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Original Research Article

MORPHOMETRIC AND MORPHOLOGICAL ANALYSIS OF FORAMEN OVALE IN DRY HUMAN SKULLS

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ABSTRACT

Introduction: Foramen ovale is an important foramen in the middle cranial fossa. Foramen ovale is situated in the greater wing of sphenoid bone, posterior to the foramen rotandum. Through the foramen ovale the mandibular nerve, accessory meningeal artery, lesser petrosal nerve, emissary veins pass .The shape of the foramen ovale is usually oval compared to other foramen of the skull.

Materials and Methods: The study was conducted on 55 dry human skulls(110 sides) in Department of Anatomy, Sri Devaraj Urs Medical college, Tamaka, Kolar. Skulls in poor condition or skulls with partially damaged surroundings around the foramen ovale were excluded from the study. Linear measurements were taken on right and left sides of foramen ovale using divider and meter rule.

Results: The maximum length of foramen ovale was 14 mm on the right side and 17 mm on the left, its maximum breadth on the right side was 8mm and 10mm on the left . Through the statistical analysis of morphometric measurements between right and left foramen ovale which was found to be insignificant , the results of both sides marks as the evidence of asymmetry in the morphometry of the foramen ovale.

Conclusions: Regional variations in morphometric and morphological analysis of foramen ovale are useful in neurosurgical procedures like administration of anaesthesia involving the mandibular nerve, treatment of trigeminal neuraglia and in cases dealing with tumours of the cavernous sinus.

KEY WORDS: Foramen Ovale, Sphenoid bone, Trigeminal neuralgia.

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INTRODUCTION

Foramina ovale is one of the important openings on the infratemporal surface of the greater wing of the sphenoid bone. Variations in number, size, symmetry leads to vascular compromise. The region of the foramen ovale is found to be covered by an osseous lamina and continuous with the lateral pterygoid plate and thus forms a wall of an apparent canal, which opens on the lateral side of the pterygoid process[1]. It has has clinical implication in trigeminal neuralgia, diagnosing tumours and abnormal bony growth in this region. Moreover percutaneous biopsy of cavernous sinus is also performed through foramen Ovale [2]. Variations of Foramen Ovale are found to be associated

with vascular and nervous malformations as implicated by clinical symptoms. Knowledge of variations of foramen ovale will help in distinguishing potentially abnormal foramina from normal during computed tomography and magnetic resonance imaging. Moreover percutaneous biopsy of cavernous sinus is also performed through foramen Ovale [1,2].

The structures which pass through the foramen ovale are the mandibular nerve, accessory meningeal artery, lesser petrosal nerve, emissary veins. The shape of the foramen ovale is usually oval compared to other foramen of the skull[3,4]. This is one of the important foramina which is situated in the transition zone between the intracranial and extracranial structures[5].It is situated posterolaterally to the foramen rotandum and anteromedial to the foramen spinosum. The otic ganglion lies under the foramen ovale. The mean length of the foramen ovale is about 3.85 mm in the newborn and about 7.2 mm in adults and its width extends from 1.81 mm in the newborn to 3.7 mm in case of adults.[6,7].Knowledge of topography and variations of the foramen ovale can prevent injury to the trigeminal nerve during surgical approaches.Therefore the study has been undertaken to know the difference in linear measurements of right and left foramen ovale in human skulls of Indian origin.

Aim and objectives: The objectives of the study are; To determine the anteroposterior (length) diameters of right and left foramen ovale, to determine the transverse(breadth) diameters of right and left foramen ovale, to determine the shape of foramen ovale.

MATERIALS AND METHODS

The study was conducted on 55 dry human skulls (110 sides) in Department of Anatomy, Sri Devaraj Urs Medical college, Tamaka, Kolar. Skulls in poor condition or skulls with partially damaged surroundings around the foramen ovale were excluded from the study. Linear measurements were taken on right and left sides of foramen ovale using divider and meter rule. Measurements were taken by placing the divider on the anteroposterior (length) and transverse (width) diameters of right and left foramen ovale and then carefully transferred to a meter rule for the reading to be taken. The measurements were recorded in millimeters. The symmetry of the foramen ovale were also noted. Maximum length and breadth of the foramen ovale and variations were determined and the the variations in shape were also recorded. The data obtained was then statistically analysed.

Fig. 1: Showing oval shaped foramen ovale(black arrow) on left side of the skull.

Fig. 2: Showing almond shaped foramen ovale(black arrow) on right side of the skull.

Fig. 3: Showing irregular shaped foramen ovale (black arrow)on left side of the skull.

Fig. 4: Showing round shaped foramen ovale (black arrow)on right side of the skull.

Fig. 5: Showing bony spines in foramen ovale (black arrow)on right side of the skull.

RESULTS

Among the 55 skulls that were studied the mean length of foramen ovale on right side was 6.59 mm and mean length of foramen ovale on left side was 6.38 mm(Table 1). The mean breadth of foramen ovale on right side was 4.83 mm and mean breadth of foramen ovale on left side was 4.59 mm(Table 2). The maximum length of the foramen ovale on the right side measured 14mm and the maximum length of the foramen ovale on the left side measured 17mm. (Table 3).The maximum breadth of the foramen ovale on the right side was 8mm and on the left side was 10 mm.(Table 4).The percentage of variations in shape of foramen ovale were also determined.(Figure 1-5) Variations in the shape of the foramen ovale showed the maximum number of FOs as oval shaped followed by irregular, then almond shape and round shape (Table 5). In three skulls duplicate Foramen ovale were found and foramen ovale was absent in 1 skull on left side. Bony spurs were seen in 7 skulls while bony spines were observed in 4 skulls.

DISCUSSION

There are some studies which indicates the abnormal morphology of the Foramen ovale, such that it can be occasionally covered by ossified ligaments stretching between the lateral pterygoid process and the sphenoid spine or its venous part may be compartmentalised by a bony spur located antero-medially resulting in doubled Foramen ovale [7]. An atypical position of foramen ovale and neighbouring osseous structures could influence the anatomical organisation of the nerves that run through this opening. Thus the main trunk of the mandibular nerve was redirected more laterally and its divisions (lingual nerve and inferior alveolar nerve) had to cross the extended lateral pterygoid plate. Because of the abnormal course it would be possible for the nerves to become entrapped or compressed between osseous structures and muscles, causing neuralgia[8].The length and width of the foramen ovale were insignificantly higher in males than in females.Unlike the seldom visible laterally narrowed form of the superior orbital fissure, a wide form with or without accessory spine was the most commonly observed. The diameters of both superior orbital fissures and ovale foramina indicated the asymmetry of the neurocranium[9].Various bony outgrowths of the foramen ovale like spines, spurs, tubercles, etc indicate bony overgrowths during its developmental process, between its first appearance and the perfect ring formation [10]. Bilateral atypical foramina ovalia which is divided into medial and lateral compartments by an oblique bony lamina—the pterygoalar bar are also reported [11]. Similar to other foramina in the greater wing of sphenoid bone,the foramen ovale differs in the shape and size throughout the natural life .The earliest perfect ring –shaped foramina was observed in the 7th fetal month and the latest in 3 years after birth.

The foramen ovale can be divided into 2 to 3 components in the borders of of which in some skulls are irregular and rough [12].Also a bony lamina extending from lateral pterygoid plate divides the foramen into two incomplete compartments, a larger medial and smaller lateral compartment .[13]. The meningeal artery enters the cranial cavity through the foramen ovale or may arise from the ophthalmic artery. The venous segment of the Foramen ovale may be separated from its other contents. This results in a doubled FO [14].

Table 1: Length of Foramen Ovale.

	Length of Foramen Ovale	
	Right (mm)	Left (mm)
Average	6.59	6.38
Standard Deviation	2.21	2.52
Standard Error	0.29	0.33

Table 2: Breadth of Foramen Ovale.

	Breadth of Foramen Ovale	
	Right (mm)	Left (mm)
Average	4.83	4.59
Standard Deviation	0.97	0.97
Standard Error	0.13	0.13

Table 3: Frequency of length of Foramen Ovale.

Frequency (mm)	Right	Left
4	1	1
5	1	2
6	11	6
7	13	15
8	19	12
9	4	9
10	3	6
11	1	2
12	0	0
13	1	0
14	1	0
15	0	0
16	0	0
17	0	1

A thorough understanding of fetal growth and development is the key to understanding both the completed normal anatomic structure and the abnormal variations. Most of the central skull base develops from endochondral ossification through an intermediary chondrocranium .The sphenoid bone consists of the body (formed by the presphenoid and postsphenoid centres, with a contribution from the medial crus of the orbitosphenoid).The lesser and greater wings from orbitosphenoids, alisphenoids respectively. Ossification of the skull progresses in an orderly pattern from posterior to anterior. The postsphenoid (14 weeks) and then presphenoids (17 weeks) of the sphenoid bone ossify [15].The puncture advancement of a catheter, more than 10mm from the foramen ovale, is likely to damage the internal carotid artery.In the treatment of trigeminal neuralgia injection is given into the Gusserian ganglion situated just below the Foramen ovale [16].

Table 4: Frequency of breadth of Foramen Ovale.

Frequency (mm)	Right	Left
3	2	3
4	21	19
5	22	26
6	7	3
7	2	2
8	1	0
9	0	0
10	0	1

Table 5: Shapes Of Foramen Ovale.

Shape of foramen Ovale	Right	Left
Oval	38 (69.09%)	35 (63.63%)
Almond	5 (9.09%	9 (16.36%)
Irregular	8 (14.5%)	10 (18.18%)
Round	4 (7.27%)	1 (1.81%)

CONCLUSION

Knowledge of variations of foramen ovale will help in distinguishing potentially abnormal foramina from normal during computed tomography and magnetic resonance imaging.The present study shows variation in diameters and shape of foramen ovale. Morphometric measurements will be useful in neurosurgical procedures like administration of anaesthesia involving the mandibular nerve. Although the morphometric measurements are statistically insignificant on right and left side, there is asymmetry in the morphometry of right and left foramem ovale. Regional variations in morphometric and morphological analysis of foramen ovale are therefore of clinical significance and useful in neurosurgical procedures like administration of

anaesthesia involving the mandibular nerve, treatment of trigeminal neuraglia and in cases dealing with tumours of the cavernous sinus.

Conflicts of Interests: None

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