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Cribriform plate width is highly variable within and between subjects

Daniel H. Coelho [a,b,*], Taylor S. Pence [b], Mostafa Abdel-Hamid [b], Richard M. Costanzo [a,b]

[a] Department of Otolaryngology – Head & Neck Surgery, Virginia Commonwealth University School of Medicine, Richmond, VA, United States
[b] Department of Physiology and Biophysics, Virginia Commonwealth University School of Medicine, Richmond, VA, United States

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ABSTRACT

Objective: All successful endonasal surgery, including functional endoscopic sinus surgery (FESS), depends on knowledge of both anatomy and the specific variations that can occur between and within patients. Familiarity with these structures is a critical component in preventing complications from these procedures, and failure to understand subtle variation can have disastrous results. The aim of this study was to characterize the anatomical variations (if any) of the cribriform plate using a large cadaveric sample set. Better understanding of the disparities within and between patients may have important implications for surgical planning.
Methods: Whole human skull specimens (31 specimens, 62 sides) were examined to obtain dimensional measurements of the cribriform plate on the right and left sides.
Results: The average length of the cribriform plate was 21.28 mm (range 15.25–27.73 mm, SD 3.30 mm). The average width of the cribriform plate (including the crista galli) was 4.53 mm (range 1.75–8.03 mm, SD 1.20 mm). When comparing side differences in individual specimens, there was more variability between widths, relative standard deviation 26.4%, than between lengths, relative standard deviation 15.5%.
Conclusion: There is a range of both length and width of the cribriform plate, between and within individuals. This is particularly true for width. In practice, this emphasizes the importance of pre-operative imaging and recognition of anatomic variability for sinus or anterior skull base procedure.

1. Introduction

All successful endonasal surgery, including functional endoscopic sinus surgery (FESS), depends on knowledge of both anatomy and the specific variations that can occur between and within patients. Familiarity with these structures is a critical component in preventing complications from these procedures, and failure to understand subtle variation can have disastrous results. One such complication is the inadvertent violation of the anterior skull base dura. The cribriform plate is the thinnest and lowest part of the anterior skull base and most susceptible to violation, leading to potential cerebrospinal fluid (CSF) leak, frontal lobe injury, meningitis, and olfactory impairment [1–3].

Despite the importance of this anatomic danger zone, few studies have systematically investigated this area and none

* Corresponding author at: Otolaryngology – Head & Neck Surgery, Virginia Commonwealth University School of Medicine, P.O. Box 980146, Richmond, VA 23298-0146, United States.
E-mail address: daniel.coelho@vcuhealth.org (D.H. Coelho).

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published within the rhinologic surgery literature with clinician readership. The earliest anatomic studies on cribriform anatomy were performed in gross skull specimens, long prior to the modern age of rhinologic surgery [4]. More recent analysis has utilized computed tomography (CT) to study the skull base anatomy, though issues with resolution of both direct and reconstructed images of the cribriform plate have limited the utility of this technology.

The aim of this study was to characterize the anatomical variations (if any) of the cribriform plate using a large cadaveric sample set. Better understanding of the disparities within and between patients may have important implications for surgical planning.

2. Materials and methods

Whole human skulls were obtained from the skull collection of the VCU School of Medicine's Anatomy Lab. The skull caps were removed and the floor of the anterior cranial fossa was visually inspected for gross injuries or abnormalities. Any anterior skull base with damage that would affect measurements was excluded from analysis. Each sample was then placed on the anatomy bench in ample natural light with the intracranial floor of the anterior cranial fossa exposed (Fig. 1). A strip of 1 mm graph paper was placed just posterior to the cribriform plate, to serve as a calibration scale. Digital photographs were taken of the whole skull and then a series of images were taken in an arc perpendicular to the anterior–posterior axis of the cribriform plate. This method was used to capture continuous images in a medial to lateral fashion. Images were reviewed at the time of capture to assure they were of adequate quality. All images were taken with the same Nikon D60 (Nikon, Tokyo, Japan) digital single lens reflex camera. All images for a specific skull were taken prior to moving to the next specimen.

A single image was selected from the series that best represented both sides of the cribriform plate and allowed for the desired measurements to be obtained. Images were uploaded into ImageJ 1.X (National Institutes of Health, Bethesda, MD) for analysis [5]. Prior to taking measurements, the ImageJ measurement tool was calibrated to the 1 mm square piece of graph paper in the image. Measurements were taken as outlined in Fig. 2. The length of each side of the cribriform plate was measured from the most anterior portion of the cribriform recess to the most posterior portion. Width measurements were all taken at midpoint of the length. Each side of the cribriform plate was measured from the lateral edge at the apex of the lateral lamella to its medial side at the crista galli. The width of the crista galli was also recorded at the midpoint of the anterior/

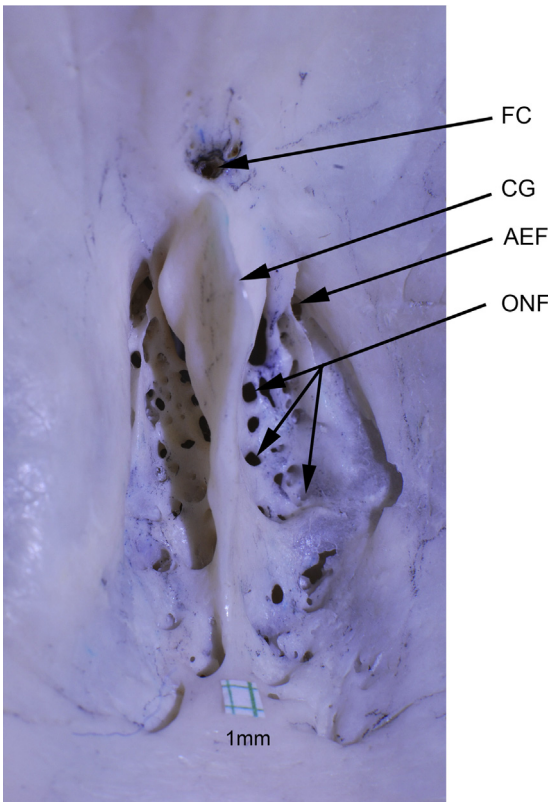

Fig. 1. Anatomy of the anterior skull base.
FC = foramen cecum.
CG = crista galli.
AEF = anterior ethmoid foramen.
ONF = olfactory nerve foramina.

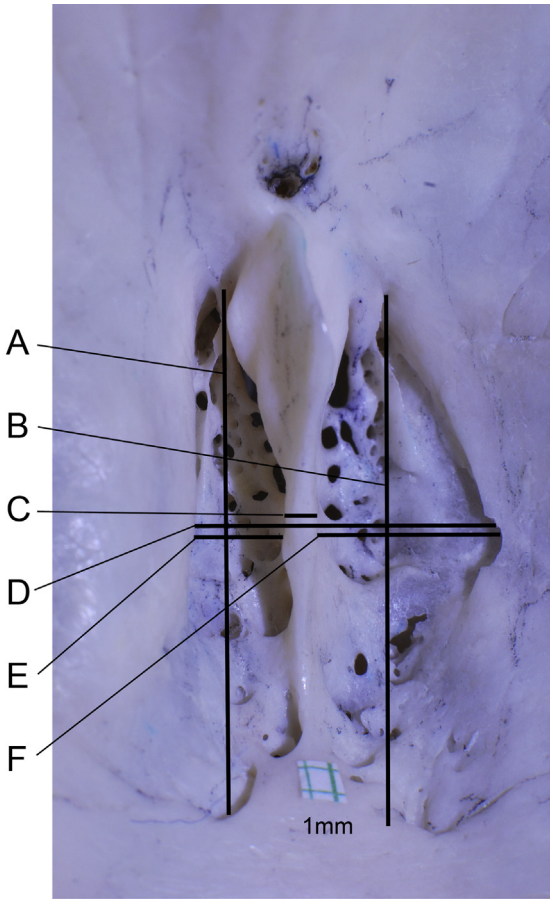

Fig. 2. Measurements recorded from the cribriform area.
A = cribriform plate length, left.
B = cribriform plate length, right.
C = crista galli width.
D = total width (C + E + F).
E = cribriform plate width, left.
F = cribriform plate width, right.

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