ORIGINAL RESEARCH

Examining foramen ovale in dried human skulls using a morphometric approach and its clinical implications

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ABSTRACT

Background: The foramen ovale is an oval shaped opening, placed obliquely in the base of the skull. It is situated in the greater wing of sphenoid bone, close to the upper end of posterior margin of lateral pterygoid plate, medial to foramen spinosum and lateral to the foramen lacerum.

- It connects the middle cranial fossa to the infratemporal fossa and transmits the mandibular branch of trigeminal nerve, accessory meningeal artery, lesser petrosal nerve and emissary vein.
- Foramen ovale assumes reasonable surgical and anatomical significance due to its location at the base of the skull. The knowledge of morphological and morphometric details and variations in foramen ovale is fundamentally essential for any surgical intervention.

Aims and Objectives:

1. To assess the dimensions of foramen ovale in dried human skulls.
- To look for any variations in location which have significance in surgeries pertaining to base of skull.
2. To assess the variations in foramen ovale in dried human skulls

Methodology:-The study was done in the Department of Anatomy GMC Srinagar. A total of 100 FO (50 right& 50 left) of 50 adult dry human skull were evaluated. The dry human skulls of undetermined age and gender were subjected to the morphometric study. **Results:** In our study with regards to variation in the shape of the foramen, the oval shape was the commonest (66%), followed by round shape (17%).On the left side, the maximum value between the anterior point of FO and PPF was 2.6cm and the minimum value was 1.3cm with a mean of 1.69cm and SD0.141.The right side maximum value of FO and PPF was 2.0cm and the minimum was 1.1cm, with a mean of 1.44cm and SD of 0.21.The maximum value between the anterior point of FO and IOF was 3.6cm on the right side, the minimum value of FO and IOF was 3.8cm with mean of 2.8cm and SD 0.28.On the left side, and the minimum value was 2.6cm and maximum 3.8cm with a mean 3.0cm and standard deviation 00.56. **Conclusion:** The favourable outcome of any surgical intervention is mainly hinged on the practitioners' and surgeons' knowledge of the landmarks of the FO and gaining the right orientation in the skull base.We assessed the range and variation in different morphometric measurements of the FO.

Keywords: Variations, Foramen ovale, greater wing of sphenoid, mandibular nerve, trigeminal neuralgia

INTRODUCTION

Foramen Ovale (FO) allows many vital structures to traverse through its aperture. These structures include the mandibular nerve(V3) of the fifth cranial nerve (trigeminal nerve-V), the accessory (meningeal) artery, and occasionally the lesserpetrosal nerve branch of the glossopharyngeal nerve also comes through it.[1,2] Furthermore, it assumes reasonable surgical and anatomical significance due to its location at the base of the skull. [3] Any abnormal osseous protrusions arising from its margins may compress the mandibular nerve which inhabits the bulk of the space of the foramen, and essentially provoke paraesthesia or neuralgia if it compresses the sensory branches of the nerve. The close proximities of foramen ovale with other osseous structures such as mastoid process (MP), zygomatic arch, pterygopalatine fossa (PPF), and inferior orbital fissure (IOF) are essential for any surgical intervention. Therefore, any treatment and diagnostic

intervention for trigeminal neuralgia is also at risk for the damage to internal carotid artery, which enters the carotid canal.[4] Especially during a percutaneous rhizotomy procedure for the treatment of trigeminal neuralgia (trigeminal rhizotomy), the importance of FO and adjacent structures becomes even more obvious.

Furthermore, many studies have shown that the foramen ovale on the right side is narrower than the left, which could be the possible reason for a higher trigeminal neuralgia on the right side.[5] Therefore, anatomical knowledge of foramen ovale is not only important for several neurosurgical and diagnostic procedures related to the middle cranial fossa, but it also helps to access the trigeminal nerve when administering anesthesia to the mandibular nerve and enables percutaneous biopsy of cavernous sinus tumors, CT guided trans-facial FNAC techniques for the diagnosis of meningiomas, squamous cell carcinoma &Meckel cave lesions. So, appropriate anatomical knowledge of foramen ovale is important across the spectrum of specialties of the doctors. In this context, we intended tostudythe morphological and morphometric details and variations in foramen ovale in dried human skulls at GMC Srinagar.

AIMS AND OBJECTIVES

1. To assess the dimensions of foramen ovale in dried human skulls.
- To look for any variations in location which have significance in surgeries pertaining to base of skull.

METHODOLOGY

The study was done in the Department of Anatomy GMC Srinagar. A total of 100 FO (50 right& 50 left) of 50 adult dry human skull were evaluated. The dry human skulls of undetermined age and gender were subjected to the morphometric study. STUDY DESIGN: Cross sectional observational study STUDY PERIOD: July 2023 - September 2023 The greater wing of the sphenoid bone was examined for the presence of FO. The parameters studied were: i. Shape of the foramen. ii. Length of the foramen (maximum anteroposterior diameter). iii. Width of the foramen (maximum transverse diameter). iv. The transverse distance between the posterior edge of FO and articular tubercle (AT). v. The vertical distance between the anterior edge of FO and IOF. vi. The transverse distance between the anterior edge of FO and PPF. The above mentioned parameters were measured by vernier calliper and then the measurements were taken. Photographs were taken. The broken or crushed skulls in the area of the greater wing of the sphenoid bone or having occluded foramen were excluded from the study.

RESULTS

This study was carried out on100 foramen ovale from 50 dry adult human skulls. Various shapes of the foramen were observed and descriptive analysis was done.

Table:-1 Skull shape characteristics

Shapes	Right side(=n & %)	Left side (=n & %)
Oval	32 (64%)	33(66%)
Round	17(34%)	14(28%)
Almond	1(0.02%)	3(0.06%)

Table:-2 Variations in morphometric size measurements of foramen ovale (FO) to articular tubercle(AT) on right side.

[FO to AT] size in centimeters(cm)	Frequency(=n)	Mean	Standard deviation (SD)
2.6	3	2.35	0.07
2.8	1		
3.0	14		
3.1	5		
3.2	11		
3.3	4		
3.4	5		
3.5	5		
3.6	1		
3.7	1		

Table:- 2 Variations in morphometric size measurements of foramen ovale (FO) to articulartubercle(AT) on left side.

[FO to AT] size in centimeters(cm)	Frequency (=n)	Mean	Standard deviation(SD)
2.6	3	2.65	0.070
2.9	3		
3.0	5		

3.1	8		
3.2	9		
3.3	10		
3.4	6		
3.5	5		
3.8	1		

Table:-3 Measurements of Foramen ovale(FO) to Pterygo-platine fossa (PPF)right side and left side.

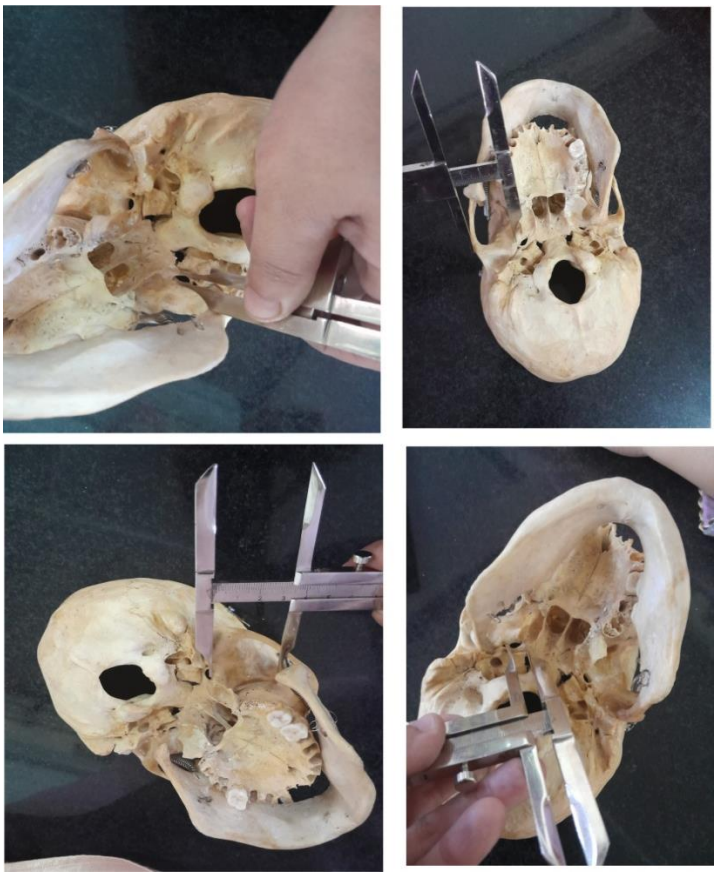
Range FO to PPF(right side)	Frequency (=n)	Mean	SD
1.0 to 1.5cm	21	1.69	0.141
1.6 to 2.0cm	29		
Range FO to PPF (left side)			
1.0 to 1.5cm	21	1.44	0.21
1.6 to 2.0cm	27		
2.1 to 2.6cm	2		

On the left side, the maximum value between the anterior point of FO and PPF was 2.6cm and the minimum value was 1.3cm with a mean of 1.69cm and SD0.141.The right side maximum value of FO and PPF was 2.0cm and the minimum was 1.1cm, with a mean of 1.44cm and SD 0.21.

Table:-4, Measurements of foramen ovale(FO) to inferior orbital fissure (IOF) on the right side and left side.

Range FO to IOF right side	Frequency (=n)	Mean	SD
2.5 to 3.0cm	10	2.8	0.28
3.1. to 3.6cm	40		
Range FO to IOF left side			
2.5 to 3.0cm	8	3.0	00.56
3.1 to 3.8cm	42		

Thevalue between the anterior point of FO and IOF was 3.6cm on the right side, the minimum value of FO and IOF was 3.8cm with mean of 2.8cm and SD 0.28.On the left side, and the minimum value was 2.6cm and maximum 3.8cm with mean 3.0cm and standard deviation 00.56



DISCUSSION

The analysis of morphometric measurements of foramen ovale and relations would help to decrease patient morbidity & in turn will drastically help in decreasing health burden and DALY(disability-adjusted life years). Moreover, it will help in performing complication-free surgical interventions thus reducing the treatment costs significantly. In our study with regards to variation in the shape of the foramen, the oval shape was the commonest(66%), followed by round shape(17%). Similar findings have been reported by other researchers in their studies. Our findings were consistent with those of Patel & Mehta whoreportedoval-shaped foramen in 69.5% % round in 27.5% & almond shaped in 12% foramina.[6]
In view of the interventional need for the management of refractory trigeminal neuralgias proximity issue of FO to IOF was takenintoconsideration and the vertical distance between the anterior point of FO and IOF and the transverse distance between the anterior point of FO and PPF were measured and recorded. While the maximum value between the anterior point of FO and IOF was 3.6cm on the right side, the minimum value of FO and IOF was 3.8cmon the left side, and the minimum value was 2.6cm. Furthermore, on the left side, the maximum value between the anterior point of FO and PPF was 2.6cm and the minimum value was 1.3cm. On the right side maximum value of FO and PPF was 2.0cm and the minimum was 1.1cm. In our study, the distance between the anterior point of FO and articular tuberde(AT) was a maximum of 3.7 cm and a minimum of 2.6cm,while on the left side maximum of 3.8cm and a minimum of 2.6cm.The findings in our study are in consonance with other studies as well.Therefore, having information regarding the range and variation of these measurements is fundamentally important for the execution of any surgical intervention.Nevertheless, it should be kept in mind that these parameters are not similar in all populations, as the morphology of the FO varies frequently in the Asian, African, and European populations. [9,10]

CONCLUSION

In this study,wemeasured various parameters of FO which can be used as anatomical guidelines during the treatment of trigeminal neuralgia or diagnostic detection of variable osseous structures. We assessed the range and variation in different morphometric measurements of the FO. Therefore, knowledge of these findings can help in reducing the complications.Thefavourable outcome of any surgical intervention is mainly hinged on the practitioners' and surgeons' knowledge of the landmarks of the FO and gaining the right orientation in the skull base.

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