International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2019): 7.583

Anatomical Variations of Foramen Ovale and Clinical Significance

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Abstract: ***Introduction: The foramen ovale is present in sphenoid bone which transmits the mandibular nerve, accessory meningeal artery, emissary vein and the lesser petrosal nerve. Materials & Methods: This study was conducted on a total 100 sides in 50 dry adult skulls. The shape of foramen will be determined by a visual examination. Margins of foramen were carefully observed for the abnormal bony outgrowths such as sharp bony projections (spine), small blunt bony projection (tubercle), bony plate and bony bar. Results: We observed the variations in shape of foramen ovale. We found oval, almond, round, triangular, slit like and irregular shaped in 62%, 20%, 9%, 4%, 3% and 2% foramina ovale respectively. We also observed abnormal bony outgrowths in the foramen ovale like spines, tubercles, bony plate and bony bar. Abnormal bony bar was dividing the foramen ovale in 2 compartments (Anterior and Posterior). Conclusions: The precise knowledge of variations of foramen ovale is of valuable contribution for neurosurgeons to development of new and different techniques to approach the middle cranial fossa. In our study we found , 100% tubercles and 80% spines were arising from anterior margin of foramen ovale. These findings are important for neurosurgeons to approach middle cranial fossa via foramen ovale for neurosurgical and diagnostic procedures like percutaneous biopsy of cavernous sinus tumours, electroencephalographic analysis, microvascular decompression, percutaneous trigeminal rhizotomy and administration of anaesthesia to the mandibular nerve. Surgeons should avoid going, close to the anterior margin of foramen ovale as spines and tubercles could interrupt the procedures.***

Keywords: Foramen ovale, Variations, Bony outgrowths

1. Introduction

The foramen ovale is present in sphenoid bone which transmits the mandibular nerve, accessory meningeal artery, emissary vein and the lesser petrosal nerve. The common location of foramen ovale is in the infratemporal surface of greater wing of the sphenoid bone posterior to the foramen rotundum, medial to foramen spinosum and lateral to the foramen lacerum. Understanding the accurate location & dimensions of foramina ovalia plays a vital role during certain diagnostic procedures like electroencephalographic analysis, microvascular decompression by percutaneous trigeminal rhizotomy and percutaneous biopsy of cavernous sinus tumours [1, 2]. Prior knowledge of topography and possible variations in the position of the ovale prevent possible injury to the trigeminal nerve during these approaches.

The variations of the foramen ovale involve the presence of bony projections and its shape. These variations may influence the structures passing through the foramen, therefore they have important clinical significance since the mandibular nerve occupies most of the foramen , and compression by the bony outgrowths may lead to paralysis of the innervated muscles[3]. The knowledge of such variations is important for neurosurgeons, radiologists and anatomists because of the refind techniques which are available these days [4].

2. Materials & Methods

A total of 50 adult dried skulls were obtained for the study irrespective of sex from department of anatomy, Maharishi Vashishtha Autonomous State Medical College, Basti and Career Institute of Medical Sciences and Hospital, Lucknow. The skulls with gross pathological deformities were excluded from our study. The shapes of foramina were determined by a visual examination. Margins of foramen were carefully observed for the abnormal bony outgrowths such as sharp bony projections (spine), small blunt bony projection (tubercle), bony plate and bony bar. The photographs were taken and findings were compared with previous studies.

3. Results

This study was conducted on a total 100 sides in 50 dry adult skulls. We observed the shape of the foramen ovale and found oval shaped [figure1] in 62 sides (32 Right, 30 Left), almond shaped (Figure 2) in 20sides (10 Right, 10 Left), round shaped (Figure 3) in 9 sides (4 Right, 5 Left),Triangular shaped (figure4) in 4 sides (2 Right, 2 Left), slit shaped (Figure 5) in 3 sides (1 Right, 2 Left) and irregular shaped (Figure 6) in 2 sides (1 Right,1 Left). We also observed abnormal bony outgrowths in the foramen ovale like spines, tubercles, bony plate and bony bar. Incidence of spine was observed in 5 foramina (4 Right, 1 Left). Out of these, in 4 foramina spine arose from the anterior margin while in 1 foramen from lateral margin of foramen (Figure7). 4 foramen ovale had tubercles (1Right,3

Left) arising from anterior margin of foramen [Figure8]. We observed bony plate [Figure9] and bony bar [Figure10] in 2 foramina (Right) and 1 foramen (Left) respectively. Abnormal bony bar was dividing the foramen ovale in 2 compartments (Anerior and Posterior).

Figure 1: Oval shaped foramen ovale

Figure 2: Almond shaped foramen ovale

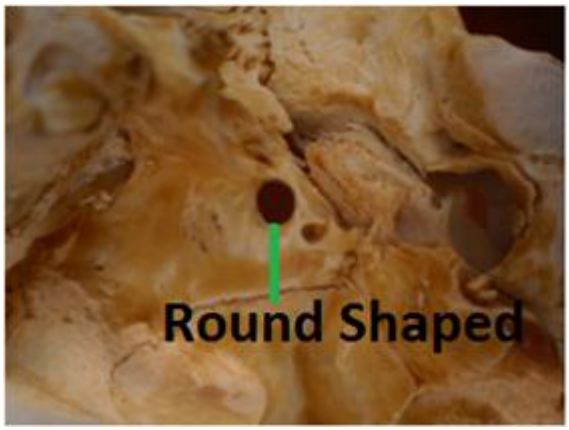

Figure 3: Round shaped foramen ovale

Figure 4: Triangular shaped foramen ovale

Figure 5: Slit like foramen ovale

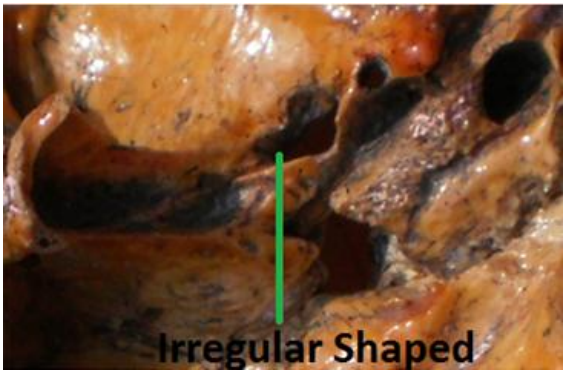

Figure 6: Irregular shaped foramen ovale

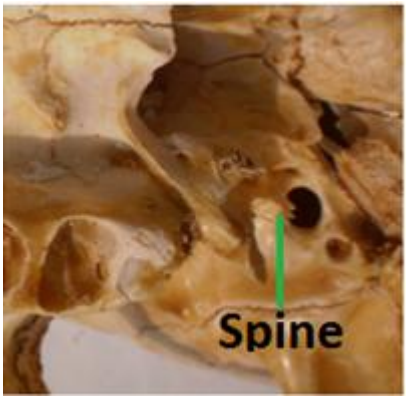

Figure 7: Spine in foramen ovale

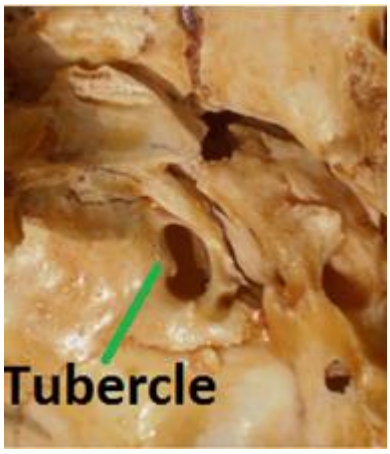

Figure 8: Tubercle in foramen ovale

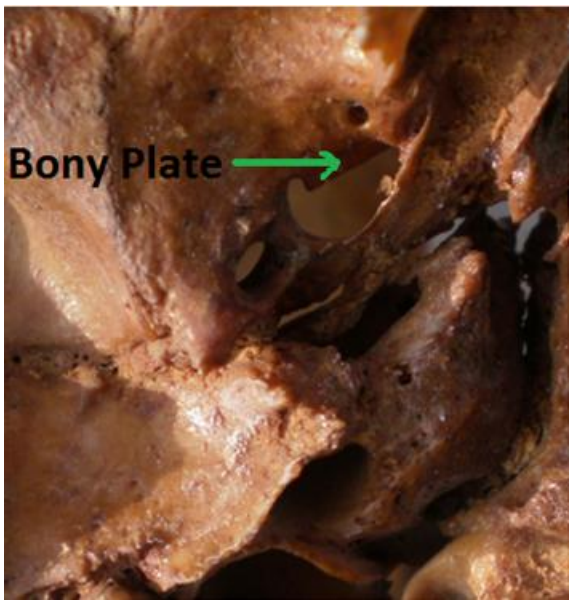

Figure 9: Bony plate in foramen ovale

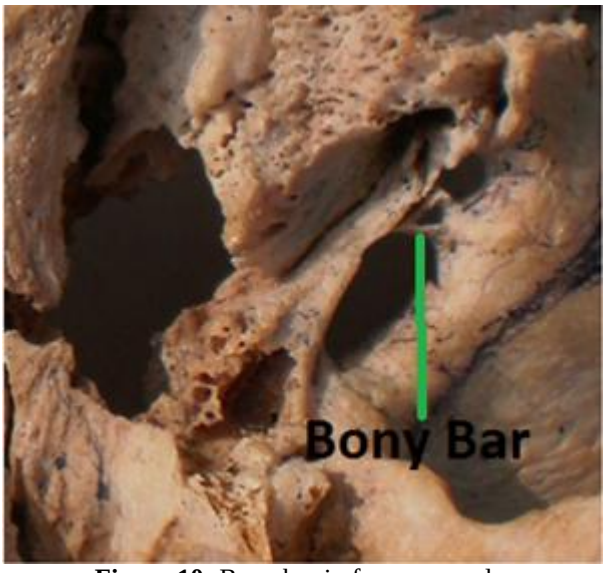

Figure 10: Bony bar in foramen ovale

4. Discussion

The present study we found variations in shape of foramen ovale. Variations in shape of foramen ovale have been noticed by other authors too [5, 6, 7, 8, 9]. All authors reported that foramen ovale in majority cases was found to be oval in shape . In our study also, the majority of the foramen ovale were oval in shape. We compared our finding with past studies by other authors (Table1).

We studied 100 sides of skull and found the abnormal bony outgrowths in foramen ovale like spine, tubercles, bony plate and bony bar. We compared our finding with studies by other Authors [5, 7, 8, 10, 11] shown in Table 2.Navneet et al, studied 498 foraminaovale and reported incidence of spine, tubercle and bony plate in 7.28%, 2.02% and 1.2% foramina respectively[10]. A study conducted by Wadhwa A. et al, on 60 foramina ovale and observed incidence of spine, tubercle & bony plate in 1.6%, 5% and 10% foramina respectively [5]. In present study we found incidence of spine, tubercle, bony plate and bony bar in 5%, 4%, 2% and 1% foramina respectively. Incidence of bony bar was not reported by [10]& [5].

A Study of 70 foramina ovale and reported incidence of spine, tubercle & bony plate in 4.2%, 5.7% and 8.5% foramina respectively [11]. They were not found incidence of bony bar in their study. In our study we found abnormal bony bar in 1 foramen, which was dividing the foramen into 2 compartments. Bokhari et al, also reported incidence of bony bar in 0.9% foramina [7].

The slit like shape of foramen ovale noted in this study signifies an over- growth during the developmental process between its first appearance and the perfect ring formation such bony obstructions could interfere with the transcutaneous needle placement into the foramen ovale or can cause the mandibular neuralgia (12). The bony outgrowths in the foramen ovale like spines, spurs, tubercles, bony plates and osseous structures may lead to ischaemia, necrosis and possible paralysis of the parts of the body being supplied, drained or innervated by its contents. Trigeminal neuralgia is caused by entrapment neuropathy or microvascular compression in 80% of cases and in the remaining 20% is by other factors such as bone anomalies in the skull base [13].

Table 1: Comparative study of variations in shape of foramen Ovale

S.No.	Shape	Ambica Wadhwa[5]	KaranBhagwan Khairnar [6]	Zahra Haider Bokhari[7]	Birjna Farooq [8]	Vaishali S Kirwale [9]	Present study
1.	Oval	70%	76.5%	73.6%	70%	66.07%	62%
2.	Almond	15%	10.5%	4.5%	17.5%	14.28%	20%
3.	Round	10%	7%	14.5%	10%	10.72%	9%
4.	Triangular	-	-	4.5%	-	1.78%	4%
5.	Slit Like	5%	6%	0.9%	2.5%	-	3%
6.	Irregular	-	-	0.9%	-	-	2%

Table 2: Comparative study about abnormal bony outgrowths in foramen ovale

S No.	Bony Outgrowths	Navneet Kumar Chauhan[10]	Ambica Wadhwa[5]	Nirupma Gupta[11]	Zahra Haider Bukhari[7]	Birjna Farooq(8)	Present Study
1	Spine	7.28%	1.6%	4.2%	4.5%	5%	5%
2	Tubercle	2.02%	5%	5.7%	-	-	4%
3	Bony plate	1.21%	10%	8.5%	3.6%	2.5%	2%
4	Bony bar	-	-	-	0.9%	-	1%

5. Conclusions

The precise knowledge of variations of foramen ovale is of valuable contribution for neurosurgeons to development of new and different techniques to approach the middle cranial fossa. In our study we found, 100% tubercles and 80% spines were arising from anterior margin of foramen ovale. These findings are important for neurosurgeons to approach middle cranial fossa via foramen ovale for neurosurgical and diagnostic procedures like percutaneous biopsy of cavernous sinus tumours, electroencephalographic analysis, microvascular decompression, percutaneous trigeminal rhizotomy and administration of anaesthesia to the mandibular nerve. Surgeons should avoid going, close to the anterior margin of foramen ovale as spines and tubercles could interrupt the procedures.

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