

Adult and Pediatric Lateral Lamella Cribriform Plate Height: In Need for a Comparative Study

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Abstract

Surgery for sinuses has evolved with the advancement of instruments and modification in techniques. Endoscopes have expanded the surgical roles for lesions in the nose and para-nasal sinuses with reduced rate of complications and cosmetic side effects. Nevertheless sinus surgery in pediatric patients has its own challenges. Pre-operative imaging is of paramount importance especially when embarking on skull base procedures. The differences between adult and pediatric anatomy need to be further studied.

Keywords

endoscopic sinus surgery, ethmoid sinus, adult, pediatric, microdebrider, lateral lamella cribriform plate height

Endoscopic sinus surgery (ESS) is a common operation, which is particularly indicated in the treatment of conditions such as nasal polyposis, mucocoele, sellar tumors, parasellar tumors, optic nerve decompression, and chronic rhinosinusitis. During the surgery, the endoscope and the microdebrider need to stay low to avoid breaching the skull base, especially the lateral lamella cribriform plate (LLCP), which is the thinnest bone and most susceptible part of the skull base.^{1–3}

Prior to further procedural advancement, intraoperative identification of the sphenoid face is needed to localize the skull base. Before reaching the sphenoid sinus via the nasal cavity, the endoscope needs to pass through the ethmoid sinus, which is just anterior to it. In a patient with high LLCP height, the olfactory fossa will be narrower and deeper; the ethmoid roof will be lower and hanging. A low ethmoid roof will increase the risk of iatrogenic injury to the LLCP.³ Complications can occur ranging from bleeding and infection to cerebrospinal fluid leak and intracranial injury.^{4,5} A study by Dessi et al. reviewed the complications in 1192 ESS procedure and found that ethmoidectomy was the most hazardous procedure.⁶

There are significant differences between pediatric and adult sinus anatomy, and to safely perform ESS in children, surgeons must appreciate and aware of these differences. The best method to understand the differences is through imaging. Barghouth et al. in 2012 studied the size evaluation of maxillary, sphenoid, and frontal sinuses by magnetic resonance imaging (MRI) and proposal of volume index percentile curves. They found that in 179 MRI of children under 17 years of age, maxillary sinuses measured at birth (mean \pm standard deviation) 7.3 \pm 2.7 mm length (or antero-posterior)/4.0 \pm 0.9 mm height (or cranio-caudal)/2.7 \pm 0.8 mm width (or transverse). While at 16 years

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old, the maxillary sinus measured 38.8 ± 3.5 mm/ 36.3 ± 6.2 mm/ 27.5 ± 4.2 mm. Sphenoid sinus pneumatization starts in the third year of life after conversion from red to fatty marrow with mean values of 5.8 ± 1.4 mm/ 8.0 ± 2.3 mm/ 5.8 ± 1.0 mm. Pneumatization progresses gradually to reach at 16 years 23.0 ± 4.5 mm/ 22.6 ± 5.8 mm/ 12.8 ± 3.1 mm. The frontal sinus is not aerated before the age of 6 years. Frontal sinuses dimensions at 16 years were 12.8 ± 5.0 mm/ 21.9 ± 8.4 mm/ 24.5 ± 13.3 mm.⁷

The likely area of risk for injury will be the LLCP and Gera classifications identifies this particular area in the form of angulation to the horizontal aspect of LLCP. Class 1 angle $>80^\circ$ is low risk, class 2 angle 45° to 80° is medium risk, and class 3 angle $<45^\circ$ is high risk.⁸

With all the precautions in place and the understanding of the differences in the anatomy between adult and pediatric, ESS can be a relatively a safe procedure. According to Elsisi, ESS is a safe and effective procedure in children, provided a proper preoperative selection of patients made mandatory. He suggested a limited surgical intervention which emphasize on the control of the disease and preservation of the nasal mucosa. A second-look operation may be needed in some cases as well as continuous follow-up is essential for the success of the procedure.⁹

Fovea ethmoidalis forms the roof of the ethmoid sinus. It is an extension of the orbital plate of frontal bone, which separates the ethmoid sinus from the anterior cranial fossa. Inferomedially, the fovea ethmoidalis attaches to the LLCP, which is part of the ethmoid bone. The olfactory fossa is a shallow depression of the cribriform plate. It is bordered medially by the perpendicular plate, the LLCP laterally, and the floor is formed by the medial lamella of the cribriform plate. It contains the olfactory nerve and artery.

The depth of olfactory fossa is classified into 3 types, which was then called the Keros classification. Keros 1 refers to the olfactory fossa depth of 1 to 3 mm, in which the lateral lamella is short, and the ethmoid roof is almost in the same plane as the cribriform plate. In Keros 2, the olfactory fossa depth measures from 4 to 7 mm, and the lateral lamella is longer. In Keros 3, the olfactory fossa depth is 8 to 16 mm, and the ethmoid roof is significantly above the cribriform plate.¹⁰ However, measurements between 3 mm and 4 mm as well as between 7 mm and 8 mm were not described in Keros classification. Shama and Montaser described measurements between 0 and less than 4 mm as Type 1 Keros. Measurements more than 4 mm and less than 8 mm were considered Type 2 Keros and 8 mm or more as Type 3 Keros. The higher the LLCP height, the narrower and deeper the olfactory fossa will be. In addition, the ethmoid roof will be more low lying. In this

position, the risk of iatrogenic injury to the LLCP will increase.³

Current available multidetector computed tomography software is capable of submillimeter measurement. This allows detailed evaluation of the LLCP height and characterization of the paranasal sinuses anatomy. Understanding of the complex anatomical relationship of the ethmoid roof is crucial to avoid complications during ESS.

The current practice applies Keros classification in the pediatric age-group in preoperative assessment. Pediatric age-group refers to the period ranging from newborn to adolescent. Adolescence begins with the onset of physiologically normal puberty and ends when an adult identity and behavior are accepted. This period of development corresponds to the period between the ages of 10 and 19 years, which is consistent with the World Health Organization's definition of adolescence.¹¹ Ethmoid air cells during development tend to expand to occupy all available space.¹² The osseous barrier will distort, but the lamella remains intact.¹² Ethmoid air cells continue to grow until late puberty or until they reach compact bone.¹³

Although the ethmoid air cells are present at birth and tend to expand with subsequent aeration, until a new study is done, there is no established study to show the difference in LLCP height between adult and pediatric.

Declaration of Conflicting Interests

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Ethical Approval

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Statement of Human and Animal Rights

This article does not contain any studies with human or animal subjects.

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