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## **Morphometric analysis of foramen ovale and its clinical implications**

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**Abstract**---Objective- The objective of this study is to reveal the morphometric measurement of foramen ovale in dry adult human skulls. Methodology- The foramen ovale of 100 dry adult human skull were examined by digital vernier caliper. The length and width of foramen ovale of both side were measured. The variation in shape and any bony out growth present in foramen ovale was also recorded. The data was tabulated and analysed statistically. Result- The mean length of foramen ovale was  $7.82 \pm 1.29$ mm (right) and  $7.67 \pm 0.99$ mm (left). The mean value of width of foramen ovale was  $4.73 \pm 0.86$ mm (right) and  $4.86 \pm 0.88$ mm (left). The shape of the foramen ovale was typically oval in most of the skull with some bony out growth like tubercle, spine etc. Conclusion- There is no statistically significant difference between the two sides in length and width. Proper knowledge on the location, dimensions and variations of foramen ovale will be providing guidance to neurosurgeons while performing various procedures through foramen ovale.

**Keywords**---foramen ovale, morphometry, dry adult human skull, sphenoid bone.

## Introduction

The inferior surface of the skull, the base of the cranium (*basis cranii externa*, *norma basilaris*) is complex: which extends from upper incisor teeth anteriorly to the superior nuchal lines of the occipital bone posteriorly.<sup>1</sup> Base of the skull are pierced by numerous foraminae for the passage of vessels and nerves. Knowledge about the foraminae in the base of the skull is of utmost importance considering the delicate neurovascular structures that traverse through their narrow terrain. The foramina of the skull, their size, shape, symmetry, variations and location have long attracted the attention of anatomists, anthropologists, forensic experts and clinicians because of their clinical, radiographic and evolutionary significance.<sup>2</sup>

Three foramina can be identified in the infratemporal surface of the greater wing of the sphenoid bone.<sup>3</sup> The foramen rotundum (FR) is generally 3.4 mm long and situated just below and behind the medial end of the superior orbital fissure, and leads forwards into the pterygopalatine fossa, to which it conducts the maxillary nerve.<sup>4</sup> Posterolateral to the foramen rotundum (FR) is the foramen ovale (FO) which transmits the mandibular nerve. Behind the FO is the foramen spinosum (FS), which transmits the middle meningeal artery.<sup>3</sup> It is generally 2 to 4 mm long with an average diameter approximately 1.5 to 3.62 mm.<sup>5</sup> In addition, there may be another foramen called foramen ovale accessorium or foramen vesalius (FV) which connects the middle cranial fossa to the pterygoid fossa. It was described as an opening with smooth walls in front and medial to FO which leads to an oblique channel directed towards the pterygoid fossa. The canal was opened near the root of the pterygoid process. It is generally known that an emissary vein "vein of vesalius" transmits through FV which the cavernous sinus and pterygoid plexus communicate.<sup>6</sup> However, a small nerve (*nervulus sphenoidalis lateralis*) may also pass through foramen into cavernous sinus.<sup>7</sup>

Foramen ovale (FO) is a fairly large oval aperture lying posterolateral to the foramen rotundum, which opens into the infra-temporal fossa. It transmits the sensory part of the mandibular nerve along with the motor root of the trigeminal nerve, accessory meningeal artery, lesser petrosal nerve, emissary veins, and sometimes the anterior trunk of the middle meningeal sinus.<sup>8</sup> The foramen ovale (FO) is of great surgical and diagnostic importance in procedures like fine needle aspiration via transfacial approach, in the perineural spread of tumour, trigeminal rhizotomy via percutaneous approach for trigeminal neuralgia and the electroencephalographic analysis. However, variations are seen in the shape and size of the FO which bear important clinical implications.<sup>2</sup>

## Material and Methods

The present study conducted on 100 dry adult human skulls which was collected from Santosh Medical College & Hospital and other medical college of NCR region. The skulls which was damage around the foramen ovale were not observed. The

morphometric parameters were measured with the help of digital vernier caliper. The following measurements were taken in dry adult human skulls-

- Length of foramen ovale i.e antero-posterior diameter of both side(Fig.1)
- Width of foramen ovale i.e medio-lateral diameter of both side(Fig.2)
- The shape and any bony outgrowth present in foramen ovale were also observed.



Fig. 1: Antero-posterior diameter of foramen ovale



Fig. 2: Medio-lateral diameter of foramen ovale

## Result

The mean length of foramen ovale was  $7.82 \pm 1.29\text{mm}$ (right) and  $7.67 \pm 0.99\text{mm}$  (left) table 1&2. The mean value of width of foramen ovale was  $4.73 \pm 0.86\text{mm}$  (right) and  $4.86 \pm 0.88\text{mm}$  (left) table 3&4. The shape of the foramen ovale was typically oval in most of the skulls(52%) table 5. There is no statistically significant difference between the two sides in length and width.

Table 1:- showing the antero-posterior diameter of foramen ovale (RT.APDMM)

Number of skulls	100
Maximum	11.1
Minimum	5.0
Mean	7.82
Standard deviation	1.293

Table 2:- showing the antero-posterior diameter of foramen ovale (LT.APDMM)

Number of skulls	100
Maximum	10.4
Minimum	5.4
Mean	7.67
Standard deviation	0.991

Table 3:- showing the mediolateral diameter of foramen ovale (RT.MLDMM)

Number of skulls	100
Maximum	6.8
Minimum	2.8
Mean	4.73
Standard deviation	0.864

Table 4:- showing the mediolateral diameter of foramen ovale (LT.MLDMM)

Number of skulls	100
Maximum	7.4
Minimum	3.3
Mean	4.86
Standard deviation	0.882

Table 5:- showing the shape of foramen ovale (in percentage %)

Shape	Percentage
Oval	52
Almond	25.5
Round	16
Slit like	9

## Discussion

Foramen ovale, which was present in the greater wing of sphenoid bone is one of the important foramen used for various neuro surgical and diagnostic procedure. So knowledge of shape, size and anatomical variations of foramen ovale is important for neuro surgeons. In the present study the mean length of FO is  $7.82 \pm 1.29\text{mm}$ (right) and  $7.67 \pm 0.99\text{mm}$  (left). Similar study was done by Biswabina Ray, Nirupama Gupta et al (2005)<sup>9</sup>they studied 35 dried human skulls and reported that APD on the right side were  $7.46 \pm 1.41\text{mm}$  and on the left sides were  $7.01 \pm 1.41\text{mm}$  respectively. Osunwoke E.A, Mbadugha C.C et al (2010)<sup>10</sup> in their study of 87 dry skulls of southern Nigerian population said that APD of FO were  $7.01 + 0.10\text{ mm}$  and  $6.89 + 0.09\text{ mm}$  on the right and left sides respectively. Somesh M.S, Sridevi H.B et al (2011)<sup>11</sup>conducted study on 82 dry skulls and reported that the APD of FO were  $7.64 \pm 1.19\text{mm}$  and  $7.56 \pm 1.12\text{mm}$  on the right and left sides respectively. Desai S.D. et al (2012)<sup>12</sup>in their study of 125 dry skulls reported that the mean APD of FO on the right side was  $8.14\text{ mm} + 1.42\text{mm}$  and on the left side was  $7.98 + 1.89\text{mm}$  respectively. Comparison of our result with those of the previous authors result shown in table 6.

Table 6: comparison of anteroposterior diameter (APD) of the foramen ovale

SI NO	Authors	Rt APD (mm)	Lt APD (mm)
1	Biswabina Ray et al (2005)	$7.46 \pm 1.41$	$7.01 \pm 1.41$
2	Osunwoke et al (2010)	$7.01 \pm 0.10$	$6.89 \pm 0.09$

3	Somesh M.S et al (2011)	7.64±1.19	7.56±1.12
4	Desai S.D et al (2012)	8.14±1.42	7.98±1.89
5	Present study (2021)	7.82±1.29	7.67±0.99

In present study the mean width(MLD) of FO is  $4.73 \pm 0.86$ mm (right) and  $4.86 \pm 0.88$ mm (left). Our study is in concurrence with the study done by Somesh M.S et al (2011)<sup>11</sup> in their study of 82 skulls and reported that the MLD of FO were  $5.12 \pm 0.82$  mm &  $5.24 \pm 0.95$  mm on the right side and left side respectively. Daimi S.R. et al (2011)<sup>13</sup> conducted a study on 90 dry skulls and found that the mean MLD of right FO was  $3.70 \pm 0.81$ mm and of left FO was  $3.34 \pm 0.77$ mm. Desai S.D et al (2012)<sup>12</sup> studied 125 dry skulls and reported that mean MLD of Rt FO was 5.26mm and MLD of Lt FO was 5.88mm respectively. Gupta N. et al (2013)<sup>15</sup> conducted a study on 35 adult dry skull and reported that the mean width of FO was  $3.57 \pm 0.70$ mm on right side and  $3.50 \pm 0.75$ mm on the left side. Ashwini et al (2017)<sup>14</sup> analyzed 55 dry human skulls and reported that the average MLD of Rt side Foramen ovale was  $4.83 \pm 0.97$ mm and MLD of Lt side Foramen ovale was  $4.59 \pm 0.97$ mm. Comparison of our result with those of the previous authors result shown in table 7.

Table 7: comparison of mediolateral diameter (MLD) of the foramen ovale

S. NO.	AUTHORS	Rt MLD (mm)	Lt MLD (mm)
1	Somesh et al (2011)	5.12±0.82	5.24±0.95
2	Desai et al (2012)	5.26	5.88
3	Gupta N et al (2013)	3.57±0.70	3.50±0.75
4	Ashwini et al (2017)	4.83±0.97	4.59±0.97
5	Present study	4.73±0.86	4.86±0.88

In the present study, the various shapes of FO were also observed. The most common shape was oval which accounted for 52% followed by almond 25.5%, round 16% and slit 6.5%. The present study coincides with study which is done by Somesh et al (2011)<sup>11</sup>, observed that oval shape of FO as 56% followed by almond, round and slit as 28.6%, 10.97% & 9% out of 82 dry skulls. Anju et al (2013)<sup>16</sup> reported that shape of FO as oval 54.29%, almond 35.71%, round 8.57% and slit 1.43%. Roma Patel et al (2014)<sup>17</sup> reported that shape of FO as oval in 59.5%, almond 12%, round 27.5% and slit 1%. Poornima et al (2017)<sup>18</sup> found that the most predominant shape of FO was oval 60% followed by round 13%, almond 25% and slit 2%. Comparison of our result with those of the previous authors result shown in table 8.

Table 8 :- comparison of shapes of foramen ovale

SNO	AUTHORS	OVAL (%)	ALMOND (%)	ROUND (%)	SLIT (%)
1	Somesh et al (2011)	56	28.6	10.97	9
2	Anju et al (2013)	54.29	35.71	8.57	1.43
3	Roma Patel et al (2014)	59.5	12	27.5	1
4	Poornima et al (2015)	60	25	13	2

5	Present study	52	25.5	16	9
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## Conclusion

The present study shows variations in shape of the foramen ovale, typically oval shape in most of the skulls (52%) followed by almond shaped. There was no statistical difference in length(antero-posterior diameter) and width(medio-lateral diameter) of foramen ovale. The knowledge of present study helps in clinical and anatomical significance for the medical practitioners in cases of treatment of trigeminal neuralgia and in diagnostic detection of tumors and abnormal bony outgrowths.

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