris. Determining the distribution of Keros classification among this population may be useful in determining the risk of inadvertent intracranial entry during ESS and consequently avoid post-operative complications. This study aimed to describe the distribution of Keros classification of Kashmir's on basis of age group and gender; and the distribution on differences in laterality.

METHODS

The interdepartmental cross sectional descriptive study was conducted in tertiary care hospital of Kashmir SMHS hospital for a period of six months between April 2015 to September 2015. All available coronal CT scans of the paranasal sinuses of patients, performed at the SMHS Hospital were reviewed and out of that 100 were selected for this study purpose.

Inclusion criteria

1. Ethnic Kashmiri patient.
2. All the CT PNS /NOSE done for chronic rhino sinusitis, polyposis septal deviation was selected for this study.
3. Age >1 year.

Exclusion criteria

1. AGE <1 year.
2. History of trauma with skull base fractures especially ethmoid bone.
3. Nasopharyngeal and /or nasal masses with bony erosions.
4. Any history of previous nasal surgery.

The images were examined in the bone window on a digital screen. All of the cases included in the study were evaluated by the same radiologist. Both the right and left lateral lamella in the CT scan were measured and coded separately. The ethmoid roof measurements were performed manually using a digital screen. Standard anatomic point's references were considered and used during the measurements. These points were the medial ethmoid roof (the point where the ethmoid roof medially joins with the lateral lamella the cribriform plate point and the infraorbital nerve point Measurements were performed using the distance measurement technique in the coronal plane. Measurements between the right and left sides were compared.[2,4] The results were categorized according to Keros classification, and their distributions were analysed according to gender and age group and differences on laterality.

RESULTS

Table 1: Age wise distribution of cases.

Age group	No. of cases	Percentage
0-10	5	5
11-20	14	14
21-30	13	13
31-40	11	11
41-50	19	19
51-60	16	16
61-70	18	18
71-80	4	4
Total	100	100

Table 2: Sex distribution of study group.

Sex	No of cases	Percentage
Females	42	42
Males	58	58
T0tal	100	100

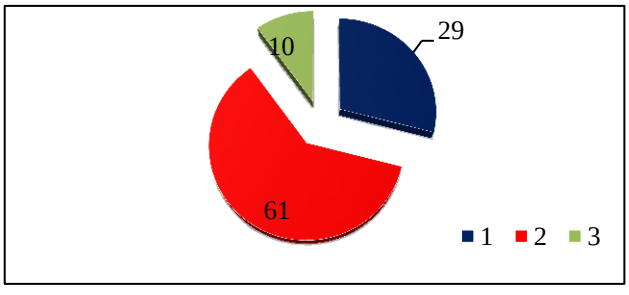

Figure 1: KEROS class.

Table 3: Distribution on KEROS class.

Keros class	Number	Percentage
1	29	29
2	61	61
3	10	10
Total	100	100

The study comprising the noncontrast CT PNS/NOSE of hundred patients with 58 males and 42 females. The ages of the patients ranged between 2 and 78 years, with a mean age of 44.5 year (Table 1). On basis of Keros classification the study group CT scans were grouped as Keros I in 29%, Keros II in 61% and Keros III in 10% of cases (Table 3,4) (Figure 1,2). The mean length of lateral lamella is 5.08mm in both sexes .The keros on laterality has not changed but on right side mean length in males is 5.5mm and in females it is 4.5mm and on left it is 5.4mm in males and 4.5mm in females that makes statistically significant difference in the height of lateral lamella between the right and left lateral lamella (Table 6). The olfactory fossa is more lower on right side than on lest side. There was no significant difference seen in the height of the lateral lamella (t-test: p=0.98 on right side & p=0.89 on left side) and the distribution of Keros classification (Fisher's Exact test: p=0.823) among younger (1-14 year) and older (>14 year) Kashmiri age groups. There is significant difference in the height of lateral lamella, (t-test: p=0.03 on right side and p=0.03 on left side) between males and female group but the on basis of Keros classification it is statistically insignificant (Fishers Exact Test: p=0.11) between Kashmir females and males (Table 5). In 50% of cases there was angulation of the lateral lamella in one of the sides, most frequently at left.

Table 4: Age wise distribution KEROS class.

Age group	KEROS 1	KEROS II	KEROS III	Total
0-10	1	4	0	5
11-20	6	8	0	14
21-30	2	7	4	13
31-40	4	7	0	11
41-50	6	13	0	19
51-60	2	11	3	16
61-70	7	9	2	18
71-80	1	2	1	4
Total	29	61	10	100

DISCUSSION

For endoscopic sinus surgery, CT examination has become a routine essential part of preoperative evaluation. Together with the clinical examination and nasal endoscopy in the preoperative period, CT scans PNS & NOSE are necessary for determining the pathological changes and anatomic variations of a given set of nasal and paranasal sinuses. The lateral lamella, a thin bone component of the lamina cribrosa, forms the medial wall of the ethmoid period because they provide a map for the surgical procedure and help in avoiding complication. ESB is an important landmark for ESS which gets injured commonly. Extensive and exhaustive studies have been done on ESB height on various populations using Keros method. A brief review of literature of previous studies, shows Keros II as the common type where olfactory fossa measures 4-7 mm deep. An olfactory fossa depth between 8-16 mm classified as Keros III was seen predominantly more in Caucasians compared to other populations studied and this is considered as high risk type during ESS.[2-4] Stumberger and Kennedy as cited, by Gauba et al reported that the anatomical associations of the Keros classification suggest that longer lateral lamellae pose greater risks of intracranial entry during surgery.[5,6] The change in angulations along with the length of the lateral lamella also contributes to increased risk. In our study the differences in height of lateral lamella on basis of laterality, age group and gender was seen along with their configuration of angulations that was anatomically monitored in ethnic Kashmir's aiding surgical significance for rhinologists during ESS. The percentage distribution of Keros classification among Kashmir's are similar to the results presented by Floreani et al and Nitinavakarn et al.[7,8] Both studies had majority of cases belonging to Keros II. In a study with 300 adult cases, Elwany et al from Egypt classified 42.5% of the cases as Keros Type I and 56.8% of the cases as Keros Type II.[9] Keros Type III was found in 1.4% of the men and in none of the women. Elwany et al reported that Keros Type II was found more frequently in men, and Keros Type I was found more frequently in women Souza et al from Brazil evaluated the CT scans of 200 cases and found that Keros Type II was the most frequent type (73.3%) followed by Type I (26.3%) and Type III (0.5%).[9] Solares et al evaluated 50 CT scans in the United States.[10] They found that 83% of the cases were Keros Type I, 15% were Type II, and 2% were Type III. These studies support and strengthen the hypothesis that the ethmoid roof configuration varies between populations of different ethnic groups.

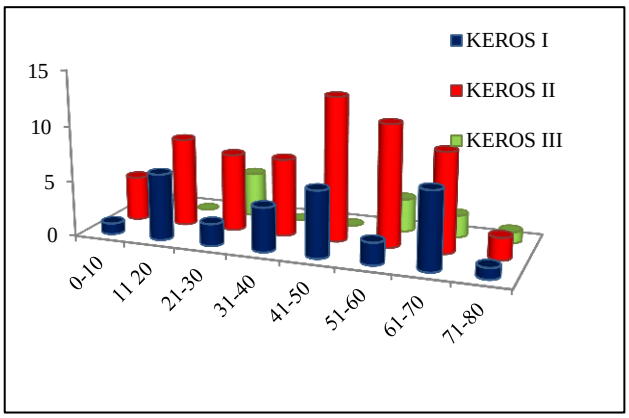

Figure 2: Age distribution of KEROS class.

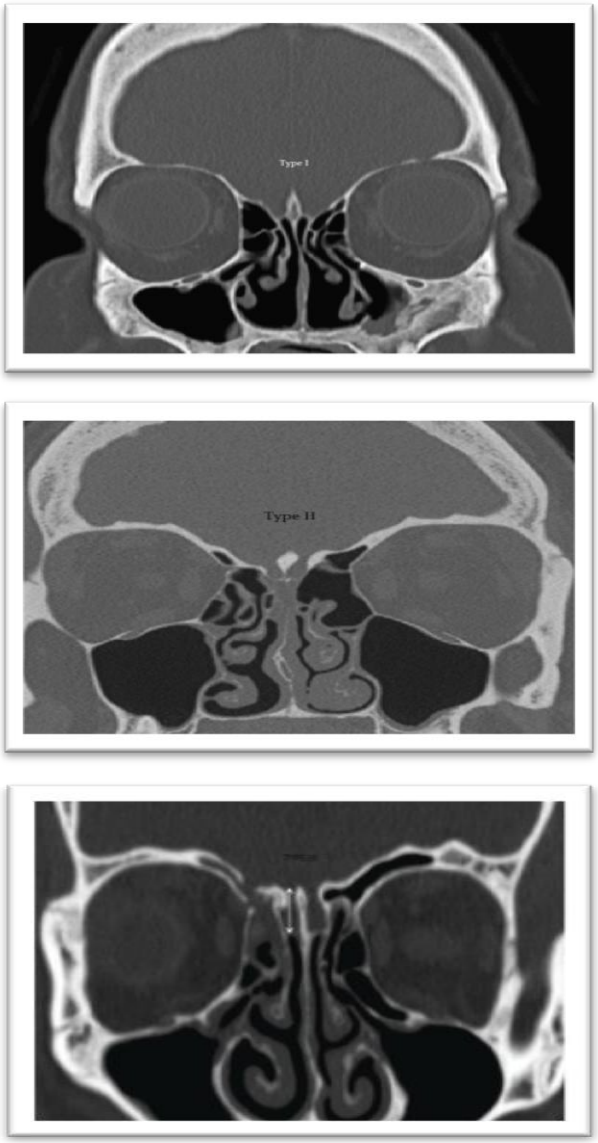

Figure 3: Coronal ct of patients showing keros type I, II, III.

Table 5: Sex wise distribution of keros class.

	KEROS class			
Sex	1	2	3	Total
Males	13	38	7	58
Females	17	23	3	42
Total	29	61	10	100

The majority of the Kashmir patients included in our study had Keros II classification. This suggests that there is a risk of inadvertent intracranial entry through the lateral lamella among Kashmir's should they undergo ESS. The sinus surgeon can perform relatively safe surgery particularly in the ethmoid roof with the knowledge of preoperative assessment of CT. The results of the study also revealed that there is no statistical difference in the distribution of Keros type according to age group, there is equal risk for a trainee ENT surgeon of intracranial entry through the lateral lamella during ESS for the younger and the older age group. Hence, the same degree of caution should be practiced when performing ESS in both age groups. The means of the height of the lateral lamella between Kashmir's females and males were significantly different. The distribution of Keros classification between males and females did not differ with difference in length of lateral lamella. A thorough search couldn't retrieve any study from literature describing and comparing Keros classification differences on basis of gender. There was seen a statistically significant difference in the height of lateral lamella between the right and left lateral lamella. There was no significant difference in the Keros classification of the right and left lateral lamellae. Therefore the risk of intracranial entry through the lateral lamella during ESS is the more on right side and more in males. The presence of asymmetry of the ethmoid roof has been reported consistently in literature. In the literature review, similar results were seen in various studies reporting the frequency of asymmetry in the height of the lateral lamella of the cribriform plate.

Table 6: Variation on basis of laterality.

	Sex	No of cases	Mean LEB	SD
Right	Male	58	5.5	2.1
	Female	42	4.5	2.2
Left	Male	58	5.4	2.0
	Female	42	4.5	2.2

Table 7: Angulation of lateral lamella.

Lateral Angulation	Number of cases
Absent	50%
Present at left	30%
Present at right	20 %
Total	100.0%

A number of studies report a lower ethmoid roof mean height on the right side than on the left side. Wormald has observed that the right fovea ethmoidalis was lower in 59% of cases.[12] Erham et al analysing the height of the ethmoidal roof on 150 CT studies, have observed asymmetry in 15 patients (10%).[11] Lebowitz et al in a review of 200 CT studies, have observed asymmetry in 19 cases (9.5%).[13] In these three studies, ethmoidal roofs were lower at right. In the present study, asymmetry related to the angulation of the lateral lamella of the cribriform plate was observed in 50% of cases, in agreement with Lebowitz et al, who have also demonstrated this finding in 48% of cases in their tomographic studies series.[13] Both in the present study and in the one developed by Lebowitz, there was a prevalence of lateral angulation to the left.[13] In the current series of patients, the lateral ethmoid roof was consistently higher than the medial ethmoid roof in the anterior coronal plane.

CONCLUSION

Preoperative assessment of ethmoid roof anatomy and keros level is mandatory for alerting the surgeon of the potential iatrogenic injury during endoscopic sinus surgeries to minimize the grave complications during ESS. This study evaluated the height, classification, and configuration of the ethmoid roof and variation on basis of age, gender was analysed and elucidated the differences between gender and its relationship on laterality. In our study, males and females both were predominating keros II but males have higher height of lateral lamella than females and more on right side. Therefore, extra care must be taken during surgeries on males.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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