



# VARIATIONS IN THE SHAPE OF THE FORAMEN OVALE IN DRY OSSIFIED HUMAN MIDDLE CRANIAL FOSSA-A CROSS SECTIONAL STUDY

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## Abstract:

**Background:** The foramen ovale acts as the passageway for neurovascular structures which pass from the middle cranial fossa into the infratemporal fossa. The mandibular nerve and accessory meningeal artery passes through this foramen. Foramen ovale is important in functional cranial anatomy. Anatomical awareness of variations in the shape of the foramen ovale in middle cranial fossa are important for the neurosurgeons, who operate in this area, and radiologists who interpret imaging for this area. The study was planned to observe the shape of the foramen ovale. In this study different shapes of foramen ovale were carried out in both right and left middle cranial fossa. Then the results were compared between right and left middle cranial fossa.

**Objective:** To evaluate the different shapes of the foramen ovale.

**Materials & Methods:** A cross-sectional, analytical type study was conducted in the Department of Anatomy of Dhaka Medical College, Dhaka from January 2011 to December 2011. The study materials consists of 117 (one hundred and seventeen) dry ossified human middle cranial fossa.

**Results:** The most frequently observed was ovoid foramen ovale and minimum observed was round. Elongated and kidney shaped were not found. There were difference in shape of the foramen ovale in right and left middle cranial fossa but statistically were not significant ( $p < 0.05$ ).

**Conclusion:** This study is of clinical and anatomical significance to medical practitioners in cases of trigeminal neuralgia and in diagnostic detection of tumours and abnormal bony outgrowths. The present study was planned to observe the shape of the foramen ovale to establish a baseline data of our own for future studies and to guide the neurosurgeons and radiologists to adopt appropriate plans for diagnosis and treatment of respective fields.

## Keywords:

Foramen ovale, Shape, Middle Cranial Fossa

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## Introduction:

Part of the middle cranial fossa is formed by the cerebral surface of the greater wing of sphenoid bone. Foramen ovale is located in the posterior part of the greater wing. The foramen ovale transmits mandibular nerve, the accessory meningeal artery, lesser petrosal nerve and an emissary vein.<sup>1</sup>

The major factors in the determination of variability of shape of the foramen ovale are thought to be the presence and number of veins that pass through it.<sup>2</sup> It is an important constituent of cranial anatomy with high significance in neurosurgery as it enables access to

the trigeminal nerve. Thus knowledge of its position is clinically important in the event of anaesthesia of the mandibular nerve. Foramen ovale is used for various invasive surgical as well as diagnostic procedures such as electroencephalographic analysis of the seizure for patients undergoing selective amygdalo-hippocampectomy, microvascular decompression by percutaneous trigeminal rhizotomy for trigeminal neuralgia and percutaneous biopsy of cavernous sinus tumours etc. The technique of CT-guided transfacial fine needle aspiration technique through the foramen ovale is used to diagnose squamous cell carcinoma,

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meningioma etc. and allows biopsy of deep lesions that would otherwise require open surgical biopsy or craniotomy, thus helping to decrease patient morbidity and significantly decrease the cost involved.<sup>3</sup> Anatomical knowledge of the foramen ovale is important for all neurosurgical procedures involving the trigeminal nerve and administration of anaesthesia in the mandibular nerve. Prior knowledge of the presence of foramen ovale may be important for academic and clinical purpose.<sup>4</sup> Different shapes of foramen ovale were observed and recorded during morphological examination. According to literature review- different author describes the shapes of foramen ovale were oval, circular / round, pyriform / pear shaped, elongated and figure of 8 shaped.<sup>4-7</sup> This cross sectional study has been reported in line with the STROCSS guidelines 2024.<sup>8</sup>

### Materials & Methods

This is a cross sectional study where variations in the shape of foramen ovale were investigated in 117 (one hundred and seventeen) dry ossified human middle cranial fossa. The base of skulls was collected from the Department of Anatomy of Dhaka Medical College and other government and non-government medical colleges in Dhaka city. Broken, fractured, or missing parts of the middle cranial fossa of the base of skulls were excluded from the study. All the samples were observed. Then, the results were compared between the right and left middle cranial fossa.



**Figure 1:** Photograph showing triangular (arrow marked) foramen ovale.

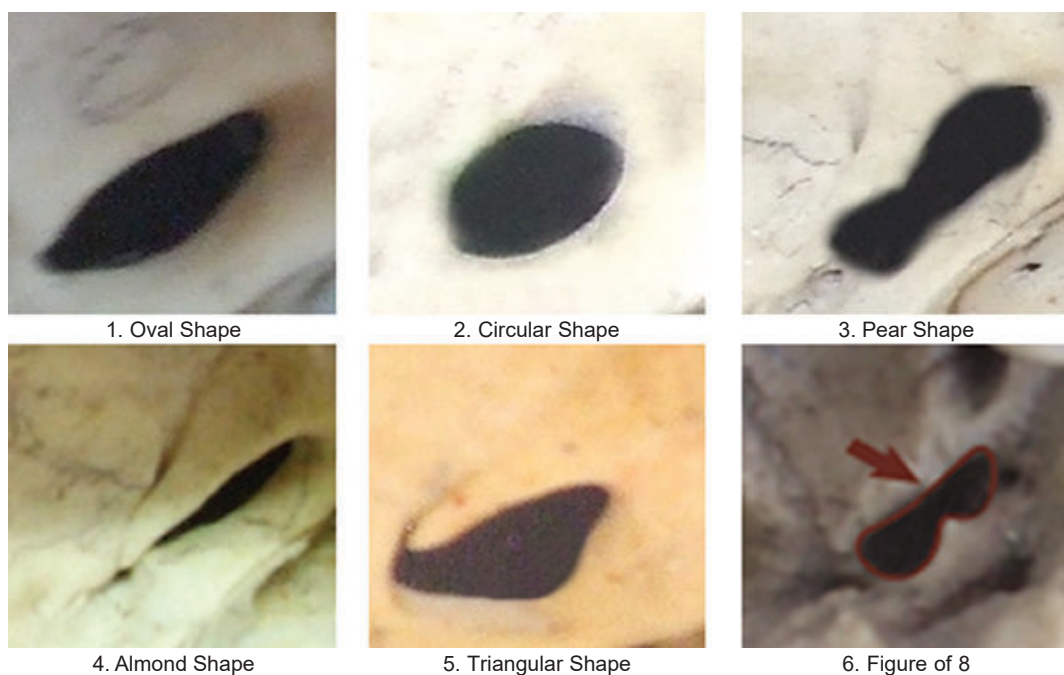


**Figure 2:** Photograph showing figure of 8 (arrow marked) foramen ovale.

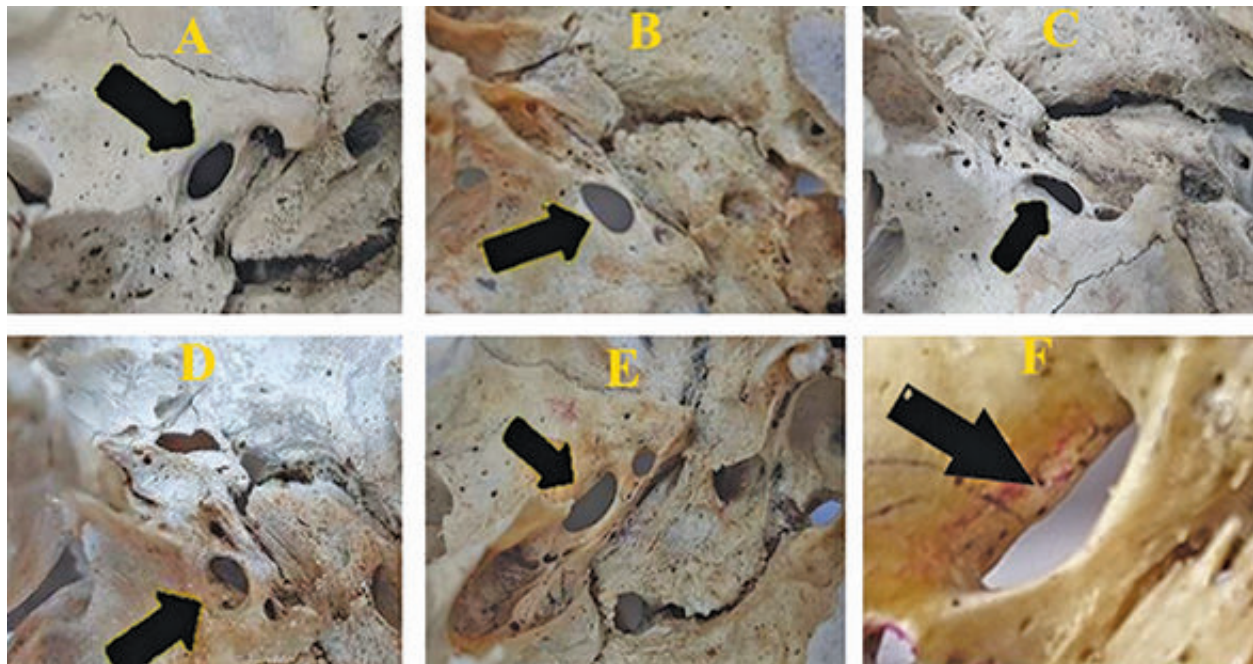
### Results

For the present study 117 dry ossified human skull with intact middle cranial fossa were studied from different medical colleges of Bangladesh.

Following table indicate the various shapes of foramen ovale.



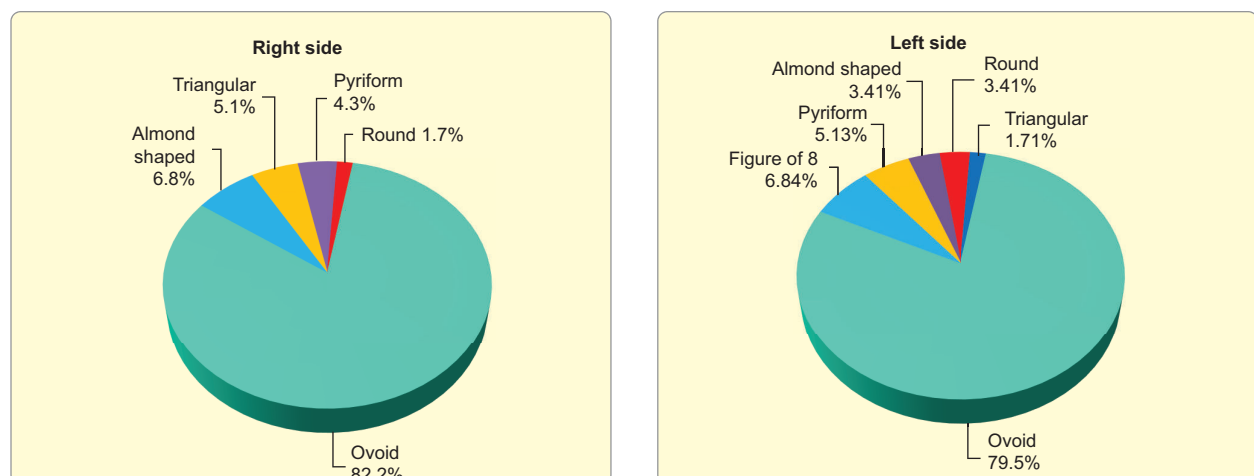
**Figure 3:** Different Shape of Foramen Ovale in our study;



**Figure 4:** Different Shape of Foramen Oval; A: Ovoid; B: Almond; C: Kidney Shaped; D: Round; E: Pyriform Shaped ; F: Elongated; Image reproduced for visualization with kind permission from Açıkgöz AK et al. <sup>[9]</sup>

**Table-I**  
Different Shapes of Foramen Oval (N = 117)

Shape	Right		Left	
	No	%	No	%
Ovoid	96	82.1%	93	79.5
Pyriform	5	4.3	6	5.13
Almond shaped	8	6.8	4	3.41
Round	2	1.7	4	3.41
Triangular	6	5.1	2	1.71
Figure of 8	0	0	8	6.84
Elongated	0	0	0	0
Kidney shaped	0	0	0	0



**Figure 5:** Different shapes of foramen ovale (Right and Left Side)



## Discussion

The present work was undertaken to study various morphometric variables in 117 (one hundred and seventeen) dry ossified human middle cranial fossa. The findings of this study was statistically analyzed and revealed important information regarding morphometric variations of right and left middle cranial fossa. A comparative discussion of results with that of different authors of abroad is mentioned below. In the present study human skulls were collected from different medical colleges of Bangladesh. The base of skull collected for the present study may or may not be of Bangladeshi people because medical students using skeleton for their study also come from neighbouring countries. The vast majority of Bangladeshis are ethnolinguistically Bengalis, an Indo-Aryan people. Ethnic minorities in Bangladesh are Tibeto-Burman, Chakmas, Austroasiatic and Dravidian people. [10] The results of the study were compared with the studies carried out by different researchers who used base of skull of Indian. By following STROCSS guideline, we have searched in Google scholar, pubmed indexed journal with full article on foramen ovale in our context but unfortunately no single article was found from Bangladesh. There are different articles from this subcontinent. The major ethnic groups in Indian include the Indo-Aryans, Dravidians, Sino-Tibetans, Austroasiatic people and various indigenous tribes. [11] Results of morphological variables showed some similarities as well as dissimilarities with the available information present in the publications, similarities may be due to the same race, and dissimilarities due to racial variation.

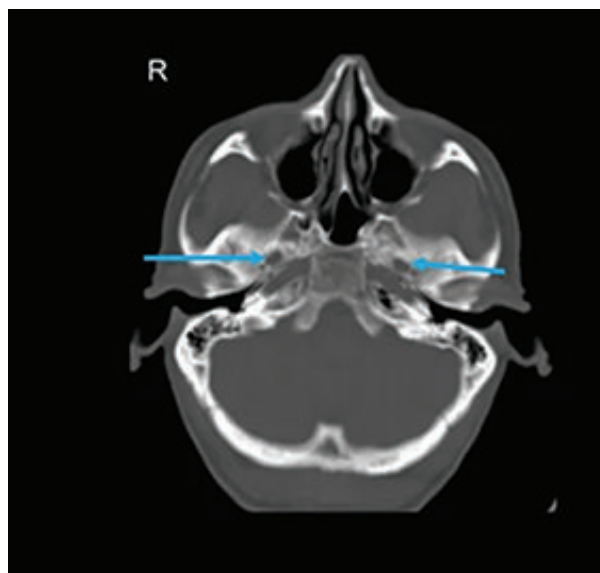
An author<sup>3</sup> studied 82 Indian skulls and stated that the oval foramen ovale was common (56.70%) with some bony variations such as spine, tubercles etc. and the incidence of oval, almond shaped, round and irregular shaped foramen ovale were 56.70%, 28.65%, 10.97% and 3.65% respectively. Another author<sup>7</sup> carried out a study using 310 skulls of Indian and found that the shape of the foramen ovale were oval in 299 foramina of right side, 6 foramina were circular, 3 pear shaped and 2 triangular on right side. On left side 297 foramen ovale were oval, 8 were circular, 3 were triangular, 1 was pear shaped and 1 was kidney shaped. They observed the variations of the shape of foramen ovale in the right and left sides were 62.8% and 60% oval in shape respectively. In the present study, foramen ovale was observed most common

ovoid shape which is 82.1% on right side and 79.5% on left side which is similar to study done by other authors.<sup>3-7</sup>

## Imaging Modalities:

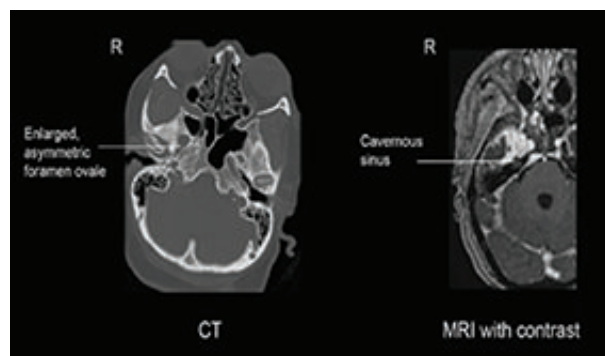
Several imaging techniques are employed for the evaluation of the foramen ovale:

- Computed Tomography (CT): High-resolution CT scans provide detailed bony architecture and are the gold standard for studying foramina variations and pathologies.
- Magnetic Resonance Imaging (MRI): Useful in assessing the neurovascular structures traversing the FO, especially in cases of nerve compression syndromes.
- Cone Beam Computed Tomography (CBCT): Preferred in dental and maxillofacial imaging due to its superior spatial resolution and lower radiation dose.



**Figure 6:** The foramen ovale in the skull base are normally symmetrical in a CT Scan of Brain Bony Window.

If a patient's CT scan shows a larger foramen ovale on one side, this could be due to a mass lesion within skull base. In this case, the tumor extended from the cavernous sinus through the foramen ovale which led to its enlargement (Fig. 5). This was much more evident on an MRI with contrast.



**Figure 7:** Due to mass lesion, Foramen ovale is asymmetrical. It is more clear in MRI with contrast than CT Scan of Brain Bony Window.

### Clinical Application of Foramen Oval in Neurosurgery:

The foramen ovale is a critical anatomical structure within the skull base, serving as a passage for the mandibular nerve and accessory vasculature. Its dimensions vary, with an average diameter of 3–9 mm. It is located posterior to the foramen rotundum and lateral to the foramen spinosum. Advanced imaging modalities such as CT and MRI play a crucial role in assessing its morphology and surrounding structures before surgical intervention. Its significance in neurosurgery is underscored by its role in various interventional procedures, including percutaneous trigeminal rhizotomy, microvascular decompression, and tumor resections.

### Different Neurosurgical Procedures:

#### • Percutaneous Trigeminal Rhizotomy

Trigeminal neuralgia, a debilitating neuropathic pain disorder, is often treated via percutaneous radiofrequency rhizotomy. The foramen ovale provides the entry point for electrode placement, targeting the trigeminal ganglion for pain relief. Fluoroscopic or CT-guided techniques are used to ensure accurate needle positioning.

#### • Balloon Compression and Glycerol Rhizotomy

In cases of refractory trigeminal neuralgia, alternative percutaneous procedures such as balloon compression and glycerol rhizotomy are performed via the foramen ovale to selectively damage pain-transmitting fibers while preserving motor function.

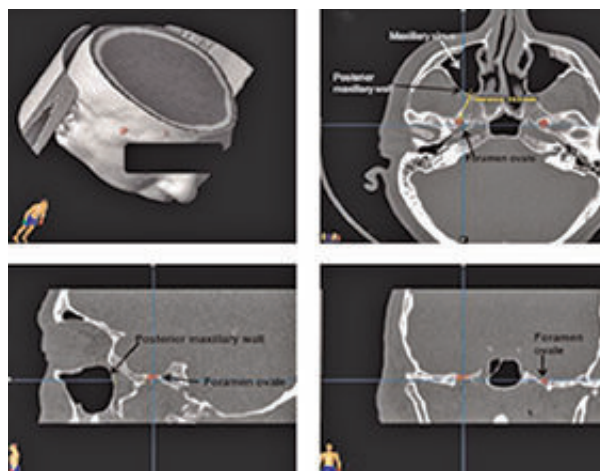
#### • Microvascular Decompression (MVD) and Endoscopic Approaches

While MVD is traditionally performed via a posterior fossa approach, recent advancements in

endoscopic techniques have explored the foramen ovale as an access route to address vascular compression of the trigeminal nerve. This minimally invasive approach reduces surgical morbidity.

#### • Tumor Biopsy and Skull Base Surgery

Neoplasms such as meningiomas, schwannomas, and metastatic tumors in the vicinity of the foramen ovale require precise neurosurgical intervention. Fine-needle aspiration or biopsy through the foramen ovale is a valuable diagnostic and therapeutic option.



**Figure 8:** Pre-operative computed tomography screencapture images showing including (a) three-dimensional reconstruction, and (b) axial, (c) sagittal and (d) coronal views showing the foramen ovale marked in pink. The position of the maxillary sinus and the posterior maxillary sinus wall are shown. Measurement of the distance from the posterior maxillary sinus wall to the foramen ovale is shown in part (b). A = anterior; P = posterior; R = right, L = left; H = head;<sup>12</sup>

### Risks and Complications in surgical practice:

Procedures involving the foramen ovale are not without risks. Potential complications include:

- Injury to the mandibular nerve, leading to dysesthesia or motor dysfunction
  - Hemorrhage due to injury to adjacent vasculature
  - Infection and cerebrospinal fluid (CSF) leakage
  - Incorrect needle placement causing intracranial complications
- Advancements in imaging and navigation techniques have significantly reduced these risks.

### Future Directions for clinical applications:

Innovations in robotic-assisted surgery, augmented reality-guided navigation, and endoscopic techniques

continue to enhance the precision and safety of procedures utilizing the foramen ovale. Further studies exploring patient-specific anatomical variations and optimizing access techniques will contribute to improved outcomes in neurosurgical practice. Furthermore, anthropometric points of foramen ovale may add forensic investigations in different subjects.<sup>13,14</sup>

### Conclusion

Foramen ovale is of great surgical importance in the neurosurgery. The knowledge of it is important in procedures like percutaneous trigeminal rhizotomy for trigeminal neuralgia, transfacial needle aspiration technique in perineural spread of tumor and electroencephalographic analysis for seizure. It is observed by reviewing existing literature that many works have been done on foramen ovale in other countries. So far it is known that there is no published article on the morphometric study of foramen ovale in our country. The findings of this study might be useful in providing data that can be used in diagnosis and treatment of various diseases and help in medical practices of neurosurgeons and radiologists.

### Ethical clearance

The study was approved by the Ethical Review Committee of Dhaka Medical College, Dhaka.

**Conflict of Interest:** None to disclose.

**Limitation of Study:** Study is limited as per design of a cross-sectional study. The size of the foramen ovale was not evaluated in different shapes, which may aid more data for further research in clinical application. Further study is required in our context to compare the findings of this study and recommend clinical applications.

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