

Original research article

Morphometric and Morphological Study of Foramen Ovale in Adult Dry Human Skulls in Telangana Region

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Abstract

Background: Foramen Ovale (FO) is the most important constant foramen of greater wing of sphenoid in the middle cranial fossa. It opens into infratemporal fossa and gives passage to mandibular nerve, accessory meningeal Artery, lesser petrosal nerve, emissary veins. It is usually oval in shape but its shape shows variations when compared to rest of the foramina in the skull. It is of great significance to neurosurgeons as transcranial approach to skull base is possible via it in case of trigeminal neuralgia.

Methods: The present study was an observational study, conducted on 50 dry human skulls (100 foramen ovale) in the department of anatomy, Osmania Medical College, Hyderabad, Telangana, India. The study has taken prior approval from Institutional Ethical Committee. This study included fully ossified, dried, cleaned skulls of unknown sex, Broken & deformed skulls were excluded from the study

Results: In the present study the mean antero-posterior diameter (APD) of FO was 6.55 ± 1.4 mm, 6.52 ± 1.3 mm on right side and left side respectively. The mean transverse diameter (TD) of FO was 4.19 ± 1.1 mm and 4.13 ± 1.4 mm on right side and left side respectively. The most common shape was oval in 65%, followed by almond shape in 14%, D-shape in 11%, longitudinal/slit like in 4%, irregular in 4% of foramen ovale and confluence of FO with spinosum was seen in 2% of foramen ovale.

Conclusion: The detailed anatomical knowledge of FO is of great importance to the clinicians in diagnosis & management of various neuro surgical procedures and micro vascular approaches. Variations in the shapes of the FO are found due to developmental reasons, which may seriously hamper clinical & diagnostic procedures

Key words: Foramen ovale, Skulls, Shape, Anteroposterior diameter, Transverse diameter

Introduction

Base of skull is provided with important foramina which allows passage of important neurovascular structures, entering into the cranial cavity from extra cranial regions or passing through the foramina to exterior. [1] FO is the most important constant foramen of greater wing of sphenoid in the middle cranial fossa [2]. It opens into infratemporal fossa and gives passage to mandibular nerve, accessory meningeal Artery, lesser petrosal nerve, emissary veins [3]. It is usually oval in shape but its shape shows variations when compared to rest of the foramina in the skull. It is of great significance to neurosurgeons as transcranial approach to skull base is possible via it in case of trigeminal neuralgia. A careful observation of these foramen will be helpful in diagnosis of the lesions present in the nasopharynx & middle cranial fossa. Neuroma of 5th cranial Nerve can lead to enlargement of the foramen ovale [3] Moreover, bony outgrowths in the form of spurs, can compress the passing mandibular Nerve & hence forth could lead to dysfunction of the muscles supplied by it [3].

Aims & Objectives:

- To determine/ evaluate the morphometry & morphology of foramen ovale in adult dry human skulls
- To study the morphometric parameters of foramen ovale like antero-posterior diameter(APD) & transverse diameter (TD)
- To study the morphology of foramen ovale (FO) like shape

Materials and Methods

The present study was an observational study, conducted on 50 dry human skulls (100 foramen ovale) in the department of anatomy, Osmania Medical College, Hyderabad, Telangana, India. The study has taken prior approval from Institutional Ethical Committee.

Inclusion criteria: This study included fully ossified, dried, cleaned skulls of unknown sex

Exclusion criteria: Broken & deformed skulls were excluded from the study

Methodology: Various morphometric parameters of FO (both Rt & Lt sides) like APD, TD were measured with the help of dividers in an accuracy of 0.01mm [All measurements were repeated twice to eliminate observer bias]. Shape of FO was observed by naked eye examination and photographs were taken by using digital camera. Margins of FO were carefully observed for any bony projections.

Statistical analysis: The collected data was uploaded on MS Excel spreadsheet and analyzed by SPSS version on 21.0 on windows format. The continuous variables were represented as mean, standard deviation, and percentages.

Results

The present study was conducted on 50 dry human skulls in the Department of anatomy, Osmania medical college, Hyderabad, Telangana. In the present study the mean antero-posterior diameter (APD) of FO was $6.55 \pm 1.4\text{mm}$, $6.52 \pm 1.3\text{mm}$ on right side and left side respectively. The mean transverse diameter (TD) of FO was $4.19 \pm 1.1\text{mm}$ and $4.13 \pm 1.4\text{mm}$ on right side and left side respectively [Table-1]. However, the difference between APD, TD of Right and Left sided FO was not significant statistically ($P\text{-value} > 0.05$). In the present study various shapes of FO was observed. The most common shape was oval in 65% cases [Figure-1], followed by almond shape in 14% [Figure-2], D-shape in 11% [Figure-3], longitudinal/slit

like in 4% [Figure-4], irregular in 4% [Figure-5] of foramen ovale and confluence of FO with spinosum was seen in 2% [Figure-6] of foramen ovale. An accessory bony structure was present in some of the FO like spine in 4% [Figure-7], septa in 3% [Figure-8] of foramen ovale.

Table 1: The mean APD & TD of foramen ovale in mm

	Right	Left	P-value
APD	6.55±1.4	6.52±1.3	0.457
TD	4.19±1.1	4.13±1.4	0.5

Table 2: Frequency distribution of shape of foramen ovale

Shape	Percentage (%)
Oval	65
Almond	14
D-shape	11
Longitudinal/ Slit	04
Irregular	04
Confluence of FO& FS	02

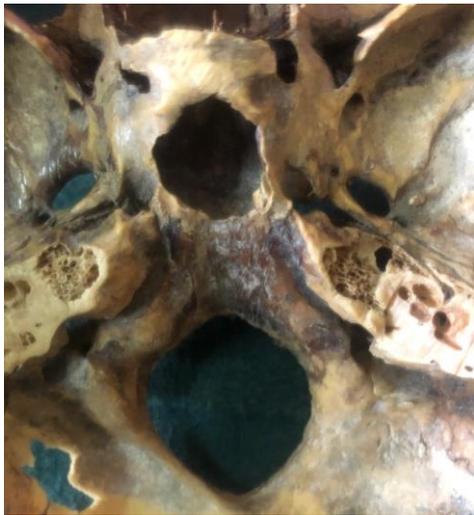


Figure-1. Oval shape of FO



Figure-2. Almond shape of FO



Figure-3. D- shape of FO (Lt side)

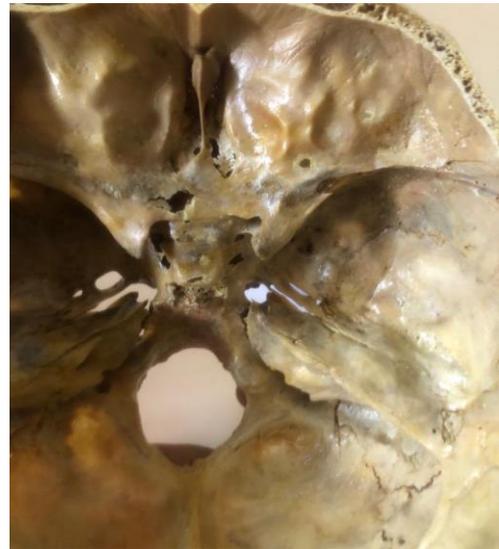


Figure-4. Slit like FO (Rt side)



Figure-5. Irregular shape of FO (Left)



Figure-6. Confluence of FO & FS (Lt)



Figure-7. Showing bony spine (Left)



Figure-8. Showing bony septa (Right)

Discussion

The cranial foramina and the variations in their presence, number, size and location besides leading to the insight towards evolution are of high clinical significance due to the neurovascular structures that traverse their narrow confines. The knowledge of the variations in the foramen ovale guides the clinicians towards a correct interpretation of radiographs and also helps in performing surgical procedures in the complicated region [4]. Hauser and De Stefano suggested that these cranial variants are the epigenetic factors which occur as a product of the genetically determined growth process of other tissues such as muscles, vessels and nerves which affect the bone formation [4]. By understanding the importance of Foramen ovale, the findings of the present study have been compared with previous studies and represented in table 3 and 4.

Table 3: Comparison of morphometric parameters of foramen ovale in various studies

Author & Year	Sample size	APD		TD	
		Rt	Lt	Rt	Lt
Prakash K.G et al., 2018 [3]	124	7.74 ± 1.94	7.60 ± 1.25	5.18 ± 0.98	5.4 ± 0.85
Katara P et al., 2020 [7]	60	7.98 ± 0.99	7.14 ± 1.24	4.24 ± 1.15	3.78 ± 0.61
Poornima B et al, 2017 [5]	100	6.5 ± 1.39	6.4 ± 1.47	3.54 ± 0.57	3.5 ± 0.84
Natasis K et al, 2017 [2]	195	7.63 ± 1.17	7.48 ± 1.20	4.47 ± 1.00	4.59 ± 1.00
Ravinther K et al, 2015 [8]	60	6.77 ± 1.65	5.74 ± 1.79	3.56 ± 0.74	4.28 ± 0.83
Sophia MM et al, 2018 [9]	111	7.57 ± 1.55	7.39 ± 1.53	4.28 ± 0.9	4.57 ± 1.1
Mishra MN et al 2019 [10]	160	4.03 ± 1.27	4.09 ± 1.44	5.95 ± 1.28	5.88 ± 1.30
Present study 2022	50	6.55 ± 1.4	6.52 ± 1.3	4.19 ± 1.1	4.13 ± 1.1

In the present study the mean APD of Rt & Lt foramen ovale was 6.55 ± 1.4 , 6.52 ± 1.3 . These observations were similar to the findings of several studies conducted by Poornima B et al., [5] Ravinther K et al., [6]. The mean TD of Rt & Lt foramen ovale was 4.19 ± 1.1 , 4.13 ± 1.1 , in our study. These parameters were close to the observations of several studies conducted by Katara P et al., [7], Natasis K et al., [2], Sophia MM et al., [8].

Table 4: Comparison of different shapes of foramen ovale in various studies

Author & Year	Sample size	Oval	Almond	D-shape	Slit	Round	Irregular	Confluence of FO & FS
Mishra SR et al, 2018 [4]	50	66	22	2	4	3	3	
Prakash KG et al, 2018 [3]	124	60.4	28.2	-	-	6.45	3.22	
Kotara P et al, 2020 [7]	60	74	-	-	-	13	16	-
Natasis K et al, 2017 [2]	195	56	19	-	-	8	17	-
Poornima B et al, 2017 [5]	100	60	25	-	2	13	-	
Farooq B et al, 2018 [9]	20	70	18	-	2	10	-	5
Sophia MM et al, 2018 [8]	111	68.5	5.85	15.3	0.9	8.55	-	-
Mishra MN et al, 2019 [10]	160	95	-	-	-	5	-	-
Present study 2022	50	65	14	11	4	-	4	2

Foramen Ovale shows variations in shape and size throughout natural life. In the 7th foetal month, the earliest formation of ring-shaped FO was observed and latest it was observed at 3 years after birth [9]. The most common shape of foramen ovale in our study was -Oval, followed by Almond shape. These findings were in accordance with observations of several studies conducted by Mishra SR et al [4], Prakash K.G. et al [3], Natsis K [2], Poornima B [5], Farooq B et al., [9]. Confluence of foramen ovale with foramen spinosum was seen in 2% of samples in our study where as it was 5% in the study conducted by Farooq B [9]. An accessory bony structure was present in some of the FO like spine in 4%, septa in 3% of FO in our study where as it was 7% and 2% in the study conducted by Mishra SR [4] et al., Stenosis or presence of a bony spicule with in the FO may result compression effect over mandibular Nerve producing different clinical symptoms [5]. Any stenosis or bony plate leads to reduced patency and difficulty in approaching for surgical procedures through this route [9]. Ray et al., [11], Khan et al., [12] claimed that the various bony structures indicate bony overgrowth during its developmental process between its first appearance & perfect ring formation [4]

Conclusion:

The shape of FO was variable, typically oval in most of the skulls (65%) followed by almond shape. There was no significant difference in measurements of various metric parameters like APD, TD between Rt & Lt sides of FO (P-value >0.05). Variations in the shapes of the FO are found due to developmental reasons, which may seriously hamper clinical & diagnostic procedures. The detailed anatomical knowledge of FO is of great importance to the clinicians in diagnosis & management of various neuro surgical procedures and micro vascular approaches.

Limitations:

The sample size was limited and concentrated on shape, APD and TD of FO. It will be beneficial to conduct similar studies with larger sample size.

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