

# Assessment of Foramen Ovale from Zygomatic Bone and Zygomatic Arch: A Morphometric Study on Dry Skull

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## Abstract

**Background:** Foramen ovale and trigeminal nerve is an important anatomical landmark for the therapeutic and diagnostic procedures. One should have a precise knowledge about it. The aim of this study is to know the exact location and position of trigeminal nerve and foramen ovale at their exit. **Material and methods:** This study was done in the department of Anatomy, AIIMS, Udaipur on 60 dry skulls obtained from the department and also from some students. Damaged skulls are excluded from this study. Distance from lateral surface of zygomatic arch to the lateral rim of foramen ovale of right (M1R) and left (M1L) are recorded in mm. Distance from antero inferior border of zygomatic bone to the anterior end of foramen ovale of right (M2R) and left (M2L) and bilateral antero posterior and transverse diameter of foramen ovale of right and left side (APR, APL, Tr. R, Tr. L) are recorded in mm with the help of compass and digital vernier calliper. **Result:** The average distance of M1L and M1R is 41.641 and 41.925mm and M2L and M2R is 51.536 and 51.708mm respectively. Average diameter of APL and APR is 6.47 7.02mm respectively. The average Tr. R is 3.595mm and Tr. L is 3.76mm. **Conclusion:** The average distance of M1 is 51.622mm M2 is 41.783mm. The average AP diameter is 6.745mm and Tr. diameter is 3.6775mm. With the help of these anthropometric measurements the surgeons can mark the exact location of foramen ovale from surface, prior to operative procedure.

**Keywords:** Trigeminal nerve, foramen ovale, vernier calliper.

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## INTRODUCTION

The trigeminal nerve arises by two roots from pons at its junction with middle cerebellar peduncle. These two roots are: (a) a very large lateral sensory root and (b) a small medial motor root. The two roots run forward and laterally over the apex of petrous temporal bone to enter the middle cranial fossa. Here the sensory root exhibit an enlargement called trigeminal ganglion. The trigeminal ganglion divides into branches: ophthalmic, maxillary and mandibular [1].

The mandibular nerve is the largest trigeminal division and is a mixed nerve. Its sensory branches supply the teeth and gums of the mandible, the skin in the temporal region, part of the auricle- including the external meatus and tympanic membrane- and the lower lip, the lower part of the face and the mucosa of the anterior two-thirds of the tongue and the floor of the oral cavity. The motor branches innervate the muscles of mastication. The larger sensory root emerges from the lateral part of the trigeminal ganglion and exits the

cranial cavity through the foramen ovale. The small motor root passes under the ganglion and through the foramen ovale to unite with the sensory root just outside the skull. As it descends from the foramen ovale, the nerve is usually around 4 cm from the surface and a little anterior to the neck of the mandible. The mandibular nerve immediately passes between tensor veli palatini, which is medial, and lateral pterygoid, which is lateral and gives off a meningeal branch and the nerve to medial pterygoid from its medial side. The nerve then divides into a smaller anterior and larger posterior trunk. The anterior division gives off branches to the four main muscles of mastication and a buccal branch which is sensory to the cheek. The posterior division gives off three main sensory branches, the auriculotemporal, lingual and inferior alveolar nerves, and motor fibres to supply mylohyoid and the anterior belly of digastric [2]. The foramen ovale is located postero lateral to the foramen rotundum, anteromedial to the foramen spinosum and anterior to foramen lacerum connecting the middle cranial fossa with the

infra temporal fossa. The foramen ovale may vary from ovale, almond shape, D shape, longitudinal, round and irregular in shape [3]. The mean length and width of foramen ovale was 6.5mm and 3.7mm on right and 6.8mm and 4mm on left side respectively [4].

The mean distance from upper edge of the zygomatic process above the articular tubercle to the lateral rim of the foramen ovale increases from about 15mm in new born to 34.33 mm in adult [5]. The average distance of the foramen ovale from the zygoma was 38.2mm [6]. Distance between Temporalis muscle to the lower point of mid cranial fossa (floor measurement (muscle thickness + mid-zygoma - to floor measurement) as  $24.16 \pm 0.74$ mm. The mean distance between Meckel's cave and the medial surface of the posterior root of the zygomatic arch was 26.5mm [7]. The aim of this study is to know the exact location and position of trigeminal nerve and foramen ovale from the superficial surface of the face. This study will be very helpful for the clinicians to treat trigeminal neuralgia, recalcitrant herpes zoster ophthalmicus, post herpetic neuralgia and some diagnostic procedures related to middle cranial fossa.

## MATERIAL AND METHODS

This study was conducted by examining the 60 dry skulls in the department of Anatomy, American International Institute of Medical Sciences (AIIMS), Udaipur and Katihar Medical College Katihar. For the study of topographic location of foramen ovale, we took two bony land marks and recorded their length. These two land marks are:

- Distance from most prominent point of zygomatic arch external surface to the lateral rim of foramen ovale (M1) of right (M1R) and left side (M1L).
- Distance from antero inferior border of zygomatic arch to the anterior limit of foramen ovale (M2) of right (M2R) and left side (M2L).

The knowledge of distance from these bony landmarks can be of help in the approach through transjugal-transoval route, through the pterygomaxillary fossa up to the foramen ovale. Antero posterior (AP) and transverse (Tr.) diameter of the foramen ovale is also measured and noted as APR for right side and APL for left side and Tr. R for transverse diameter of right side and Tr. L for left side of foramen ovale. Maximum lengths, minimum length, average value with standard deviation (average  $\pm$  SD) were noted and compiled. Damaged, fractured and any deformity around foramen ovale of skulls were excluded from the study. All the measurement was done with the help of compass and digital vernier calliper and recorded in mm.

## RESULTS

During the study of 60 dry skulls, our findings are as follows. The maximum and minimum distance of M1R is 44mm and 39mm and M1L is 45mm and 38mm

respectively. The Average of M1R and M1L are  $41.925 \pm 1.487$ mm and  $41.641 \pm 1.298$ mm respectively.

**Table-1: The length from lateral margin of foramen ovale to the most prominent point of zygomatic bone lateral surface right side (M1R) and left side (M1L) and Average with standard deviation as SD.**

	M1R	M1L
Maximum Length	44mm	45mm
Minimum Length	39mm	38mm
Average	41.925mm	41.641mm
SD	1.487	1.298

The maximum and minimum distance from antero inferior border of zygomatic bone to the anterior limit of foramen ovale of right side (M2R) is 57mm and 46mm and left side (M2L) is 56mm and 48.5 mm respectively. The average and standard deviation is noted as average value of M2R and M2L are  $51.708 \pm 2.209$  and  $51.536 \pm 1.692$ mm respectively.

**Table-2: Distance from antero inferior border of zygomatic bone to the anterior margin of foramen ovale right side (M2R) and left side (M2L) and Average with standard deviation as SD.**

	M2R	M2L
Maximum Length	57mm	56mm
Minimum Length	46mm	48.5mm
Average	51.70mm	51.53mm
SD	2.2099mm	1.692mm

Maximum antero-posterior length of foramen ovale on right side (APR) is 8.9mm and on left side (APL) is 9mm. The minimum APR is 5mm and APL is 3.5mm. The average of APR is  $7.2 \pm 1.061$  and APL is  $6.47 \pm 1.247$ mm respectively. The Tr. R is 5.5mm maximum and 2.5mm minimum and Tr. L is 6mm maximum and 2.5mm minimum. The average value of Tr. R and Tr. L is  $3.595 \pm 0.783$ mm and  $3.76 \pm 0.932$ mm respectively.

**Table-3: Antero-posterior diameter of foramen ovale of right (APR) and left side (APL), Transverse diameter of foramen ovale of right (Tr.R) and left side (Tr. L) Average with standard deviation as SD.**

	APR	APL	Tr. R	Tr. L
Maximum Length	8.9mm	8.9mm	6mm	6mm
Minimum Length	3.5mm	5mm	2.5mm	2.5mm
Average	7mm	5mm	3.59mm	3.76mm
SD	1.060	1.247	0.783	0.932

## DISCUSSION

The foramen ovale is one of the important foramina situated in the greater wing of sphenoid bone. Middle cranial fossa can be approached through this foramen for micro neuro surgical and diagnostic procedures without performing craniotomy [8]. So the knowledge of anatomical variations, location and diameter of foramen ovale is essential for surgeons.

Morphology and morphometry of the foramen ovale in both sexes has been studied by many

researchers. In the present study we try to add more accurate information regarding location and position in relation with easily assessable bony landmark on face. A Wadhwa *et al.* found that the mean length and width of foramen ovale was 6.5mm and 3.7mm on right and 6.8mm and 4mm on left side side respectively [9]. Karishma ravinthar *et al.* found that the mean length of foramen ovale on the right was  $6.773 \pm 1.652$ mm and on left were  $5.744 \pm 1.791$ mm. The maximum and minimum width of foramen ovale on right and left was 4.8mm, 2.3mm and 5.7mm, 2.9mm. Mean width of foramen ovale on right was  $3.56 \pm 0.737$ mm and on left were  $4.28 \pm 0.833$ mm [10].

In present study the Average of APR is  $7.02 \pm 1.0601$ mm and Average of APL is  $6.47 \pm 1.247$ mm. The Average value of Tr. R is  $3.595 \pm 0.783$  and Average of Tr. L is  $3.76 \pm 0.932$  respectively. Patel and Mehta *et al.* and Lang *et al.* have reported the length varying in the range from 6.5 to 11.3mm and width from 3.6 to 4.7mm. They too did not observe any significant difference between right and left side in length and width ( $p > 0.05$ ) [5, 11]. Lang J *et al.* 1984 reported that the mean distance from upper edge of the zygomatic process above the articular tubercle to the lateral rim of the foramen ovale increases from about 15mm in new born to 34.33mm in adult [5]. Tiwari *et al.* 1998 found that the average distance of the foramen ovale from the zygoma was 38.2mm [6]. Dayoub *et al.* 2010, reported the distance between the Temporalis muscle to the lower point of mid cranial fossa (floor) measurement (muscle thickness+mid-zygoma to floor measurement) as  $24.16 \pm 0.74$ mm. The mean distance between Meckel's cave is best identified medial to the foramen spinosum and just posterior to the foramen ovale [7].

In the present study the mean distance with standard deviation of M2R is  $51.708 \pm 2.209$ mm and M2L is  $51.536 \pm 1.692$ mm respectively. Not many specific references for the distance of foramen ovale to the antero inferior border of zygomatic bone could be found in literature. So our study for these dimensions can be of much help to neurosurgeons.

## CONCLUSION

The distance of foramen ovale from the antero inferior border of zygomatic bone to the anterior margin of foramen ovale is about 41.783mm and distance from most prominent point of lateral surface of zygomatic arch to the lateral rim of foramen ovale is about 51.622mm in average. The shape of foramen ovale was

very variable and the average antero posterior diameter of foramen ovale is 6.745mm and transverse diameter is about 3.6775mm. With the help of these anthropometric measurements the surgeons can mark the exact location of foramen ovale from surface, prior to operative procedure.

## REFERENCES

1. Singh, V. (2016). Textbook of Clinical Neuroanatomy 3<sup>rd</sup> ed. New Delhi: Elsevier, Relx India Pvt.Ltd, 99.
2. Standring, B. N.R., Collins, P., Crossman, A.R., Gatzoulis, M.A., Healy, J.C. (2008). Gray's Anatomy: The Anatomical Basis of Clinical Practice 40<sup>th</sup> ed. Vol.1998. London: Elsevier, Churchill Livingstone, 541-2.
3. Mishra, S. R., Sushobhana, S. S., Singh, R., & Gaharwar, A. (2014). Morphometric and Topographic Study of Foramen Ovale in Indian Skulls.
4. Wadhwa, A., Sharma, M., & Kaur, P. (2012). Anatomic variations of foramen ovale—clinical implications. *Int J Basic and Applied Med Sci*, 2, 21-24.
5. Lang, J., Maier, R., & Schafhauser, O. (1984). Postnatal enlargement of the foramina rotundum, ovale et spinosum and their topographical changes. *Anatomischer Anzeiger*, 156(5), 351-387.
6. Tiwari, R. (1998). Surgical landmarks of the infratemporal fossa. *Journal of Cranio-Maxillofacial Surgery*, 26(2), 84-86.
7. Dayoub, H., Schueler, W. B., Shakir, H., Kimmell, K. T., & Sincoff, E. H. (2010). The relationship between the zygomatic arch and the floor of the middle cranial fossa: a radiographic study. *Operative Neurosurgery*, 66(suppl\_2), ons363-ons369.
8. Rao, B. S., Yesender, M., & Vinila, B. S. (2017). Morphological variations and morphometric analysis of foramen ovale with its clinical implications. *Int J Anat Res*, 5(1), 3394-97.
9. Wadhwa, A., Sharma, M., & Kaur, P. (2012). Anatomic variations of foramen ovale—clinical implications. *Int J Basic and Applied Med Sci*, 2, 21-24.
10. Ravinthar, T. K. (2015). Morphometric Study of Size and Symmetry of Foramen Ovale in Dry Skulls. *Journal of pharmaceutical sciences and research*, 7(10), 830.
11. Patel, R., & Mehta, C. D. (2014). Morphometry of foramen ovale at base of skull in Gujarat. *J Dent Med Sci*, 13(06), 26-30.