

## Morphometry of Foramen Ovale at base of skull in Gujarat

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### Abstract:

**Aims:** Study of foramen Ovale is of great surgical importance in procedures like percutaneous trigeminal rhizotomy for trigeminal neuralgia, electroencephalographic analysis for seizure and diagnostic transfacial fine needle aspiration technique in perineural spread of tumour. Localization of the foramen ovale can be difficult due to imaging quality (improved by biplanar radiology systems), operator inexperience and anatomical variations.

**Methods and Material:** The present study was conducted over 100 dry human skulls obtained from Anatomy department, Govt. Medical College, Surat and B.J. Medical college Ahmedabad, Gujarat. In this study presence of anatomic variations in shape of foramen ovale was noted and length and width of foramen were measured. Comparison between right and left was done.

**Results:** Mean length of foramen ovale was 6.5mm and mean width was 3.5mm. There was no significant difference between mean of the length and width of the right and left foramen ovale. Foramen ovale was typically oval in 119 sides, almond in 12 sides, round in 55 sides and slit like in 2. There was accessory foramina in front of foramen ovale in one case and presence of septation in one case.

**Conclusions:** Anatomical variations in size and shape of foramen ovale could be explained by developmental reasons. Considering the surgical and diagnostic importance of foramen ovale, this study was worthwhile.

**Key words:** foramen ovale, skull, anatomical variation

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### I. Introduction

The foramen ovale lies medial to the foramen spinosum and lateral to the foramen lacerum on the infratemporal surface of the greater wing of the sphenoid bone. It transmits the mandibular division of the trigeminal nerve, the lesser petrosal nerve, the accessory meningeal branch of the maxillary artery and an emissary vein which connects the cavernous venous sinus to the pterygoid venous plexus in the infratemporal fossa. It passes through the greater wing of the sphenoid posterior to the lingula and posterior end of carotid groove<sup>[1]</sup>.

Similar to other foramina, the foramen ovale differs in shape and size throughout the natural life. The earliest perfect ring-shaped formation of the foramen ovale was observed in the 7th fetal month and the latest in 3 years after birth, in a study using over 350 skulls. In his developmental studies on the foramen ovale and foramen spinosum of the ovale is about 3.85mm in the newborn and in adults, its about 7.2mm long<sup>[2]</sup>. Raymond J, Charuta A, Wysocki J (2005); in a study conducted on 100 skulls, the foramen ovale was divided into 2 or 3 components in 4.5% of the cases. The borders of the foramen in some skulls were also irregular and rough. This may suggest, based on radiological images, the presence of morbid changes, which might be the sole anatomical variation in the foramina ovale of humans<sup>[3]</sup>.

Lang J Schafhauser O (1984); in newborn, the foramen ovale is about 3.85 mm and in the adults about 7.2 mm in length. The average maximal length is about 7.48 mm and its average minimal length is 4.17 mm in the adult. The width extends from 1.81 mm in the newborn to 3.7 mm in adults. The venous segment of foramen ovale may be separated from the remainder of the contents of the foramen by a bony spur; thus resulting so called double foramen ovale. Such spurs are located anteriorly and medially<sup>[4]</sup>.

Landl MK Walter Grand (2005); fluoroscopically assisted laser targeting of the foramen ovale showed length of 6.9 mm on right side and 6.8 mm on left side. Average width on right side was 3.4 mm on right side and 3.8 mm on left side<sup>[5]</sup>.

Skrzat et al. (2006); on a visual inspection of a dry adult human skull revealed absence of a typical foramen ovale on the left side of the cranial base. The region of the foramen ovale was covered by an osseous lamina, which was continuous with the lateral pterygoid plate and thus formed a wall of an apparent canal, which opened on the lateral side of the pterygoid process<sup>[6]</sup>.

### II. Methods

The present study was undertaken on 100 dry, adult human skull obtained from department of Anatomy, government medical college, Surat and from B.J Medical college, Ahmedabad. All skulls were normal. They were used for tutorial teaching for medical students.

Measurement of foramen ovale was done by placing a pair of divider on antero-posterior (length) and transverse (width) diameters of the foramen and then carefully transferred to a meter rule for the readings to be taken. The shape of foramen ovale was also observed.

**III. Observation:**

Mean length of foramen ovale was 6.5mm (Table-1). Maximum and minimum length observed was 10mm, and, 3 mm respectively (Table-1). Mean width on right side was 3.55mm (Table-1). Maximum width of foramen ovale was 7.0 mm (Table-1). Minimum width was 2.0 mm (Table-1).

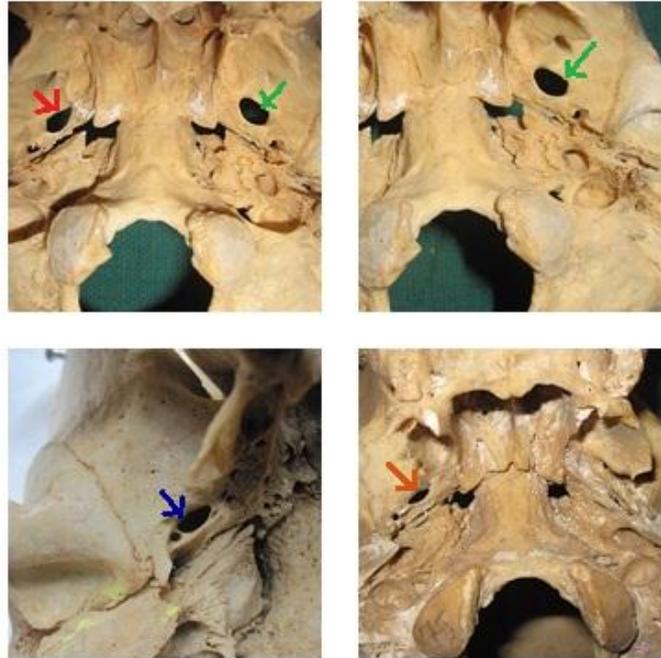


Fig. Arrow shows foramen ovale at base of skull having different shapes: ovale shape(Blue arrow) ,round shap (Green arrow) , Red arrow(almond shape) , Orange slit like),Anatomy dept., Government Medical College,Surat.Gujarat.

Shape of foramen ovale was also observed. Foramen ovale was typically oval in 119 sides (64 right, 55 left), almond in 12 sides (12 right, 12 left), round in 55 sides (23 right, 32 left ) and slit like in 2(1 right,1 left) (table-2).

There was accessory foramina in front of foramen ovale in one case and presence of septation in one case.

**Table 1:** Dimensions(in mm) of foramen ovale in right and left side

Values	Length(right)	Length(left)	Width(Right)	Width(Left)
Maximum	10	10	7	7
Minimum	3	3	2	2
Mean	6.6	6.5	3.6	3.5

**Table 2:** Variations in appearance of foramen ovale

Shape	Right	Left	Total
Ovale	64	55	119
almond	12	12	24
round	23	32	55
Slit	1	1	2

**IV. Discussion**

Foramen ovale(FO) is one of the important foramina used for various invasive surgical as well as diagnostic procedures. Knowing the anatomic variations of foramen ovale is important because surgical

treatment of trigeminal neuralgia is most commonly accomplished by microvascular decompression by percutaneous trigeminal rhizotomy done through FO [7][8]. In a study conducted in India, forty patients of trigeminal neuralgia were treated with percutaneous trigeminal ganglion balloon compression. In all patients except one, the needle could be introduced easily. The only exception was the patient with foramen ovale stenosis, in whom, the needle just fitted in the foramen. The accuracy of percutaneous biopsy of cavernous sinus tumours through the foramen ovale is 84% [9] and it is important before making any decision to indicate open surgical, radiosurgical or radiotherapeutic treatment. Nasopharyngeal carcinoma (NPC) frequently spreads intracranially and most common route of spread is through the foramen ovale (34%) [10]. The CT-guided transfacial fine needle aspiration technique through FO to diagnose squamous cell carcinoma, meningioma, Meckel cave's lesions allows biopsy of deep lesions that would otherwise require open surgical biopsy or craniotomy. This results in decreased patient morbidity and significant cost reduction.

Electroencephalographic analysis of seizure by electrode placed at FO is done. FO electrode technique provided good neurophysiological information in candidates for selective amygdalohippocampectomy. So knowledge of the exact topography and morphometry of the FO electrodes is required for a more precise anatomo-electro-clinical correlation of seizures [11].

In the present study mean length of FO was 6.6mm on right side and 6.5mm on left side. Though right foramen ovale was longer than left but no significant difference was observed between the two sides ( $p > 0.01$ ).

In a study conducted by N.Gupta an average mean length of foramen ovale was 7.46 mm on right side and average length was 7.01mm on left side and difference between right and left side was not observed which is similar to present study, but there is statistical difference between our study and N.Gupta study ( $p < 0.01$ ) [12] (fig.3).

In a developmental study conducted in Japan (Yanagi, 1987) an average maximal length of foramen ovale was 7.48 mm and average minimal length was 4.17mm and significant difference between right and left side was not observed which is similar to present study [2]. A German study (Lang J, 1984) showed length to be 7.2mm [4] and a fluoroscopically-assisted laser targeting of the FO conducted in New York (Landl MK, 2005) showed length 6.9mm on right side and 6.8mm on left side with range length 5.0-10.0mm; left, 6.0-9.0mm; right [5].

According to present study mean width on right side was 3.6 mm and 3.5mm on left side. Maximum width of foramen ovale was 7.0 mm on both right and left sides. Minimum width was 2.0 mm on both right side and left side. Difference between the width of right and left side was not statistically significant ( $p > 0.01$ ).

In a study conducted by N.Gupta maximum width of foramen ovale was 5.0mm on both right and left sides while minimum width was 1.0mm on right side and 2.2mm on left side. Mean width on right side was 3.21+/-1.02mm and 3.29+/-0.85mm on left side. Difference between the width of right and left side was not statistically significant ( $p > 0.01$ ), but there is statistical difference between our study and N.Gupta study ( $p < 0.01$ ) [12] (fig.4). Similar findings were observed by a German study where average width was 3.7mm in adult skull [4]. Average width on right side was 3.4mm and 3.8mm on left side was reported in a study conducted by fluoroscopically-assisted laser targeting of foramen ovale in New York [5].

In the study done by Osunwoke E.A the mean of the lengths of the right foramen ovale was 7.01mm while that of the lengths of the left foramen ovale was 6.89mm with the range; 5.0 – 9.5mm and 5.0 – 9.0mm, on right and left side respectively. The mean of the widths of the right foramen ovale was 3.37mm while that of the left foramen ovale was 3.33mm with range of 2.0-5mm on both sides. There was no significant difference between the mean of the length and width of the right and left foramen ovale [13].

Arun Kumar found in his study that maximum length of foramen ovale was 9.8 mm and minimum length was 2.9 mm. Mean length on left side was 6.56 mm, on the right side was 5.08 mm; Mean width on left side was 3.60 mm on the left side, on the right side 3.64 mm [14].

Variations in the shape of foramen ovale showed maximum number of foramen to be ovale shaped; 59.5% followed by almond shaped, round and slit like incidence of which were 12%, 27.5%, and 1% respectively. Study conducted by N.Gupta reported majority of foramen ovale to be ovale shape (61.4%), others are almond shaped, round and slit like incidence of which were 12%, 27.5%, and 1% respectively [12].

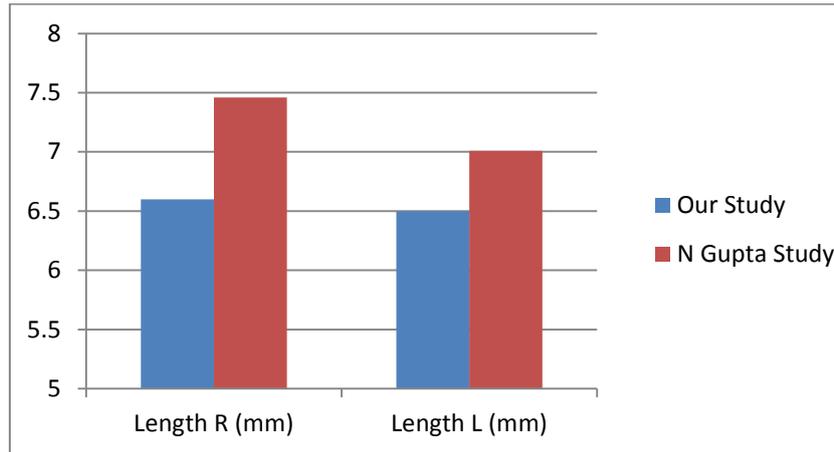


Fig:3 : Bar diagram showing comparison of Length (in mm)of Foramen Ovale on both sides of skull of our study and N.Gupta study R=right,L=left.(The values are expressed as Mean)

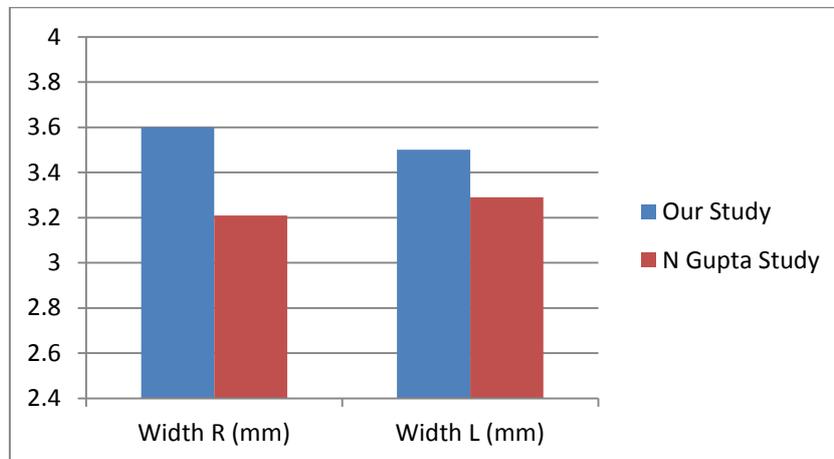


Fig:4 : Bar diagram showing comparison of Width (in mm)of Foramen Ovale on both sides of skull of our study and N.Gupta study R=right,L=left. (The values are expressed as Mean)

Variation in the dimension and shape of foramen ovale can be explained by developmental reasons. Foramen ovale is situated at the posterior border of greater wing of sphenoid. 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 paired lesser wings (orbitosphenoids), and the greater wings (alisphenoids). Postsphenoids is the part with which are associated the greater wings and pterygoid processes. The first ossific nuclei to appear are those for the great wings (ali-sphenoids). One makes its appearance in each wing between the foramen rotundum, ovale and spinosum. At 22 weeks 3 days the foramen ovale and spinosum are seen as discrete openings and are contained in an area of unossified cartilage<sup>[15]</sup>. Ossification takes place around the large trunk of mandibular nerve and other structures passing through the foramen ovale in later life. Foramen ovale of man is enclosed by membrane bone, derived from a medial process associated with the scaphoid fossa. The earliest perfect ring-shaped formation of this foramen is observed in the 7<sup>th</sup> foetal month and the latest in 3 years after birth. Spine, tubercle, bony plate, spur, leading to double foramen ovale and raised margin, all these variations indicate bony overgrowth during developmental process, between age of its first appearance at eighth week in utero and its perfect ring shaped formation. Various inconstant patterns of grooves and foramina in the vicinity of the foramen ovale can be interpreted as arising from the interplay of various parts of membrane bone and the emissary venous plexus from the middle meningeal veins to the pterygoid plexus<sup>[16]</sup>. An accessory or ectopic foramen ovale can develop in the process when those inconstant foramina disappear leaving behind foramen ovale as one large oval opening.

Also this study is of clinical and anatomical significance to medical practitioners in cases of trigeminal neuralgia and in diagnostic detection of tumors and abnormal bony outgrowths that may lead to ischemia, necrosis and possible paralysis of the parts of the body being supplied, drained or innervated by the contents of these foramina.

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