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Original Article

Morphology of the olfactory fossa – A new look

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ABSTRACT

Introduction: The olfactory fossa is a depression in the anterior cranial cavity whose floor is the cribriform plate of the ethmoid bone. This delicate bony plate separates the anterior cranial fossa from the nasal cavity.

Methods: We studied the morphology of the olfactory fossa in 32 dry skulls, derived from North India, of undetermined sex, using a hydroxyphilicsiloxane based gel. Molds of the olfactory fossa and adjacent cranial fossa were made and measurements of length, width, depth and angle of embankment (angle between the lateral wall of the olfactory fossa and the medial part of the anterior cranial fossa) were done on them and their coronal sections.

Results: The average length of the olfactory fossa was 2.11 cm. The average width was 0.39 cm and the mean angle of embankment was 130.5°. According to the measured depth, the incidence of Keros' type I (1–3mm) was 23.44%, type II (4–7mm) – 70.83% and type III (8–16mm) – 5.73%. Type III was more frequent on the left side. The fossa in north India is deeper in the middle than its anterior and posterior ends. It had a narrow anterior and broad posterior end (54.69%). There were no overall significant differences between the right and left side for the various morphometric parameters.

Discussion: This study provides baseline morphometric data of the olfactory fossa in the North Indian population and this knowledge may help the radiologists to analyze scans of this region and minimize complications associated with surgeries in this delicate area.

1. Introduction

Functional endoscopic sinus surgery (FESS) has become a common modality of treatment for disorders of the nose and paranasal sinuses. Prior knowledge of the anatomy of the paranasal sinuses, anterior skull base and olfactory zone is necessary for good results.[1,2]

The ethmoid is a complex and delicate bone that lies in the midline of the facial skeleton. It is the key bone in FESS.[3] It consists of a midline perpendicular plate and crista galli and two lateral labyrinths of air cells connected to each other

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superiorly by the cribriform plate. The labyrinths are covered laterally by the lamina papyracea in the medial wall of the orbit. The roof of the ethmoid labyrinth is formed medially by the cribriform plate and the lateral lamina and laterally by the portion of the frontal bone that covers and closes the ethmoid cells superiorly – the fovea ethmoidalis.[4–7] The levels of the ethmoid roof and cribriform plate can vary even in the same person; depending on the vertical extent of the lateral lamina. The olfactory fossa (OF) is the thinnest and an extremely variable part of the anterior skull base. After the analysis of 450 cadaveric skulls Keros noted three main forms of the OF, depending on the level of the ethmoid roof. Keros type I characterizes the depth of the OF to be 1–3 mm; type II – 4–7 mm and type III – 8–16 mm. Keros type III is called 'dangerous ethmoid' due to the high incidence of complications associated with its presence during surgeries in this region.[8–10] In Keros' III, the OF is deeper and the bone is thin. Keros' classification provides an objective assessment of anterior skull base anatomy and can therefore guide the surgeon to the superior bony extent of the medial orbital wall during orbital decompression.[11] Keros also has described the width of the ethmoid labyrinth and OF at different points. He noted that there is a gradual enlargement of its width posteriorly.[9]

Preoperative imaging helps in identifying the marginal thickness of the cribriform plate, various anatomical variants of the OF and the variable width of the cribriform plate in the anterior and posterior third. Imaging modalities like Computerised Tomographic (CT) scans and Digital Volume Tomography (DVT) can evaluate the bony configuration of the OF. Good attention to the anatomy of this region would help in preventing serious consequences such as CSF rhinorrhoea, meningitis, anosmia and brain abscesses.[9] It has been shown that 30.1% of CSF leaks are due to iatrogenic causes.[12]

To the best of our knowledge, there are no anatomic studies of the OF in the North Indian population. Therefore, we planned this project to study the morphology of the olfactory fossa in dry skulls using a hydroxyphilic siloxane gel that can set and reproduce the form of the area without any distortion.[13]

We hope that this study would help the Indian endoscopic surgeon and the radiologist by providing the baseline morphometric information regarding the OF. This would also be a method to replicate in studies that need to assess the volumes of regions that are difficult to access anatomically, without distortions and without damaging the anatomical specimens that are in short supply today, especially because research in surgical anatomy is becoming more and more important.

2. Materials and methods

The study was conducted on thirty-two dry skull bases of undetermined sex and age after obtaining clearance from the Institutional Protocol and Human Ethics Committee of Maulana Azad Medical College, New Delhi, India[#].

Initially, the skulls were studied for the general shape and form of the OF and checked for any osteological deformities. Thereafter, we used a hydroxyphilic siloxane based gel (Aquasil LV – Dentsply, U.S.A.)[†] to make molds of the OF and the adjoining parts of the anterior cranial fossa. This material has been reliably used by dentists to create impressions and molds.[13–15]

The product consists of two gels – the base and a catalyst – attached to a double-barrel injection gun that has a mixing nozzle. The gun operates in such a way that the catalyst and the base are mixed in equal quantity within the nozzle. The mixture was injected into the OF (Figs. 1 and 2), starting from the floor and ending by covering most of the crista galli and the medial part of the anterior cranial fossa. It was allowed to set for ten minutes and the casts were removed by pulling on its edges because the set product was flexible, non-adherent and retained the shape of the structure in which it was set. The various dimensions of the OF were measured on the casts as shown in Fig. 3.

First of all, we measured the length of the fossa at the base of the mold by using Vernier callipers. We then sectioned the casts into nine equal parts depending on their individual length. Therefore, there were three sections each for the anterior, middle and posterior parts. Further measurements were made on the anterior surfaces of the sections (Fig. 3). We measured the maximum width and height of the olfactory fossa using Vernier callipers on the anterior surface of the sections of the molds. The measurements were taken for each section, hence, we had three measurements of height and width for the anterior, middle and posterior thirds of the molds. The arrows indicating the dimensions measured on the mold have been shown in Fig. 3. We also traced the sections on a piece of paper, extrapolated the vertical and horizontal limbs of the lateral edges and measured the angle between them using a protractor. This represented the angle of embankment between the lateral wall of the OF and the medial part of the anterior cranial fossa.

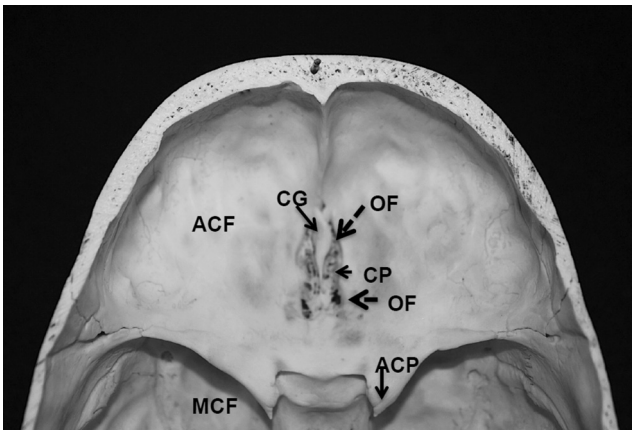

Fig. 1 – Photograph of the anterior part of the cranial cavity showing the anterior cranial fossa (ACF) and the middle cranial fossa (MCF). In the midline is the crista galli (CG) flanked by the cribriform plate of the ethmoid (CP). One can observe that the anterior end of the olfactory fossa (OF) is narrow (arrow with broken line) and its posterior end is wide.

[†] Aquasil LV was provided free of cost by Dentsply, India for this work.

[#] The dry skulls were from the bone collection at the Department of Anatomy, Maulana Azad Medical College, New Delhi, India.

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