International Journal of Anatomy and Research,
Int J Anat Res 2016, Vol 4(3):2738-42. ISSN 2321-4287
DOI: http://dx.doi.org/10.16965/ijar.2016.320

Original Research Article

COMPUTED TOMOGRAPHIC STUDY OF DEPTH OF ANTERIOR SKULL BASE IN DAKSHINA KANNADA POPULATION

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ABSTRACT

Introduction: Variations in anterior skull base depth (depth of olfactory fossa) is common. The endoscopic surgeons should have knowledge about this. A coronal CT scan of paranasal sinuses (PNS) is mandatory prior to Functional endoscopic sinus surgery. The aim of this study was to calculate the depth of olfactory fossa and classify it according to that done by Keros . Comparison of Olfactory fossa depth was done among males and females .

Materials and Methods: A retrospective study was conducted among 100 Dakshina Kannada patients. Coronal CT scans of PNS were observed. The depth of the lateral lamella of cribriform plate (LLCP) was calculated by subtracting the depth of the cribriform plate from the depth of the medial ethmoid roof. The observations were classified according to Keros classification. Data was compared among males and females. Any asymmetry in the Ethmoid roof was noted.

Result: The mean LLCP height on the right side was 4.06 ± 1.283 mm and 4.44±1.313 on the left side. There is statistically significant difference in the height of lateral lamella between the right and left side independent of gender (P<0.05). However, there was no statistical significance in mean LLCP height in case of males and females. Ethmoid roof was found to be low more frequently on the left side, both in case of males and females.

Conclusion: Keros Type II class was more frequent in the present study .When compared with other studies variations have been observed in different populations. The anatomical variations of anterior skull base in each patient should be carefully evaluated preoperatively to avoid complications during endoscopic sinus surgeries.

KEY WORDS: Olfactory Fossa, Anterior Skull Base, Lateral Lamella Of Cribriform Plate, Keros.

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Access this Article online

Quick Response code

DOI: 10.16965/ijar.2016.320

Web site: International Journal of Anatomy and Research
ISSN 2321-4287
www.ijmhr.org/ijar.htm

Received: 17 Jul 2016 Accepted: 16 Aug 2016
Peer Review: 17 Jul 2016 Published (O): 31 Aug 2016
Revised: None Published (P): 31 Aug 2016

INTRODUCTION

Functional endoscopic sinus surgery (FESS) is a minimally invasive technique in which sinus air cells and sinus ostia are opened under direct visualization. The goal of this procedure is to restore sinus ventilation [1]. Endoscopic Sinus Surgery (ESS) requires in depth knowledge of anatomy of frontal recess. A common reason for ESS failure is inadequate removal of cells obstructing the outflow of the frontal sinus [2]. The complexity of this region creates anxiety to the surgeons as operating here puts medial wall of frontal recess {Lateral lamella of cribriform plate (LLCP)} and anterior ethmoidal artery at

risk [3]. The height and its shape vary from case to case and also from side to side. Anterior ethmoidal artery enters anterior cranial fossa through LLCP [4].

Keros determined three heights and classified depth of olfactory fossa: In Type I the olfactory fossa is flat, the roof of ethmoid is almost vertical and LLCP is low (< 3 mm). In Type II the lateral lamella is higher, olfactory fossa is deeper (4-7 mm) and in Type III, the roof of ethmoid is considerably higher than lamina cribrosa, lateral lamella is long and olfactory fossa very deep (8-16 mm) [4,5].

The bony wall of olfactory fossa varies in thickness and provides little resistance to penetration [4].

In this study we have measured the depth of olfactory fossa in patients of Dakshina Kannada district and classified it according to that by Keros. The olfactory fossa depth in males and females has been compared. Ethmoid roof asymmetry was noted.

MATERIALS AND METHODS

Images obtained from 100 patients of Dakshina Kannada district who underwent paranasal sinus CT for various reasons at our hospital between July 2015 to December 2015 were evaluated retrospectively. The CT scan images of 3mm thickness were taken using GE Bright Speed 16 slice scanner. All the images were analysed using Radiant DICOM viewer. Patients with skull base fractures, tumours , congenital malformations and who underwent sinus surgeries were excluded. Coronal images were utilised for the present study. All the observations were taken by one person to avoid observer variation.

The position of cribriform plate and ethmoidal roof was calculated relative to orbital floor as shown by the infraorbital foramen {a plane passing through the two foramina was used (IOP)}. Two reference points were chosen at the skull base.

1. Point of articulation of medial ethmoidal roof with lateral lamella of cribriform plate (MERP).

2. Lowest point on the cribriform plate (CP)

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

The LLCP was calculated by subtracting CP height from MERP height (MERP-CP = LLCP) [6].

The mean LLCP height was calculated in males and females and compared. Asymmetry in the ethmoid roof was also noted. The LLCP was the classified according to Keros classification and compared on both sides in males and females.

Statistical analysis was done using SPSS 16.

RESULTS

The coronal CT scans of 100 patients were analysed. 54 patients were males and 46 were females.

The mean LLCP height on the right side was 4.06 ± 1.283 mm with minimum being 1mm and maximum being 8mm .Mean height of 4.44±1.313 on the left side with minimum height being 2mm and maximum being 8mm.

Mean height on right and left side of males and females is shown in Table 1:

There is statistically significant difference in the height of lateral lamella between the right and left side independent of gender (P<0.05). This was calculated using one sample t test. However, there was no statistical significance in mean LLCP height in case of males and females. There was no statistical significance when mean height of right and left side in males and right and left side in female group was compared.

The ethmoid roof showed asymmetry in our study. It was found to be low more frequently on the left side, both in case of males and females. Table 2 shows the distribution of asymmetry in ethmoid roof.

Distribution and percentage of LLCP according to Keros classification is shown in Table 3.

Table 1: Variation in mean LLCP based on laterality.

	Males (n=54)		Females (n=46)	
	Right	Left	Right	Left
Mean (mm)	4.148	4.537	3.956	4.326
Standard deviation	1.334	1.366	1.228	1.253
Minimum (mm)	1	2	2	2
Maximum (mm)	8	8	8	7

Table 2: Distribution of asymmetry of depth of lateral lamella of cribriform plate.

Gender	Right ethmoid roof low	Left ethmoid roof low	Symmetrical
Males n= 54(%)	17(31.48)	24(44.44)	13(24.07)
Females n= 46(%)	10(21.73)	21(45.65)	15(32.61)
Total n=100 (%)	27	45	28

Table 3: Distribution and percentage of LLCP according to Keros classification.

KEROS TYPE	RIGHT		LEFT		TOTAL
	MALES	FEMALES	MALES	FEMALES	
I	16 (29.6)	18 (39.13)	10 (18.51)	12 (26.09)	56 (28)
II	37 (68.59)	27 (58.69)	43 (79.63)	34 (73.91)	141 (70.5)
III	1 (1.85)	1 (2.17)	1 (1.85)	0 (0)	3 (1.5)
TOTAL	34 (100)	22 (100)	64 (100)	77 (100)	200 (100)

Fig. 1: Calculation of height of LLCP(LLCP =MERP – CP).

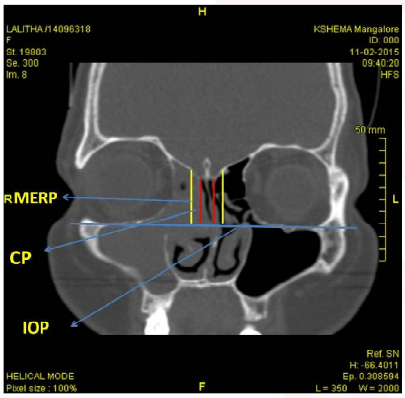


Fig. 2: Keros type 1: LLCP =1-3 mm.

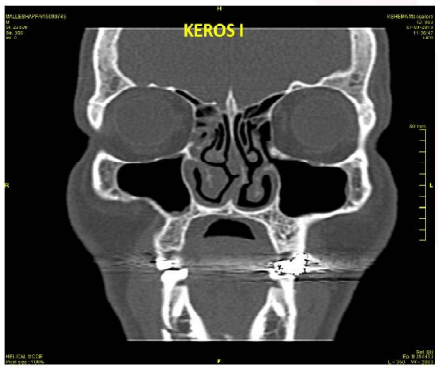


Fig. 3: Keros type 2: LLCP =4-7 mm.

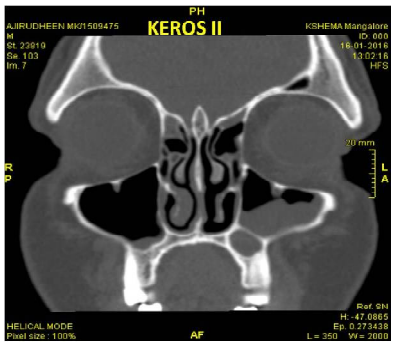
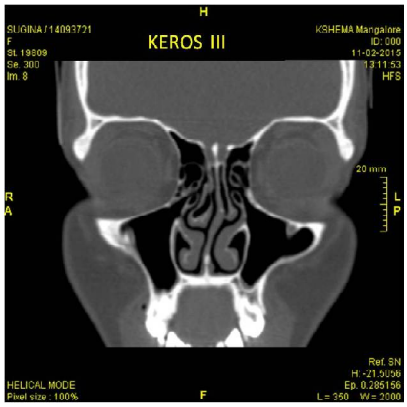


Fig. 4: Keros type 3: LLCP = > 8mm.



DISCUSSION

The anatomy and variation in frontal recess is poorly understood by a large number of endoscopic surgeons. Fine cut coronal CT scans aid the surgeons to formulate a precise surgical plan [2].

Various studies have been done in determining LLCP height and classification of it based on Keros method. Keros created three categories for the classification of the olfactory groove according to LLCP height studied in 450 patients. Type I (1-3 mm) was found in 12% of the specimens, Type II (4-7 mm) in 70% of the specimens, and Type III in 18% of the specimens [5].

Majority of the patients included in our study fall under Keros II classification (70.5%), followed by type I (28%). The least common variety was type III i.e 1.5%.

In a study conducted among the Egyptian population by Elwany et al 42.5% of the cases were classified as Keros Type I and 56.8% of the cases as Keros Type II. Keros Type III was found in 1.4% of the men and in none of the women [7].

A study by Salroo I N among the Kashmiris patients Keros II predominated. They suggested that there is a risk of inadvertent intracranial entry through the lateral lamella among Kashmis should they undergo ESS [8]. Similar complication can be suggested in our study too.

In a Study by Solares et al among 50 CT scans in the United States, 83% of the cases were Keros Type I, 15% were Type II, and 2% were Type III [9].Souza et al. evaluated the CT scans of 200 cases in Brazil and found that Keros Type II was the most frequent type (73.3%) followed by Type I (26.3%) and Type III (0.5 %).This data is consistent with our study [10].

Erdem et al found that 8.1% of the cases were Keros Type I, 59.6% were Keros Type II, and 32.3% were Keros Type III [11].

Hatice Kaplanoglu and colleagues in their study of 500 patients, found that, 13.4% were Keros Type I, 76.1% were Keros Type II, and 10.5% were Keros Type III [12].

We compared the measurement of LLCP height with various other studies .In our study mean LLCP height on the right side was 4.06 ± 1.283 mm and 4.44 ± 1.313 mm on the left side.

Meloni et al. found the mean depth of the cribriform plate to be 5.9 mm in subjects from Italy [13].

Arslan et al. found a mean of 8 mm for the height of the right side of the ethmoid roof, and a mean of 9.5 mm for the height of the left side in Turkish population [14].

Study by Shama and Montaser in Egyptians , showed mean LLCP height on the right side to be 4.87±1.71mm and 4.91±1.66mm on the left [15].

Alazzawi et al. found a mean height of 2.64 mm for the LLCP in their study on 3 ethnic groups in Malaysia [16].

The differences in the heights of the fossa may be explained by the difference in extent of pneumatisation of the ethmoid labyrinth and the frontal sinus [17].

A number of studies report a lower ethmoid roof mean height on the right side than on the left side.[7, 18] In the present study we found low ethmoid roof more on the left side (44.4%in males and 45.65% in case of females) than on the right side (31.48% in males and 21.73% in case of females).

Arikan et al. in a study conducted on a Turkish population determined that their subjects had a higher left side ethmoid roof than right side ethmoid roof [19].

In the study by Hatice Kaplanoglu, LLCP height was found to be lower on the right side than on the left side [12]. Lebowitz et al in a review of 200 CT studies, have observed asymmetry in 19 cases (9.5%). In this study, ethmoidal roof was lower more on the right(63.2%) [20].

Thus it shows that there is no consistency in depth of anterior skull base and appears to be frequent anatomical variation.

CONCLUSION

Various studies have been done on the variation in depth of anterior skull base by CT study. The Variation are frequent and inconsistent. In the present study we have found Keros type II to be more predominant skull base type and left side olfactory fossa to be deeper. Thus it is necessary that nasal endoscopic surgeons must have a thorough knowledge about this and a coronal CT scan of PNS is mandatory prior to FESS.

ABBREVIATIONS

PNS - Paranasal sinuses (PNS).
FESS - Functional endoscopic sinus surgery (FESS).
ESS - Endoscopic Sinus Surgery (ESS).
LLCP - Lateral lamella of cribriform plate (LLCP).
IOP - A plane passing through the two Infraorbital foramina was used (IOP).
MERP - Point of articulation of medial ethmoidal roof with lateral lamella of cribriform plate (MERP).
CP - Lowest point on the cribriform plate (CP).

Conflicts of Interests: None

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How to cite this article:

Pretty Rathnakar, Shrinath D. Kamath. P. COMPUTED TOMOGRAPHIC STUDY OF DEPTH OF ANTERIOR SKULL BASE IN DAKSHINA KANNADA POPULATION. Int J Anat Res 2016;4(3):2738-2742. **DOI:** 10.16965/ijar.2016.320