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Original Research Article

Observing the Morphology of Foramen Ovale in Dry Adult Human Skull Bones: Morphometric Study

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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 60 foramen ovale using 30 dry adult human skull bones of unknown sex and the bones were taken from the Anatomy Department, Anugrah Narayan Magadh Medical College, Gaya, Bihar, India. Skulls which were fractured at the surrounding of foramen ovale were not included in the study.

Results: Out of 60 foramen ovale, minimum to maximum anteroposterior diameter on left side were 3.2 mm-8.0 mm and on right side were 3.8 mm-8.2 mm. Average anteroposterior diameter on left side was 5.8±1.420 mm and on right side was 5.6±1.385 mm. Minimum transverse diameter on left side was 2.2 mm and on right side was 2.7 mm. Maximum transverse diameter was 6.3 mm and 5.5 mm on left and right sides respectively. Majority of the foramen were oval shaped and it was seen in 24 sides (left 8, right 16), almond shape was seen in 20 sides (12 left, 8 right), round shape was seen in 12 sides (8 left, 4 right), slit like foramen was seen in 4 sides (2 left, 2 right). Out of 60 foramina, bony spine was observed in 10 followed by 5 bony plates and 1 osseous lamina.

Conclusion: Morphometric and morphological anatomy of foramen ovale is very useful for medical practitioners while handling the cases of trigeminal neuralgia, tumour detection, bony outgrowths that leads to necrosis, ischaemia. The Foramen ovale is important foramina of the skull base.

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

Introduction

Foramen ovale (FO) is one of the several foramina present on the base of the skull. [1] It is an oval osseous aperture with its long axis directed anteriorly & laterally. It is present in the greater wing of sphenoid bone, near the superior end of posterior margin of lateral pterygoid plate. [2] It lies posterolateral to the foramen rotundum, anteromedial to the foramen spinosum, & lateral to foramen lacerum. It connects the infratemporal fossa with the middle cranial fossa. [3] It transmits the mandibular division of the trigeminal nerve, the lesser petrosal nerve, the accessory meningeal artery & an emissary vein that connects the cavernous sinus with the pterygoid venous plexus. The otic ganglion lies immediately below the foramen in the infratemporal fossa. [4] As the mandibular nerve occupies most of the space in this foramen, any abnormal osseous protrusions arising from its margins may compress the nerve. It may provoke paraesthesia or neuralgia if it compresses the sensory branches of the nerve whereas compression of the motor component of the nerve may lead to weakness or paresis of the innervated muscles. [5] The sphenoid bone (having a body, a pair of greater wings & a pair of lesser wings) develops by both intra-membranous & endochondral ossification. The body of sphenoid (basisphenoid) develops mainly from presphenoid & post sphenoid centers. It is the post sphenoid center in the body which is associated with the development of the greater wing of sphenoid that lodges foramen ovale. The greater wing is formed by endochondral ossification – the mandibular nerve gets surrounded by cartilage to form this foramen. [6]

Foramen ovale is the most important constant foramen of greater wing of sphenoid in the middle cranial fossa. [7] It opens into infratemporal fossa and gives passage to mandibular nerve, accessory meningeal Artery, lesser petrosal nerve, emissary

veins. It is usually oval in shape but its shape shows variations when compared to rest of the foramina in the skull. It is of great significance to neurosurgeons as transcranial approach to skull base is possible via it in case of trigeminal neuralgia. A careful observation of these foramens will be helpful in diagnosis of the lesions present in the nasopharynx & middle cranial fossa. Neuroma of 5th cranial Nerve can lead to enlargement of the foramen ovale. Moreover, bony outgrowths in the form of spurs, can compress the passing mandibular Nerve & hence forth could lead to dysfunction of the muscles supplied by it. [8]

The foramen is found on the lateral side of the lacerum foramen and anterior side of the Eustachian tube, External opening of carotid canal (EoCC) and spinous foramen of the skull. In addition, the localization of the FO has an important place on the anterior side, due to its proximity with the Pterygopalatine fossa (PPF) and the Inferior orbital fissure (IOF). Knowledge of the foramen ovale (FO) morphometry and morphology is important in procedures involving Trigeminal neuralgia and administration of anaesthesia via mandibular nerve. [9] Through foramen ovale, percutaneous biopsy of cavernous sinus can be performed. [9-11]

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

Materials and Methods

The study was carried out on 60 foramen ovale using 30 dry adult human skull bones of unknown sex and the bones were taken from the Anatomy Department, Anugrah Narayan Magadh Medical College, Gaya, Bihar, India for 12 months. 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 (FO) on both sides (Right and Left)

Values	Anteroposterior diameter(mm)		Transverse diameter(mm)	
	Right	Left	Right	Left
Maximum	8.2	8.0	5.5	6.3
Minimum	3.8	3.2	2.7	2.2
Mean	5.6	5.8	3.45	3.50
Standard Deviation	1.385	1.420	0.565	0.830
p-value	0.635		0.815	

Out of 60 foramen ovale, minimum to maximum anteroposterior diameter on left side were 3.2 mm- 8.0 mm and on right side were 3.8 mm-8.2 mm. Average anteroposterior diameter on left side was 5.8±1.420 mm and on right side was 5.6±1.385 mm. Minimum transverse diameter on left side was 2.2 mm and on right side was 2.7 mm. Maximum transverse diameter was 6.3 mm and 5.5 mm on left and right sides respectively.

Table 2: Variations in the shape of foramen ovale (N=60)

Foramen ovaleshapes	Right	Left	Total
Oval	16	8	24
Almond	8	12	20
Round	4	8	12
Slit	2	2	4

Majority of the foramen were oval shaped and it was seen in 24 sides (left 8, right 16), almond shape was seen in 20 sides (12 left, 8 right), round shape was seen in 12 sides (8 left, 4 right), slit like foramen was seen in 4 sides (2 left, 2 right).

Table 3: Incidence of Accessory bony structures in Foramen Ovale

Accessory bony structures	RIGHT SIDE	LEFT SIDE
Spine	5	5
Bony plate	3	2
Osseous lamina	0	1

Out of 60 foramina, bony spine was observed in 10 followed by 5 bony plates and 1 osseous lamina.

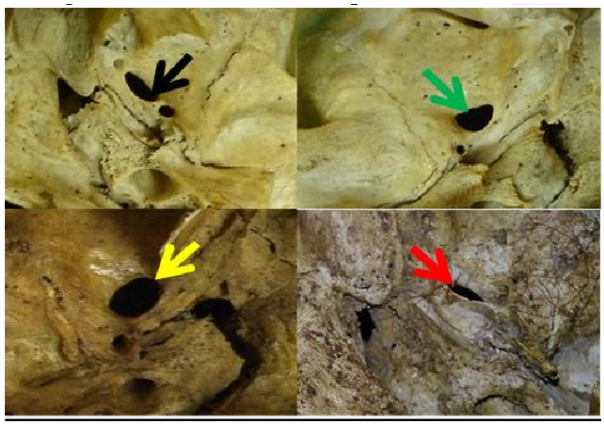

Figure 1: Variations in the shape of foramen ovale: oval shape (black arrow), almond shape (green arrow), round shape (yellow arrow), slit like (red arrow)

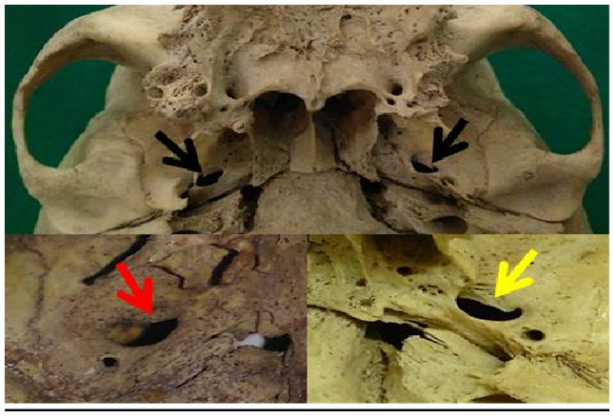

Figure 2: Margins of the foramen ovale exhibiting variable projections: bilateral presence of spine (black arrow), tubercle (red arrow), bony plate (yellow arrow)

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. [2,12] Foramen ovale is situated at the transition zone between the extra cranial and the intracranial structures. [13] 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. [14] This would help to decrease patient morbidity & also reduce the cost significantly.

Out of 60 foramen ovale, minimum to maximum anteroposterior diameter on left side were 3.2 mm-8.0 mm and on right side were 3.8 mm-8.2 mm. Average anteroposterior diameter on left side was 5.8±1.420 mm and on right side was 5.6±1.385 mm. Minimum transverse diameter on left side was 2.2 mm and on right side was 2.7 mm. Maximum transverse diameter was 6.3 mm and 5.5 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 [15] was not that significant. Osun woke 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 [16] was not observed.

Majority of the foramen were oval shaped and it was seen in 24 sides (left 8, right 16), almond shape was seen in 20 sides (12 left, 8 right), round shape was seen in 12 sides (8 left, 4 right), slit like foramen was seen in 4 sides (2 left, 2 right). Incidences of various shapes of the foramen ovale were oval 55%, almond 25%, round 18% and slit like 2%. Out of 60 foramina, bony spine was observed in 10 followed by 5 bony plates and 1 osseous lamina. 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%. [15] 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. [12] Since the proximity of FO to IOF and PPF poses a risk factor in refractory trigeminal neuralgia treatment . Nader A. et al. reported an other application via the PPF as an alternative that might reduce injury to the corneal reflex. [17] Taking this proximity issue into considaration 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.

In various diagnostic and surgical procedures, foramen ovale is used. It is used for electroencephalographic analysis of the seizure for patients undergoing selective amygdalohippocampectomy, [18] percutaneous biopsy of cavernous sinus tumours and micro vascular decompression by percutaneous trigeminal rhizotomy for trigeminal neuralgia. [18,19] Through the foramen ovale the CT-guided trans facial 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. [20]

Conclusion

Morphometric and morphological anatomy of foramen ovale is very useful for medical practitioners while handling the cases of trigeminal neuralgia, tumour detection, bony outgrowths that leads to necrosis, ischaemia. The Foramne ovale is important foramina of the skull base. Undoubtedly, taking a single bone or a point of a bone as a landmark is insufficient. Orientation waypoints are valuable information for physicians and surgeons. It is an incontestable fact that it can help easier access to the Foramen ovale, reducing the risk of mandibular nerve injury. The success rate of the operation mainly relies on the practioners' and surgeons' knowledge of the landmarks of the Foramen ovale and gaining the right orientation in the skull base. The information maintained in this study along with the existing imaging can help surgeons provide a shorter surgery time and avoid complications.

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