

A Morphometric Assessment of Foramen Ovale and its Variations in Dry Skulls: An Observational Study

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Abstract

Aim: To evaluate the morphometry of foramen ovale and its variations in dry skulls of India.

Methodology: This present study was undertaken on 50 dry adult human skulls obtained from Department of Anatomy, Santosh Medical College, Ghaziabad, Uttar Pradesh, India. The foramen ovale was observed from the extra cranial view of skull base. Skulls with damaged walls of foramen ovale were not considered. The shape of the foramen ovale was noted by direct inspection as per the classification. Accessory foramen and bony growth around the margins of foramen were also noted. Measurements of foramen ovale were taken by placing a pair of divider on antero-posterior length and transverse diameters of the foramen and then carefully transferred to a meter rule for the readings to be taken. Variation in right and left side in length and breadth was also evaluated.

Results: A total of 38 skulls were studied. We found most common shape of foramen ovale was of oval type and was present in 52% cases. The shape of foramen ovale was round in 18% cases, almond in 24% cases and D-Shaped in 6% cases. Out of 50 skulls, spines were present in 4 skulls (8%). The maximum length and width of foramen ovale on the right and left side was 8.08 mm, 5.14 mm and 9.98 mm, 5.26 mm respectively. Minimum length and width of foramen ovale on right and left side was 6.04 mm, 2.92 mm and 5.62 mm, 2.16 mm respectively. Mean length on right and left side was 7.10 mm and 7.66 mm and mean width on right and left side was 4.02 mm and 3.83 mm respectively.

Conclusion: Knowledge in variations of morphometry of foramen ovale has various clinical, anatomical and surgical importance. The results of this study will provide an in-depth knowledge about the foramen ovale in dry skulls to the anatomists. This knowledge will also be useful to clinicians and surgeons in planning and executing procedures of the skull base in Indian population.

Keywords: Foramen Ovale, Morphometry, Surgery.

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Introduction

Skull base has many important foramina which gives passage to multiple important neurovascular structures, entering into the cranial cavity from extra cranial regions or

passing through the foramina to exterior. In middle cranial fossa, there are 3 such foramina which are persistently present at the junction of body and greater wing of sphenoid-foramen rotundum, foramen ovale, foramen spinosum. The Foramen Ovale is present in the posterior part of the greater wing of the sphenoid. The important structures which pass through it are the mandibular nerve, the accessory meningeal artery, the lesser superficial petrosal nerve and the emissary vein [1]. This is the one of the important foramina which are situated at the transition zone between the intracranial and the extra cranial structures [2]. The foramen ovale opens into the infratemporal fossa, through its other opening on the lateral surface of the greater wing [3].

The foramen ovale also differs in size and shape like other foramina. The earliest perfect ring shaped formation of foramen ovale was observed in the 7th foetal month and latest in the 3 years after birth and seen as a discrete foramen at 22 weeks. The length of the foramen ovale was about 3.85 mm in the new born and 7.2 mm in adults and the width of foramen ovale was about 1.81 mm in the new born and 3.7 mm in adults [4]. The previous studies which indicates the different variations of foramen ovale such as the venous component of the foramen ovale may be separated from the other contents of the foramen by a bony spur located antero-medially resulting in double foramen ovale [5] or it can be covered by ossified ligaments extending between the lateral pterygoid process and the sphenoid spine or found to be divided into 2 to 3 components associated with irregularities [6].

Although variations in the shape of the FO may normally be present, a careful evaluation of these foramina will facilitate the diagnosis of the lesions which are present in the middle cranial fossa and the nasopharynx. When an enlargement of the FO occurs, it is tempting to consider neurinoma of the fifth nerve [7]. This study not only has developmental anatomical

importance, but it also has a profound surgical importance, as in trigeminal neuralgia and a diagnostic importance as in tumours and in various types of epilepsy, as of the fine needle aspiration technique in a perineural spread of the tumour and as of the electroencephalographic analysis in seizures. The mandibular nerve which traverses the foramen ovale and trigeminal ganglion that is situated in the Meckel's cave are targeted by neurosurgeons and pain physicians in patients with trigeminal neuralgia. Trigeminal rhizotomy procedures which are done for treating trigeminal neuralgia necessitate an in-depth knowledge about the foramen ovale. Hence, this study was designed to evaluate the morphometry of foramen ovale and its variations in dry skulls of India.

Methodology

This present study was undertaken on 50 dry adult human skulls obtained from Department of Anatomy, Santosh Medical College, Ghaziabad, Uttar Pradesh, India. The foramen ovale was observed from the extra cranial view of skull base. Skulls with damaged walls of foramen ovale were not considered. The shape of the foramen ovale were noted by direct inspection as per the classification given by Roma *et al* [8] and Daimi *et al* [9] such as oval, round, almond, D-shaped and slit shapes. Accessory foramen and bony growth around the margins of foramen were also noted. Measurements of foramen ovale were taken by placing a pair of divider on antero-posterior length and transverse diameters of the foramen and then carefully transferred to a meter rule for the readings to be taken. Variation in right and left side in length and breadth was also evaluated.

Results

A total of 38 skulls were studied. We found most common shape of foramen ovale was of oval type and was present in 52% cases. The shape of foramen ovale was round in 18%

cases, almond in 24% cases and D-Shaped in 6% cases. Out of 50 skulls, spines were present in 4 skulls (8%).

Table 1: Dimensions of foramen ovale in right and left side.

VALUES	Length (right side in mm)	Length (left side in mm)	Width (right side in mm)	Width (left side in mm)
Maximum	8.08	9.98	5.14	5.26
Minimum	6.04	5.62	2.92	2.16
Mean	7.10	7.66	4.02	3.83

The maximum length and width of foramen ovale on the right and left side was 8.08 mm, 5.14 mm and 9.98 mm, 5.26 mm respectively. Minimum length and width of foramen ovale on right and left side was 6.04 mm, 2.92 mm and 5.62 mm, 2.16 mm respectively. Mean length on right and left side was 7.10 mm and 7.66 mm and mean width on right and left side was 4.02 mm and 3.83 mm respectively.

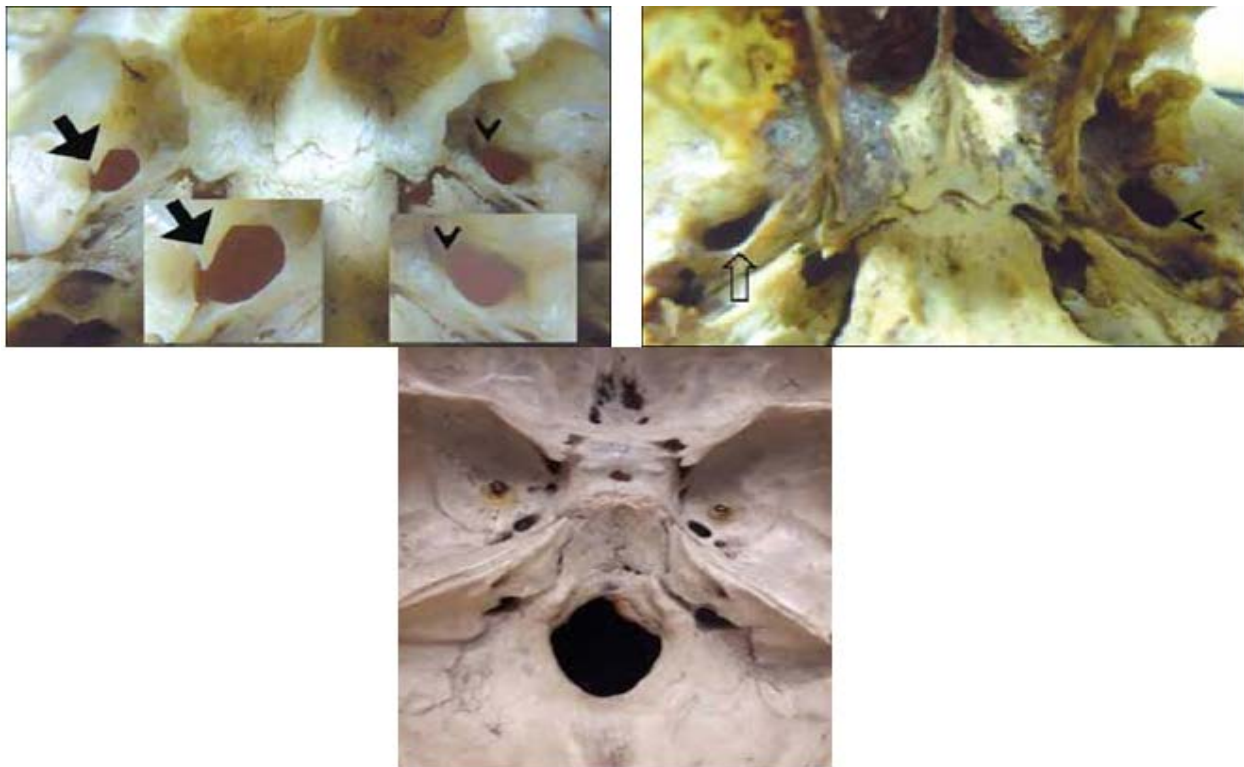


Figure 1: Types of foramen ovale.

Discussion

Information on foramina variants of the human skull gives insight into associations between neurovascular anatomy and the cranial morphology. The sphenoid bone, because of its complex structure and intricate embryological origin, should be studied in different anatomical aspects, including its normal and abnormal variation. FO is used for various

invasive surgical as well as diagnostic procedures such as electroencephalographic analysis of the seizure for patients undergoing selective amygdalo-hippocampectomy [10], microvascular decompression by percutaneous trigeminal rhizotomy for trigeminal neuralgia [11, 12] and percutaneous biopsy of cavernous sinus tumours [13] etc. The technique of CT-

guided trans facial fine needle aspiration technique through the FO is used to diagnose squamous cell carcinoma, meningioma, meckel etc., and allows biopsy of deep lesions that would otherwise require open surgical biopsy or craniotomy [14, 15], thus helping to decrease patient morbidity and significantly decrease the cost involved.

The study by Ray *et al* found the length to be 7.46 mm on right side and 7.01 mm on left side and the width to be 3.21 and 3.29 mm on the right and left sides, respectively [16]. Lang *et al* found the length of adult foramen ovale to be 7.2 mm and width to be 3.7 mm [17]. Hwang *et al* observed the length to be 8.24 mm on left side and 8.1 mm on the right side and width to be 4.12 and 4.01 mm on the right and left sides, respectively [18]. Somesh *et al* reported the mean AP diameter to be 7.64 and 7.56 mm on right and left sides, respectively [19]. In the study conducted by Wadhwa *et al*, the mean length of the right and left foramen ovale was found to be 6.8 and 6.5 mm and the mean width of right and left foramen ovale to be 3.7 and 4 mm, respectively [20]. These results were found to be closely related to the data obtained from the present study. This might be due to the fact that the number of nerve fibers passing through the trunk of the mandibular nerve is fairly constant in the human population.

Ray *et al* observed that 63% of the skulls on the right side and 60% of the skulls on the left side possessed oval-shaped foramen ovale. Khan *et al* have reported that one skull has a large irregular foramen with 12 mm APD (anteroposterior diameter) and 6 mm TD (transverse diameter) [21]. So it is seen that in our study, the foramen ovale is oval shaped in two-thirds of the skulls which is in agreement with earlier studies. The shape of the foramen ovale can cause unforeseen difficulties in surgical procedures if there are any unusual shapes that may be present in the patients.

Some of the accessory bony structures that have been found are completely or

incompletely ossified pterygoalar and pterygospinous ligaments, bony shelves at the margins of the foramen ovale, and bony septations of the foramen ovale. Khan *et al* also noted that one skull had a bony spicule which divided the foramen ovale into two [21]. The foramen present in the ossified pterygoalar ligament is termed as foramen of Hyrtl and the foramen present in the ossified pterygospinous ligament is termed as foramen of Civinini. Tubbs *et al* identified the ossified ligaments of Hyrtl and Civinini in 2.6% of cases [22, 23]. In studies conducted by Reymond *et al*, it was found that 4.5% of cases had septation in the foramen ovale [24]. Similar results pertaining to the above mentioned morphological variations were also obtained in our study.

Conclusion

Knowledge in variations of morphometry of foramen ovale has various clinical, anatomical and surgical importance. The results of this study will provide an in-depth knowledge about the foramen ovale in dry skulls to the anatomists. This knowledge will also be useful to clinicians and surgeons in planning and executing procedures of the skull base in Indian population.

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