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Original Research Article

A Cadaveric Investigation to Delineate Anatomical Differentiations within the Foramen Ovale

Satyajit Bhanu

Assistant Professor, Department of Anatomy, Shree Narayan Medical Institute and Hospital, Saharsa, Bihar, India

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Corresponding Author: Dr. Satyajit Bhanu
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Abstract

Aim: The aim of the present study was to define anatomical variations in foramen ovale.

Method: The study was carried out on 50 foramen ovale using 250 dry adult human skull bones of unknown sex and the bones were taken from the Department of Anatomy. Skulls which were fractured at the surrounding of foramen ovale were not included in the study.

Results: Out of 50 foramen ovale, left side anteroposterior diameter was 3.1–8.0 mm and right side was 3.4–8.4 mm. The average left anteroposterior diameter was 5.6 ±1.412 mm, whereas the right side was 5.5 ±1.375 mm. Left side minimum transverse diameter was 2.3 mm, right side 2.8 mm. Left and right sides had maximum transverse diameters of 6.5 and 5.6 mm. Most of the foramen were oval, with 27 sides (left 12, right 15), almond, round, and slit-like. These foramen ovale morphologies were oval 54%, almond 26%, round 16%, and slit-like 4%. Three bony spines, two bony plates, and one osseous lamina were found in 50 foramina.

Conclusion: Medical practitioners find the morphometric and morphological architecture of the foramen ovale to be highly valuable when dealing with cases of trigeminal neuralgia, tumor identification, bone outgrowths resulting in necrosis, and ischemia. The Foramne ovale is a significant foramen located at the base of the skull.

Keywords: Foramen Ovale, Middle Cranial Fossa, Mandibular Nerve, Trigeminal Neuralgia.

Introduction

In the infratemporal surface of the larger wing of the sphenoid, the foramen ovale is located. This foramen plays a crucial role in transmitting the mandibular division of the trigeminal nerve, lesser petrosal nerve, emissary veins, and accessory meningeal arteries. [1] The foramen ovale exhibits variations in shape and morphometry among distinct subgroups within the human population. [2-4] To the best of our knowledge, the Indian population does not possess this morphometric information. Neurosurgeons and pain specialists focus on the mandibular nerve, which passes through the foramen ovale, and the trigeminal ganglion located in Meckel's cave when treating patients with trigeminal neuralgia. The successful execution of trigeminal rhizotomy operations for the treatment of trigeminal neuralgia requires a comprehensive understanding of the foramen ovale.

Similar to other foramina, the foramen ovale exhibits variations in both size and form. The creation of a perfect ring-shaped foramen ovale was first noticed in the 7th month of pregnancy and was not observed until the 3rd year after delivery. It was recognized as a distinct foramen at 22 weeks. The foramen ovale had a length of around 3.85 mm in newborns and 7.2 mm in adults. Additionally, the foramen ovale had a width of approximately 1.81 mm in newborns and 3.7 mm in adults. [5] Previous studies have shown that the foramen ovale can have various variations, such as the venous component being separated from other parts of the foramen by a bony spur located antero-medially, resulting in a double foramen ovale. [6] Alternatively, it can be covered by ossified ligaments that extend between the lateral pterygoid process and the sphenoid spine. Additionally, the foramen ovale can be divided into 2 to 3 components, each associated with irregularities. [7]

The foramen is located on the lateral aspect of the lacerum foramen and the anterior aspect of the Eustachian tube, EoCC, and spinous foramen within the cranium. Furthermore, it is crucial to consider the placement of the FO on the anterior side, as it is in close proximity to both the PPF and the IOF. A comprehensive understanding of the morphometry and morphology of the foramen ovale has significant importance in operations pertaining to Trigeminal neuralgia and the

administration of anesthesia through the mandibular nerve. [8] Percutaneous biopsy of the cavernous sinus can be conducted via the foramen ovale. [8-10]

The primary objective of the current investigation was to delineate anatomical differentiations within the foramen ovale.

Materials and Methods

The study was carried out on 50 foramen ovale using 250 dry adult human skull bones of unknown sex and the bones were taken from the Department of Anatomy, Shree Narayan Medical Institute and Hospital, Saharsa, Bihar, India. Skulls which were fractured at the surrounding of foramen ovale were not included in the study.

a) Maximum transverse diameter, anteroposterior diameters of the foramen were measured with the help of vernier calipers.

b) Any variations in the shape of foramen were noted.

c) Margins of foramen were carefully observed for any bony projections.

d) Duplication of foramen ovale was observed.

Independent sample 't' test was used for statistical analysis.

Results

Table 1: Anteroposterior and transverse diameters of foramen ovale on both sides (Right and Left)

Values	Anteroposterior diameter(mm)		Transverse diameter (mm)	
	Right	Left	Right	Left
Maximum	8.4	8.0	5.6	6.5
Minimum	3.4	3.1	2.8	2.3
Mean	5.5	5.6	3.43	3.52
Standard Deviation	1.375	1.412	0.554	0.812
p-value	0.650		0.855	

Out of 50 foramen ovale, minimum to maximum anteroposterior diameter on left side were 3.1 mm- 8.0 mm and on right side were 3.4 mm-8.4 mm. Average anteroposterior diameter on left side was 5.6 ±1.412 mm and on right side was 5.5±1.375 mm. Minimum transverse diameter on left side was 2.3 mm and on right side was 2.8 mm. Maximum transverse diameter was 6.5 mm and 5.6 mm on left and right sides respectively.

Table 2: Variations in the shape of foramen ovale

Foramen ovaleshapes	Right	Left	Total
Oval	15	12	27
Almond	6	7	13
Round	4	4	8
Slit	1	1	2

Majority of the foramen were oval shaped and it was seen in 27 sides (left 12, right 15), almond shape was seen in 13 sides (7 left, 6 right), round shape was seen in 8 sides (4 left, 4 right), slit like foramen was seen in 2 sides (1 left, 1 right). Incidences of various shapes of the foramen ovale were oval 54%, almond 26%, round 16% and slit like 4%.

Table 3: Incidence of Accessory bony structures in Foramen Ovale

Accessory bony structures	Right Side	Left Side
Spine	2 (4%)	1 (2%)
Bony plate	1 (2%)	1 (2%)
Osseous lamina	0	1 (2%)

Out of 50 foramina, bony spine was observed in 3 followed by 2 bony plate and 1 osseous lamina.

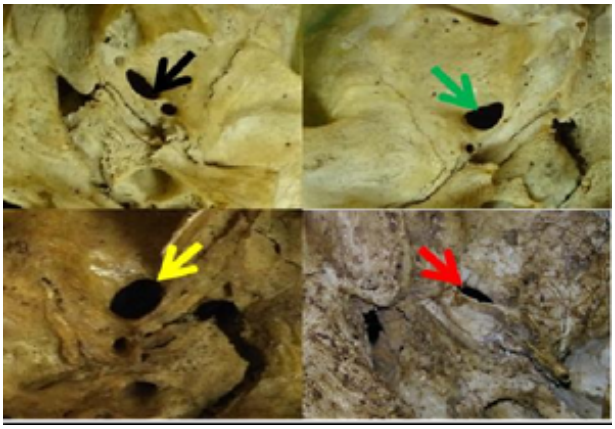

Figure 1: Variations in the shape of foramen ovale: oval shape (black arrow), almond shape (green arrow), round shape (yellow arrow), slit like (red arrow)

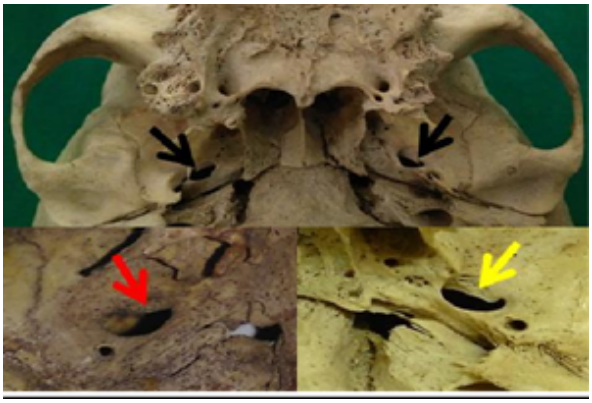

Figure 2: Margins of the foramen ovale exhibiting variable projections: bilateral presence of spine (black arrow), tubercle (red arrow), bony plate (yellow arrow)

Figure 3: Showing duplication of foramen ovale (yellow arrow)

Discussion

There are several foramina piercing the greater wing of the human sphenoid bone and one amongst them is the foramen ovale. Foramen ovale is present medial to the foramen spinosum and foramen lacerum is located medial to the foramen ovale. It transmits the mandibular division of the trigeminal nerve, accessory meningeal branch of the maxillary artery, lesser petrosal nerve and an emissary vein which connects the pterygoid venous plexus in the infratemporal fossa to the cavernous sinus. [1,11] Foramen ovale is situated at the transition zone between the extra cranial and the intracranial structures. [12] Thus, it is one of the important foramina of the skull. Hence, it is used for diagnostic and surgical procedures. The foramen ovale which is present in the posterior part of the greater wing of sphenoid bone is of great diagnostic & surgical importance. It is used for various procedures like microvascular decompression by percutaneous trigeminal rhizotomy for trigeminal neuralgia, and permits

biopsy of deep seated lesions which would otherwise require a craniotomy or a biopsy through open surgical procedure. [13] This would help to decrease patient morbidity & also reduce the cost significantly.

Out of 50 foramen ovale, minimum to maximum anteroposterior diameter on left side were 3.1 mm-8.0 mm and on right side were 3.4 mm-8.4 mm. Average anteroposterior diameter on left side was 5.6 ±1.412 mm and on right side was 5.5±1.375 mm. Minimum transverse diameter on left side was 2.3 mm and on right side was 2.8 mm. Maximum transverse diameter was 6.5 mm and 5.6 mm on left and right sides respectively. The study of Gupta N was similar with the results of our study which was conducted on 35 dry adult skulls. Their study revealed that the mean length of foramen ovale was 7.228±1.39mm on right side and 6.48±1.131mm on left side. On left side, mean width was 3.50±0.75mm and on right side was 3.57±0.70mm. The difference between the mean values of the length and width of the right and left foramen ovale [14] was not that significant. Osunwoke E.A. study revealed that the mean of the lengths of the right and left foramen ovale was 7.01mm and 6.89mm with the range; 5.0-9.5mm and 5.0-9.0mm, on right and left sides respectively. The mean value for the widths of the right and left foramen ovale was 3.37mm and 3.33mm with range of 2.0-5mm on both sides. Significant difference between the mean of the length and width of the right and left foramen ovale [15] was not observed.

Majority of the foramen were oval shaped and it was seen in 27 sides (left 12, right 15), almond shape was seen in 13 sides (7 left, 6 right), round shape was seen in 8 sides (4 left, 4 right), slit like foramen was seen in 2 sides (1 left, 1 right). Incidences of various shapes of the foramen ovale were oval 54%, almond 26%, round 16% and slit like 4%. Our results are in agreement with study of Gupta N and Rai AL, which followed in the same sequence of oval shaped 54.2%, almond shaped 35.7%, round shaped 8.5% and slit like 1.4%. [14] In a study conducted by Ray B et al, they observed the presence of a bony spur that divided the foramen ovale in two separate compartments. [13] Reymond et al, in their study found that in 4.5% of the cases the foramen was divided into two or three different compartments. [11] Since the proximity of FO to IOF and PPF poses a risk factor in refractory trigeminal neuralgia treatment. Out of 50 foramina, bony spine was observed in 3 followed by 2 bony plate and 1 osseous lamina. Nader A. et al. reported another application via the PPF as an alternative that might reduce injury to the corneal reflex. [16] Taking this proximity issue into considaration the vertical distance between the anterior point of FO and IOF and the transvarse distance between the anterior point of FO and PPF were measured and recorded.

In various diagnostic and surgical procedures, foramen ovale is used. It is used for electroencephalographic analysis of the seizure for patients undergoing selective amygdalohippocampectomy, [17] percutaneous biopsy of cavernous sinus tumours and micro vascular decompression by percutaneous trigeminal rhizotomy for trigeminal neuralgia. [17,18] Through the foramen ovale the CT-guided transfacial fine needle aspiration technique is performed. It is done to diagnose meningioma, squamous cell carcinoma etc., and biopsy of the lesions which require open surgical biopsy or craniotomy. [19]

Conclusion

Medical practitioners can evaluate foramen ovale morphology to diagnose trigeminal neuralgia, tumors, bone outgrowths that cause necrosis, and ischaemia. Important skull base foramina include the Foramne ovale. Undoubtedly, a single bone or bone point is insufficient as a marker. Physicians and surgeons value orientation waypoints. It clearly improves Foramen ovale access, minimizing mandibular nerve damage risk. The operation's effectiveness depends on the surgeon's awareness of the Foramen ovale markers and skull base alignment. This study's data and imagery can assist surgeons reduce surgical time and problems.

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