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Original Article

MORPHOMETRIC VARIATION OF FORAMEN OVALE IN DRY ADULT SKULL OF INDIAN POPULATION WITH CLINICAL CORRELATIONS

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ABSTRACT

Objective: The present study aim is to evaluate morphology and morphometric measurements of foramen Ovale present in the Greater wing of Sphenoid bone of the Middle Cranial fossa of the Skull base, using Digital sliding Vernier caliper. The anatomical knowledge of Foramen Ovale and its variations are of great help to neurosurgeons, oncologists and radiologists while performing any diagnostic and surgical interventions into and nearby foramen to deal with unavoidable complications as Tic douloureux.

Methods: This study was done in 35 dried Human skulls taken from the Department of Anatomy, GBCM, Dehradun, India. The length and the width of the Foramen Ovale were measured. The different shapes of the foramen were also seen. All data collected was subjected to Statistical analysis using Student's T-test.

Results: In the present study, Incidence of Oval shape foramen Ovale was maximum, followed by Elongated shape. There were no statistical differences between the mean length and mean width on the two sides of Foramen Ovale.

Conclusion: The vast knowledge of different shapes and sizes of foramen Ovale to Neurosurgeons and Oncologists helps to operate with least invasive procedures to avoid clinical manifestations.

Keywords: Foramen ovale, Sphenoid bone, Facial numbness and trigeminal neuralgia

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INTRODUCTION

In day-to-day dialect, we say a hole in skull is a Foramen. Numerous foramina are found in middle cranial fossa, mainly constituted by greater wing of sphenoid bone in its lateral part Cerebral surface and inferior surface of the greater wing of sphenoid bone presents Foramen Ovale anterior to Foramen spinosum, which in turn is anterior to the angle of the greater wing of sphenoid bone also known as the spine of sphenoid bone [1].

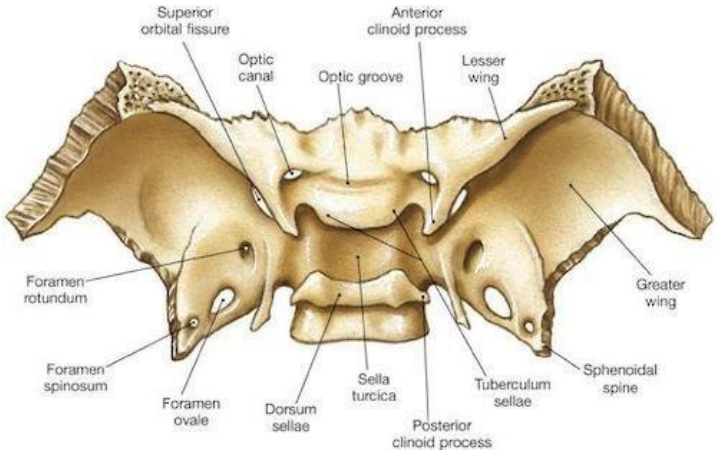

Fig. 1: Showed the superior surface of sphenoid bone

The ossification of the sphenoid bone occurs in both Membrano-cartilaginous models. At birth, sphenoid bone consists of 3 pieces but at 1styear of life, all 3 unites to form a single bone [2].

Ossification of the greater wing extends backwards, slowly towards the Petro-squamous angle, so that the foramina in this part (Ovale et spinosum) are enclosed and completed rather late, just after birth or at the end of 1st year of life.

Through Foramen Ovale passes Mandibular nerve, division of Trigeminal nerve Accessory meningeal artery, branch of 1st part of maxillary artery, lesser petrosal nerve, branch of glossopharyngeal nerve passes through it, if an osseous ridge Canaliculus Innominatus between Foramen Spinosum and Foramen Ovale not present. Sometime passes through the canaliculus Innominatus, if present and an emissary vein connecting cavernous sinus with the Pterygoid venous plexus.

The adjacent bones also undergo constant remodeling, which lays an impact on developing cranial foramina in vicinity. Thus, descriptive knowledge of normal morphology and morphometry along with its congenital malformation of foramen Ovale is must for a Neurosurgeon to be aware of its clinical manifestation like Trigeminal Neuralgia and its implications.

MATERIALS AND METHODS

This study was carried out on a total 35 [35 of right side and 35 of left sided Foramen Ovale] dried human skulls of undetermined gender and age. Skulls were obtained from the Department of Anatomy, Gautam Buddha Chikitsa Mahavidyalaya affiliated to Ras Bihari Bose Subharti University Dehradun, Uttarakhand.

Exclusion criteria

Fractured or damaged skulls in the area of greater wing of sphenoid bone or in vicinity of the foramen Ovale were excluded from the study.

The following Morphometric parameters were studied in each Foramen Ovale:

Length of the foramen (maximum anteroposterior diameter)

Width of the foramen (maximum transverse diameter)

The different shapes of the foramen ovale as oval, round, triangular, irregular, elongated and bean-shaped, were seen and noted and even anatomical variations like bony spicules, tubercles, duplications, and irregular bony margins were carefully observed, recorded and photographed. Each morphometric and morphological parameter was independently measured and assessed twice by the same observer to avoid interobserver bias. The percentage of the occurrence of different shapes of foramen ovale was calculated. All the data collected were tabulated and subjected to statistical analysis. The mean value ± standard deviation and p-value using

Student's T-Test was calculated using excel 2011 and considered statistically significant at 0.05 level of significance.

The measurements were taken with the help of digital sliding Vernier caliper (fig. 2)

Fig. 2: Showed digital sliding vernier caliper

Fig. 3: Showed the morphometric measurements of FO

RESULTS

In the present study, the collected data showed the shape of foramen ovale in majority of the skull as oval shape with the incidence of 34.28% on right side while 42.85% on left side followed by elongated shape, 25.71% on the right and 17.14% on the left side (table 1).

Table 1: Prevalence of different shapes of Foramen Ovale

S. No.	Shape of foramen ovale	Incidence	
		Right	Left
1	Round	5.71%	25.71%
2	Oval	34.28%	42.55%
3	Triangular	5.71%	0
4	Slit like	5.71%	8.57%
5	Irregular	8.57%	5.71%
6	Elongated	25.71%	17.14%
7	Kidney shaped	11.42%	2.85%

In the present study, the mean length of the foramen ovale on the right side was 4.419±1.091 mm and on the left side was 4.227±1.045 mm. However, the mean width of the foramen ovale on the right side was 4.770±1.029 mm, while on the left side as 5.029±0.925 mm (table 2).

Table 2: Mean±standard deviations values of length and width of foramen ovale in both right and left side of skull

Foramen ovale diameter	Right	Left
Length	4.419±1.091 mm	4.227±1.045 mm
Width	4.770±1.029 mm	5.029±0.925 mm

There were no significant differences between the mean length and the mean width on the two sides according to Student's T-Test analyzed. Since the values obtained of T-tests are greater than 0.05 level of significance (table 3).

Table 3: Statistical analysis of foramen ovale parameters

Foramen ovale parameters	T-test value	Degree of freedom (DF)	Mean difference (MD) value	Standard error of deviation (SED)	p-value
Length/Antero-posterior diameter	0.461	66	0.192	0.259	>0.05
Width/Medio-lateral diameter	0.280	66	-0.258	0.237	>0.05

DISCUSSION

In the present study the commonly occurring shape of the foramen ovale is oval shape (77.13%) followed by elongated shape (42.85%) bilaterally. The findings of most of the study depicted oval-shaped foramen ovale similar to the present study, followed by round shape but the shape of foramen ovale observed by Sink Z. *et al.* [5] is irregular shape (21%) in second position after Oval shape. Similarly seen by Ashwini N. S. and Venkatesh KV [20]. Oval shape (69.09%) followed by irregular shape (14.5%) (table 4).

Table 4: Comparison of shape of FO between present and previous studies

S. No.	Authors	Years of study	Shape of foramen ovale (%)						
			Round	Oval	Triangular	Slit like	Irregular	Elongated	Kidney shape
1.	Garapati S. *et al.* [3]	2024	9	70	……	……	2	6	…….
2.	Alaftan M. *et al.* [4]	2023	31	47	……	……	……	1.5	…….
3.	Sink Z. *et al.* [5]	2023	3.0	37.1	0.7	0.7	21.0	……..	1.5
4.	Mukharjee B. *et al.* [7]	2023	……	66	……	1	……..	……..	……
5.	Shivamurthy K. *et al.* [8]	2023	6	73	……	…….	2	…….	……
6.	Jaiswal P. *et al.* [9]	2023	……	66.67	……	1.45	1.45	……..	……
7.	Kaur A. *et al.* [10]	2022	4	68	1	1	……..	…….	……
8.	Yadav Y. *et al.* [11]	2022	16	52	……	9	……..	…….	……
9.	Sthapak E. *et al.* [12]	2022	1	84	……	2	0.5	…….	……
10.	K. A. Ahmat *et al.* [13]	2022	12.85	34.2	…….	8.57	……..	……..	……
11.	Akcay E. *et al.* [14]	2021	5	70	……	6.25	……..	……..	……
12.	Das S. *et al.* [15]	2019	21.05	53.94	……	……	……..	……..	……
13.	Manavalan MS. *et al.* [16]	2018	8.55	68.46	……	0.9	…….	…….	……t
13.	Mishra, SR. *et al.* [17]	2018	3	66	……	4	3	……..	……
14.	Das S. *et al.* [18]	2018	8	70	……	….	……..	……..	……
15.	Nagy AA. *et al.* [19]	2018	……	58	……	……	…….	…….	…….
16.	Ashwini NS and Venkatesh KV. [20]	2017	7.27	69.09	……	……	14.5	……..	……
17.	Bokhari Z. *et al.* [21]	2017	10.3	72.7	……	…….	…….	……..	……
18.	Khairnar KB. *et al.* [24]	2013	7	76.5	……	6	……..	……..	……
19	Wadhwa A. *et al.* [25]	2012	6	42	……	3	……	……..	…….
20	**Present study**	**2024**	**11**	**27**	**2**	**5**	**5**	**15**	**5**

Both the length and the width measurements of Foramen Ovale bilaterally in the present study was found to be statistically insignificant, similar to most of the previous literature found. However, the comparative results of the metric dimensions of FO bilaterally were found to be statistically significant as their P-value found to be much less than 0.05 level of significance by Nagy A A. *et al.* [20]. Similarly, Shivmurthy K. *et al.* [8] seen statistically significant differences between the right and left breadths of FO (P–value 0.0126) but found statistically insignificant differences in length measurements of FO bilaterally.

Table 5: Comparing present study morphometric measurements with previous studies

S. No.	Authors	Area of study	Year of study	Foramen ovale length (mm)		Foramen ovale width (mm)	
				Rt.	Lt.	Rt.	Lt.
1.	Garapati S. *et al.* [3]	South India	2024	7.09±1.07	7.06±1.01	4.16±0.79	4.15±0.5
2.	Alaftan M. *et al.* [4]	Saudi Arabia	2023	6.462±1.681	4.897±1.0631	2.4565±0.51275	6.451±1.6691
3.	Bhattarai R. *et al.* [6]	Nepal (BPKIHS)	2023	7.79±1.10	6.92±1.11	3.68±0.64	3.69±0.95
4.	Sink Z. *et al.* [5]	Slovenia	2023	7.13±1.34	7.20±1.29	3.71±0.81	3.88±0.84
5.	Mukharjee B. *et al.* [7]	Kolkata	2023	9.68±o.524	10.008±0.412	3.12±0.718	4.18±1.063
6.	Shivamurthy K. *et al.* [8]	South India	2023	6.86±1.26	6.84±1.3	3.51±0.58	3.53±0.59
7.	Jaiswal P. *et al.* [9]	Rajasthan	2023	7.03±1.17	6.88±1.11	3.62±0.74	3.65±0.63
8.	Kaur A. *et al.* [10]	Egypt	2022	6.99±1.44	6.59±1.37	4.17±0.76	4.09±0.74
9.	Yadav Y. *et al.* [11]	NCR Noida Delhi	2022	7.82±1.29	7.67±0.99	4.73±0.86	4.86±0.88
10.	Sthapak E. *et al.* [12]	lucknow	2022	7.75±1.16	3.98±091	6.90±078	3.57±1.04
11.	Ahmat KA. *et al.* [13]	Turkey	2022	6.144±0.913	7.981±0.109	2.885±0.565	4.559±0.067
12.	Akcay E. *et al.* [14]	Istambul	2021	7.09±1.07	7.06±1.01	4.16±0.79	4.17±0.5
13.	Das S. *et al.* [15]	Kolkata	2019	7.17±1.31	7.26±1.91	3.49±0.54	3.73±0.23
14.	Mishra SR. *et al.* [17]	Kanpur	2018	7.50±0.90	4.20±0.70	7.7±1.00	3.9±0.80
15.	Das S. *et al.* [18]	Bhubaneshwar India	2018	7.11±1.688	6.53±1.333	3.148±0.686	3.2±0.678
16.	Nagy AA. *et al.* [19]	Egypt	2018	Male 7.68±1.32 Female 7.02±1.19	7.7±1.21 6.9±1.13	5.58±1.18 5.02±1.08	5.63±1.26 5.1±0.97
17.	Ashwini NS. and Venkateshu KV [20]	Tamaka, Karanataka (India)	2017	6.59±2.21	6.38±2.52	4.83±0.97	4.59±0.97
18.	Bokhari Z. *et al.* [21]	lahore	2017	7.04±1.08	7.18±1.14	5.15±0.92	3.99±1.14
19.	Srikantaiah, VC. *et al.* [22]	Mysura, South India	2019	7.45±3.1	6.8±1.5	6.0±1.7	5.6±1.4
20.	Patil J. *et al.* [23]	South India	2013	7.0±2.17	6.8±1.40	5.0±0.42	4.70±0.91
21.	Wadhawa A. *et al.* [25]	Jalandhar (Punjab)	2012	6.5	6.8	3.7	4
22	**Present study**	**Dehradun India**	**2024**	**4.41±1.09**	**4.22±1.04**	**4.77±1.02**	**5.02±0.92**

The uniqueness in the location of the foramen ovale on the base of the skull as well as the vast structural knowledge of it serves immensely important to Neurosurgeon as it transmits neurovascular structures from middle cranial fossa to the infratemporal fossa [26].

The percutaneous approach to the foramen ovale is any surgical intervention to relief long-term pain of Trigeminal Neuralgia performing Microvascular Decompression, Rhizotomy using glycerol injection, Balloon compression etc. and Brain stereotactic radiosurgery using Gamma knife [27]. In all these procedures, the trigeminal nerve fibers are damaged to block pain signals, inserting a hollow needle through the face up to the base of the skull and to avoid commonly occurring complications facial numbness and hearing loss [28].

CONCLUSION

The knowledge of morphological and morphometric variation in Foramen Ovale plays a great impact to neurosurgeons, clinicians, oncologists and radiologist while performing any diagnostic procedure or therapeutic, surgical intervention may cause hindrance in needle insertion into the foramen may cause impingement of neurovascular structures of foramen, especially Mandibular nerve injury.

The attributed accomplishment rate of any successful surgery depends mainly upon the surgeon's vast thorough topographical knowledge of particular foramen/area where the procedure is to be performed or in the nearby vicinity to gain access with better orientation in minimal duration performing minimally invasive procedure with reduced complications and best prognosis post-surgically.

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AUTHORS CONTRIBUTIONS

Dr. Sumita Agarwal as Supervisor and Roshan Kumar Yadav as Research Scholar.

CONFLICT OF INTERESTS

Declared none

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