

## Study of Length of Lateral Lamella of the Cribriform Plate

Deepa G<sup>1</sup>, Shrikrishna BH<sup>2</sup>

### Abstract

**Introduction:** The roof of ethmoid (fovea ethmoidalis) separates the ethmoidal cells from the anterior cranial fossa. Medially the fovea attaches to the lateral lamella of the cribriform plate (LLCP), which is the thinnest bone of the skull base. Hence, it is at a high risk of getting damaged during endoscopic sinus surgery. **Objective:** To evaluate the height of lateral lamella of cribriform plate using the computed tomographic (CT) images of patients. **Materials and Methods:** Coronal views of 80 computed tomography films of paranasal sinus region were studied. Coronal sections at the level of centre of infra-orbital foramina were taken as the reference slide. The height of the lateral lamella of the cribriform plate was measured and then classified according to Keros classification. **Results:** The CT scans from 80 patients were analyzed. The median height of the LLCP in 160 sides was 3.3 mm (SD+1.63). The LLCP height was 0 to 3.9 mm in 122 sides, 4.0 to 7.0 mm in 33 sides, and greater than 7.0mm in 5 sides. The lateral lamella of the cribriform plate averaged 3.47 mm (SD +1.68) in height on the right side and 3.08 mm (SD+1.59) on the left. The LLCP height was greater on the right side in 55 patients, greater on the left side in 19 and equal on both sides in 6 patients. The difference between sides was 0 to 1.9 mm in 78 patients, 2.0 to 3.9 mm in 1 patient, and greater than 4.0 mm in 1 patient. Student t test was used to compare the mean height of LLCP on each side. t value = 1.519. The difference of the height was not significant when right and left sides were compared (p = 0.131). **Conclusion:** In our study, the median height of the LLCP was 3.3 mm. Mean height of the LLCP on right side (3.47) was more than mean height of the LLCP on left side (3.08). But the difference was not statistically significant. However, variations do exist between right and left sides. A surgeon must take proper caution while operating in the area of lateral lamella of cribriform plate to prevent unintentional skull base injury and cerebrospinal fluid leak. A proper pre-operative evaluation of computed tomography of para nasal sinuses is essential to avoid life threatening complications during endoscopic sinus surgery.

**Keywords:** Computed tomography; lateral lamella; cribriform plate; olfactory fossa; endoscopic sinus surgery.

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### Introduction

Anatomical variations are common in the sinonasal region. These anatomical variations frequently contribute to sinusitis. Pre-operative

Computed Tomography (CT) scan not only reveals the presence but also the extent of sinus disease as well as anatomical variations, thus providing the surgeon with invaluable guidance [1]. Iatrogenic complications during sinus surgery are frequent if the sinonasal anatomic variations, especially of ethmoid roof are not studied pre-operatively. The depth of the olfactory fossa is determined by the height of the lateral lamella of the cribriform plate (LLCP). Keros has classified the ethmoid roof into 3 types based on the distance between the cribriform plate and the lateral lamella: type 1, 1-3 mm; type 2, 4-7 mm; and type 3, 8-16 mm [2]. The type 3 ethmoid roof is weak, and the cribriform plate of the ethmoid skull base, which forms a large part of the roof, is less protected than in the other

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Keros types. Therefore, type 3 patients are more susceptible to iatrogenic complications [3].

We studied this crucial anatomy of the ethmoid roof using computed tomography scans of paranasal sinus area and analysed the asymmetry of lateral lamella of the cribriform plate (LLCP).

### Materials and Methods

Our study is an observational hospital based prospective study conducted during June 2015 to May 2017. Ethical clearance was received from our institutional ethical clearance committee. Our study group consisted of adult patients who underwent CT scan of paranasal sinus region in the oto-rhino-laryngology department at Navodaya Medical College Hospital, Raichur. Patients with nasal polyp or tumour, severe paranasal sinusitis, any prior operation on the paranasal sinuses, congenital abnormalities of the face and age less than 18 years were excluded from our study. After this exclusion, coronal views of 80 computed tomography films of paranasal sinus region were pooled and studied. A direct coronal positioning was done with the patient prone with the chin extended (neck hyper extended). The slice thickness was 1 mm. Bone algorithm was used for acquisition and the scans were interpreted in bone window. Coronal sections at the level of centre of infra-orbital foramina were taken as the reference slide. A specialized computer software "picture

archiving and communication system" (PACS) was used for morphological evaluation of the CT scans. This software provided tools to establish the necessary distance measurements. The height of the lateral lamella of the cribriform plate was measured and then classified according to Keros classification. The data was tabulated in an excel spreadsheet which was then exported to SPSS Ver. 20.0 for analysis.

### Results

The CT scans from 80 patients were analyzed. Few images are shown in figures 1, 2 and 3. The median height of the LLCP in 160 sides was 3.3 mm (SD±1.63). The LLCP height was 0 to 3.9 mm (Keros type 1) in 122 sides (76.25%), 4.0 to 7.0 mm (Keros type 2) in 33 sides (20.63%) and greater than 7.0 mm (Keros type 3) in 5 sides (3.12%). The lateral lamella of the cribriform plate averaged 3.47 mm (SD±1.68) in height on the right side and 3.08 mm (SD±1.59) on the left. The LLCP height was greater on the right side in 55 patients (68.75%), greater on the left side in 19 (23.75%) and equal on both sides in 6 patients (7.5%). The difference between sides was 0 to 1.9 mm in 78 patients, 2.0 to 3.9 mm in 1 patient, and greater than 4.0 mm in 1 patient. Student t test was used to compare the mean height of LLCP on each side. t value = 1.519. The difference of the height was not significant when right and left sides were compared (p = 0.131).

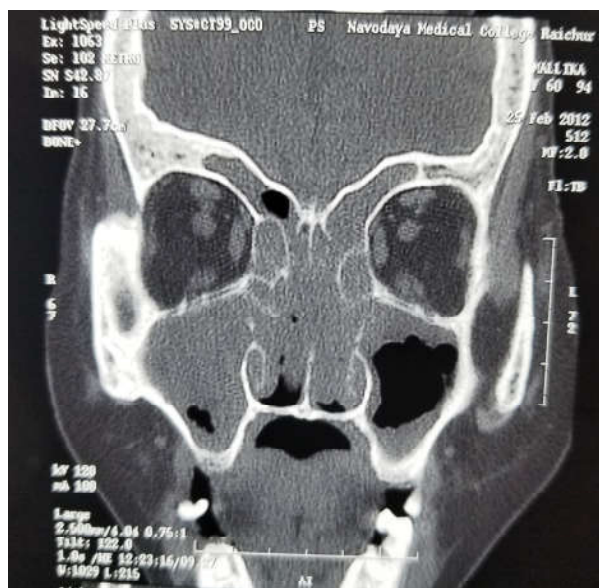


Fig. 1: Bilateral Short Lateral Lamellae

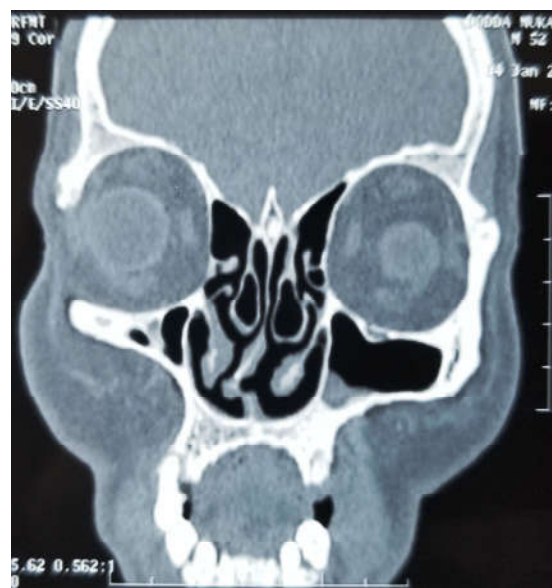


Fig. 2: Right and Left Lateral Lamellae Equal and Medium in Length

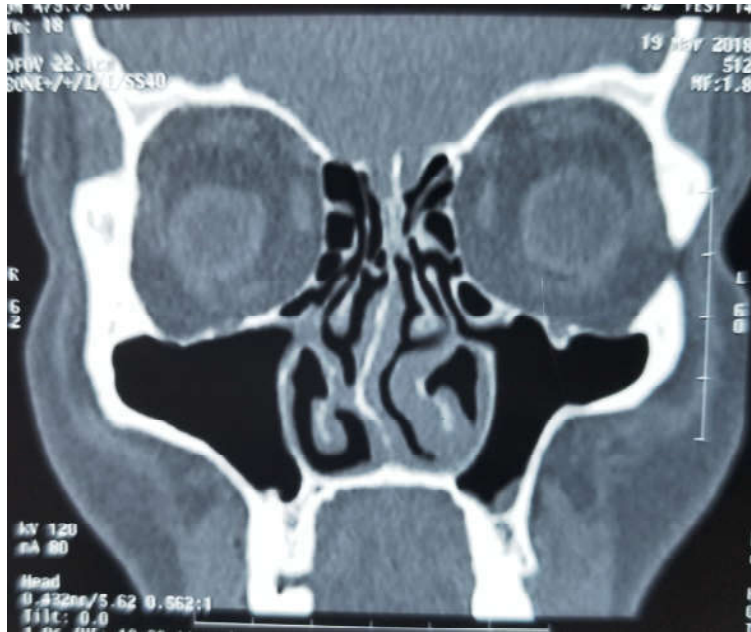


Fig. 3: Right Lateral Lamella is Longer than left Lateral Lamella.

## Discussion

Endoscopic sinus surgery is a frequently performed procedure for refractory sinusitis. The advent of rigid telescopes and the computed tomography has reduced the risks during endoscopic sinus surgery. The endoscope brings better vision and exposure with lesser bleeding - together leading to better results. An optimal preoperative evaluation including CT scan and a thorough knowledge of paranasal anatomy is paramount in a successful endoscopic sinus surgery. But, a proper analysis of the ethmoid roof, more so of the height of lateral lamella of the cribriform plate will reduce iatrogenic complications like cerebro-spinal fluid rhinorrhea, damage to orbital structures, bleeding and meningitis. The paranasal sinus region exhibits varied anatomical variations, the knowledge of which is essential for any endoscopic sinus surgeon. One of these important anatomical variations is that of the height of lateral lamella of cribriform plate. Keros has classified the ethmoid roof into 3 types based on the height of lateral lamella of cribriform plate: type 1, 1-3 mm; type 2, 4-7 mm; and type 3, 8-16 mm [2]. The type 3 ethmoid roof is weak, and the cribriform plate of the ethmoid skull base, which forms a large part of the roof, is less protected than in the other Keros types. Therefore, type 3 patients are more susceptible to iatrogenic complications during endoscopic sinus surgeries [3].

In our study, the LLCP height was 0 to 3.9 mm (Keros type 1) in 122 sides (76.25%), 4.0 to 7.0 mm

(Keros type 2) in 33 sides (20.63%) and greater than 7.0 mm (Keros type 3) in 5 sides (3.12%). In a similar study by Bask et al., 9% of patients had Keros type 2, 53% had type 3, and 38% had type 1 [4]. A similar study by Souza et al. revealed 26.2% patients with type 1, 73.3% patients with type 2, and 0.5% patients with type 3 [5]. A similar study by Gluer et al. revealed 26% patients with type 1, 66% patients with type 2, and 8% patients with type 3 [6]. A similar study by Anderhuber et al. revealed 14.2% patients with type 1, 70.6% patients with type 2, and 15.2% patients with type 3 [7]. A similar study by Nitinavakarn et al. revealed 11.9% patients with type 1, 68.8% patients with type 2, and 19.3% patients with type 3 [8]. A similar study by Alazzawi et al. revealed 80% patients with type 1, 20% patients with type 2, and none with type 3 [9]. A similar study by Erdem et al. revealed 8.1% patients with type 1, 59.6% patients with type 2, and 32.3% patients with type 3 [10]. A similar study by Ali et al. revealed 20% patients with type 1, 78.7% patients with type 2, and 1.3% patients with type 3 [11]. A similar study by Jang et al. revealed 30.5% patients with type 1, 69.5% patients with type 2, and none with type 3 [12]. A similar study by Nouraei et al. revealed 92% patients with type 1, 7% patients with type 2, and 1% patients with type 3 [13]. A similar study by Solares et al. revealed 83% patients with type 1, 15% patients with type 2, and 2% patients with type 3 [14]. A similar study by Adeel et al. revealed 29.9% patients with type 1, 49.4% patients with type 2, and 20.8% patients with type 3 [15]. The reason for apparent differences in the LLCP height is difficult to determine. The cause

may be due to different methodologies used in the respective studies like cadaveric dissection, CT imaging etc.

Also important is the difference in the height of LLCP between right and left sides because, the possibility of injuring the skull base increases with increasing height of the LLCP. In our study, the lateral lamella of the cribriform plate averaged 3.47 mm (SD±1.68) in height on the right side and 3.08 mm (SD±1.59) on the left. The LLCP height was greater on the right side in 55 patients (68.75%), greater on the left side in 19 (23.75%) and equal on both sides in 6 patients (7.5%). The difference between sides was 0 to 1.9 mm in 78 patients, 2.0 to 3.9 mm in 1 patient, and greater than 4.0 mm in 1 patient. This finding is in accordance to the findings in the studies by Wormald [16] and Dessi P et al. [17], where in it was observed that the right fovea ethmoidalis is lower than the left in more cases. A pre-operative knowledge about this possible anatomical variation helps in preventing dreadful skull base injuries during endoscopic sinus surgeries.

The Keros type III is considered as the most vulnerable for iatrogenic lesion during frontoethmoidal surgery due to its long length of the lateral lamella. The area of the entry of AEA through the lateral lamella into the olfactory fossa is considered the thinnest and at risk of injury causing CSF leak [18,19]. In our study, Keros type III i.e. greater than 7.0 mm was noticed in 5 sides. These asymmetries in the anatomy of ethmoidal roof need to be kept in mind to prevent complications. These previous studies, together with the present one, should alert surgeons to the frequency of ethmoid roof asymmetry, which should be taken into consideration to avoid iatrogenic injury.

### Conclusion

In our study, the median height of the LLCP was 3.3 mm. Mean height of the LLCP on right side (3.47) was more than mean height of the LLCP on left side (3.08). But the difference was not statistically significant. However, variations do exist between right and left sides. Endoscopic sinus surgery should be preceded by planning CT as intra-operative discovery of anatomical variations creates problems. A surgeon must take proper caution while operating in the area of lateral lamella of cribriform plate caution to prevent unintentional skull base injury and cerebrospinal fluid leak. A proper pre-operative evaluation of computed tomography of para nasal sinuses is

essential to avoid life threatening complications during endoscopic sinus surgery.

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