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RADIOLOGICAL OBSERVATION OF ETHMOID ROOF ON BASIS OF KEROS CLASSIFICATION AND ITS APPLICATION IN ENDONASAL SURGERY

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ABSTRACT

Introduction: The most complex structure of paranasal sinus or skull base is ethmoid bone or sinus. The Fovea ethmoidalis (FE) and lateral lamella of the cribriform plate (LLCP) is most vulnerable parts or region in the skull base which is most likely to be injured during endoscopic sinus surgeries (ESS). Keros first proposed a three category classification of ethmoidal fovea based on the length of the lateral lamella of the cribriform plate (LLCP). The aim of the present study is to describe the distribution of Keros classification on the basis of gender and laterality among Bengal population.

Material and Methods: We did a cross sectional study on computed tomography (CT) scan of paranasal sinuses in 100 patients. We excluded patients with sinonasal tumours, nasal polyposis, previous trauma or surgery either to base of skull or to ethmoid roof. The depth of the olfactory fossa was determined by the height of the lateral lamella. The measurement of both right and left lateral lamella in the CT scan was obtained. The results were grouped according to the Kreos classification and their distributions were analyzed according to gender and laterality.

Results: Out of 200 sides CT images studied, the most frequent Keros type was type II (59%) followed by type I (39%) and type III (2%). There is significant difference in the gender. In our study Keros type II (70.34 %) was the most common configuration among males and type I (52.63%) among females.

Conclusion: Considering the significant implication of knowing depth of olfactory fossa for the ENT surgeons, radiologist should specifically include this in their routine tomographic reports.

KEY WORDS: Ethmoid roof, Endoscopic sinus surgeries, Computed Tomography, Olfactory Fossa.

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INTRODUCTION

The ethmoid bone is an important landmark bony structure in endonasal region which is of various clinical importances, particularly in respect to endoscopic nasal and sinus surgeries (ESS). Skull base entry, orbital and ocular injuries are the most common complications of widely performed sinus surgeries [1].

The most complex structure of paranasal sinus or skull base is ethmoid bone or sinus. The Fovea ethmoidalis (FE) constitute the roof of the ethmoid bony labyrinth, a part of frontal bone which primarily separates the ethmoidal air cells from the anterior cranial fossa. Medially fovea ethmoidalis articulates with lateral lamella of the cribriform plate (LLCP), which forms the medial wall of frontal recess [2]. LLCP is the thinnest bone in the entire anterior skull base. FE and LLCP is most vulnerable parts or region in the skull base which is most likely to be injured during FESS [3,4].

Keros first proposed a three category classification based on the length of the lateral lamella of the cribriform plate (LLCP). In Keros type 1, the depth of the olfactory fossa is 1 to 3 mm, the lateral lamella is short, and the ethmoid roof as well as cribriform plate is almost in the same plane. In Keros II, the depth of the olfactory fossa is from 4 to 7 mm, and the lateral lamella is longer. In Keros III, the depth of the olfactory fossa is 8 to 16 mm deep, and the ethmoid roof lies significantly above the cribriform plate [5]. Keros type III is the most vulnerable one and associated with higher the risk of penetration into the anterior cranial fossa during surgeries. This is because; in Keros type III height of the LLCP is comparably more than other type [6].

With the advancement of computed tomography (CT) scanning technique, the comprehensive, noninvasive assessment of the anatomy and possible lesion in the sinonasal region can be studied in detail prior to surgeries. These CT scans are used as road map while operating on the paranasal sinuses. A sound and accurate anatomical knowledge of ethmoid roof and its variability is essential for the surgeon to avoid traumatizing the ethmoid roof during endoscopic surgery. In view of this, we have conducted this study with the aim to describe the distribution of Keros classification on the basis of gender and laterality among Bengal population.

MATERIALS AND METHODS

This is a retrospective and interdepartmental study consisting of 100 patients who underwent paranasal sinus CT for various reasons at IQ city medical college between March 2016 to January 2017. Patients with sinonasal tumour, nasal polyposis, previous trauma or surgery either to base of skull or to ethmoid roof were excluded from the study. The medical ethics committee of IQ city medical college approved the study.

The study was done to all patients using TOSHIBA Aquilion 16 slice CT scanner with 512 elements, 256 x 256 matrix. The CT data obtained was performed according to standard protocol of the volume mode. The technical parameters adopted for collection of data include a 120 kV tube voltage and 150 effective mAs, 1 second rotation time, section thickness of 1mm, a field of view (FOV) of 25cm.

The CT images were analyzed in the bone window. All the CT images were interpreted by the same radiologist. The following were the established anatomical points which was identified and used for measurements.

1. The medial ethmoidal roof point (Fovea ethmoidalis)
2. Cribriform plate
3. Lateral lamella of cribriform plate (LLCP)

The measurement of both right and left lateral lamella in the CT scan was recorded and coded separately. The depth of the olfactory fossa was determined by the height of the lateral lamella. The measurements between the right and left sides were compared. The results were grouped according to the Keros classification and their distributions were analyzed according to gender and laterality.

RESULTS

A total of 100 (200 sides) CT scans of nose and paranasal sinuses were reviewed. Among them 62 were males and 38 were females, age ranging between 8-72 years (mean ± SD, 40.24 ± 11.31 years). Table 2 shows the distribution of study group based on Keros classification. In our study, the commonest Keros type in males was type II (70.34 %), in females it was type I (51.3%) on both sides.

Table 1: Sex Distribution of Study Group.

Sex	No Of Cases	Percentages (%)
Males	62	62
Females	38	38

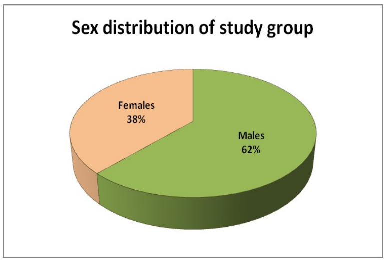

Fig. 1: Shows the sex distribution of study group.

Table 2: Distribution Of cribriform plate lateral lamella depth based on Keros Classification according To Their Sides and Sex.

Keros Type	Right (n (%))		Left (n (%))		Total (n (%))		
	Male	Female	Male	Female	Male	Female	Overall
Keros I (1-3 mm)	18 (29)	19 (50)	20 (32.3)	21 (55.3)	38 (48.7)	40 (51.3)	78(39)
Keros II (4-7 mm)	42 (67.8)	18 (47.4)	41(66.1)	17 (44.7)	83 (70.34)	35 (29.66)	118(59)
Keros III (8-16 mm)	2 (3.2)	1 (2.6)	1 (1.6)	0 (0)	3 (75)	1 (25)	4(2)
Total	62 (100)	38 (100)	62 (100)	38 (100)	124 (62)	76 (38)	200(100)

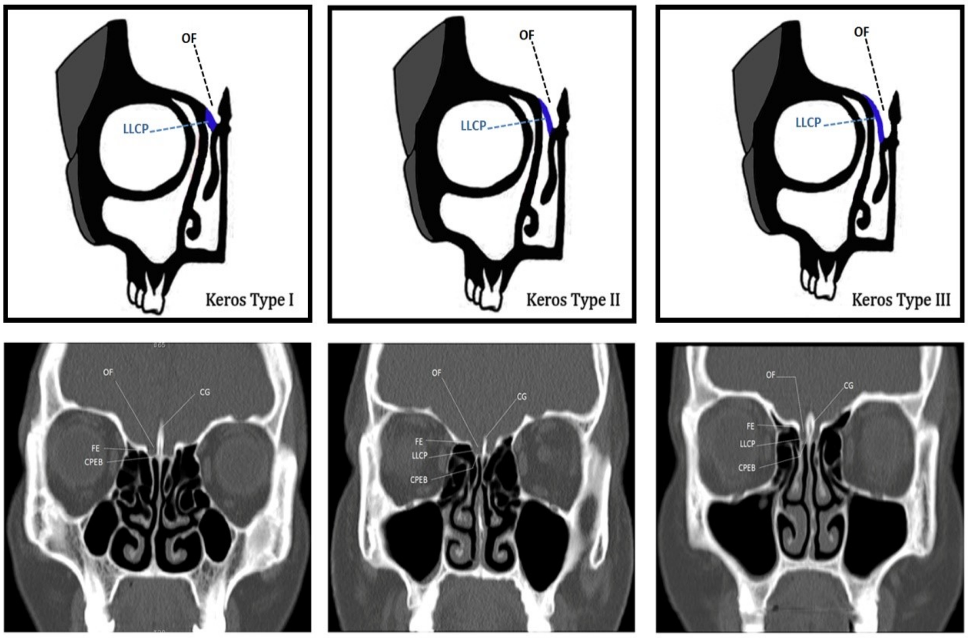

Fig. 2: Schematic representation and Coronal CT images showing three types of Keros classification.

CG- Crista galli, OF- Olfactory Fossa, FE- Fovea ethmoidalis, LLCP- Lateral lamella of the cribriform plate, CPEB- Cribriform plate of ethmoid bone.

DISCUSSION

Table 3: Results of Keros distribution among various population.

Authors	Type I	Type II	Type III
Basak et al (1998) [7]	9%	53%	38%
Jang et al (1999) [8]	53.80%	69.50%	0%
Anderhuber (2001) [9]	14.20%	70.60%	15.20%
Souza et al (2008) [10]	26.20%	73.30%	0.50%
Elwany et al (2010) [11]	42.50%	56.80%	0.60%
AlazzawiS et al (2012) [12]	80%	20%	0%
Kaplanoglu et al (2013) [13]	13.40%	76.10%	10.50%
Present study (2017)	39%	59%	2%

A cadaveric study conducted by Keros among 450 skulls to study the configuration of the ethmoidal roof, first proposed a three category classification of olfactory fossa depth based on the length of the lateral lamella of the cribriform plate (LLCP). He reported that the incidence of type I, type II and type III lateral lamella in 12%, 70% and 18% respectively [5].

In the present study, Ethmoid roof was studied based on Keros Classification. Out of 200 sides CT images studied, the most frequent Keros type was type II (59%) followed by type I (39%) and type III (2%). All studies, except Alazzawi et al have reported Keros II as the most common type followed by type I and III [7-13]. These studies are summarized in Table 3.

In the present study, the most common Keros type in males was type II (70.34 %) and in females it was type I (52.63%) on both sides. Our findings were similar to Elwany et al who also reported that Keros type II was found more common in males and Kreos type I was found more common in females [11].

Literature review has shown asymmetry as the rule when comparing the height between right and left ethmoidal fovea [12-15]. Salroo et al in their study observed that there is a significant difference in the height of lateral lamella between the right and left side [16]. We also observed a significant asymmetry in height of the right and left lateral lamella.

Wormald and other authors have reported more frequency of lower ethmoidal roof on right than on the left side [13,16,17]. This increases the risk of inadvertent entry into cranial cavity more on right side during endoscopic sinus surgery. Various authors have concluded that longer the length of lateral lamellae, greater the risks of intracranial entry during endoscopic sinus surgeries (ESS) [3].

CONCLUSION

Ethmoid roof asymmetry is a common anatomical variation observed among the population. Pre operative assessment of depth of ethmoidal fovea, using computed tomogram of nose and paranasal sinuses, helps the surgeon to plan the surgery and avoid the risk of intracranial entry during endoscopic sinus surgery. Our study provides a precise a quantitative analysis of depth of ethmoidal fovea and reports the gender related differences and individual asymmetry. In our study Keros type II was the most common configuration among both males and type I among females.

Considering the significant implication of knowing the depth of olfactory fossa for the ENT surgeons, radiologist should specifically include this in their routine tomographic reports.

Conflicts of Interests: None

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