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FORAMEN OVALE-MORPHOMETRY AND ITS SURGICAL IMPORTANCE

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ABSTRACT

Objective- To conduct the morphometric study of foramen ovale in human sphenoid bone and present the anatomic variations in dimensions and appearance of foramen ovale. ***Methodology*** : The study was carried out using 35 dried human skulls available in the Department of Anatomy ,School of Medical Sciences and Research, Greater Noida, UP, India. Variations in size , shape were noted. Comparision with other races and difference between right and left sides were discussed. ***Results***-out of 70 sides in 35 adult dry skulls, mean length and width of foramen ovale was 7.228±1.139mm & 3.57±0.70mm on right side and 6.48±1.131mm & 3.50±0.75mm on left side. Shape of the foramen ovale was typically oval in 54.29%, almond shape in 35.71%, round in 8.57% and slit like in 1.43%.Margins of the foramen exhibited variable projections 4.2% had spines, 5.7% tubercles, 8.5% had bony plate. ***Conclusion*** -This study is of great surgical, anatomical and diagnostic importance in cases of trigeminal neuralgia, fine needle aspiration technique in perineural spread of tumor and in neurovascular compression due to abnormal bony growth.

INTRODUCTION

The greater wing of the human sphenoid bone is pierced by several foramina and Foramen Ovale (FO) is one amongst them. It is located in its posterior part and transmits mandibular nerve, accessory meningeal artery and lesser petrosal nerve and emissary vein [1,2].Several studies have shown that right side foramen ovale is narrower than left side. It has been hypothesized that entrapment of mandibular nerve when it cross FO is a primary cause of Trigeminal neuralgia (TN) and accounts for the higher incidence of TN on the right side [3].Anatomical knowledge of the foramen ovale is important for neurosurgical procedures involving the TN and administration of anaesthesia via mandibular nerve [4]. Moreover percutaneous biopsy of cavernous sinus is also performed through FO [4,5,6].The present study was undertaken to define anatomical variations in FO and review the literature regarding the same. Prior knowledge of variations in FO may be important for academic, anthropological, forensic and clinical purpose and this study aims to highlight such [4].

MATERIAL AND METHODS

This study was carried out on 70 FO using 35 adult human skulls obtained from preserved sets of bones received at Department of Anatomy, School of medical sciences and research, Greater Noida, Uttar Pradesh, India. FO was identified as an oval aperture located in the posterior part of greater wing of sphenoid bone. Skulls with damaged surroundings of the foramen ovale were not considered. Maximum length and width of FO was measured with the help of divider and transferred to a meter scale for readings. Various shapes of foramina and bony growth around the margins of the foramen were noted. Incidence of variation of shape and dimensions evaluated. Variation in right and left side and sex difference in dimensions calculated. Statistical analysis was done by using student's t test.

RESULTS

This study was conducted on a total of 70 sides in 35 dry adult skulls. Maximum and minimum length observed was 9.2mm, 4.1mm and 9.0mm, 3.2mm on right and left sides respectively (Table I). Maximum length in male was 9.2mm and in female was 9.1mm and minimum length was 4.1mm in male and 6.0mm in female skulls (Table-I). Mean length of FO was 7.228 ±1.139mm on right, 6.485±1.31mm on left side (Table-I). Mean length of FO in male was 6.80±1.3mm and in females was 6.95±1.27mm. (Table-II). Difference between the length of right and left side and the two sexes was not statistically significant, ($p>0.05$).

Maximum width of FO was 5.1mm on right side and 6.0mm on left side. Maximum width was 6.0mm, 4.2mm in male and female skulls. Minimum width was 3.0 on right side and 2.5 mm on left side (Table-I).Minimum width in male was 3.0 and 2.5 in females (Table-II). Mean width of FO was 3.57±0.70mm on right side 3.50±0.75mm on left side. Mean width of FO in male was 3.61±0.76mm and in female was 3.30±0.65mm (Table-II). Shape of FO was also observed and had been tabulated in Table-III. Foramen ovale was oval in 38 sides (20 right , 18 left), almond in 25 sides (14 right, 11 left), round in 6 sides (1

right, 5 left). Few foramen had irregular margins 3 sides out of 70 had spine (Figure 1); 4 had tubercle (Figure 2) and 6 sides had bony plate protruding from margin of the foramen ovale (Figure1 &2).

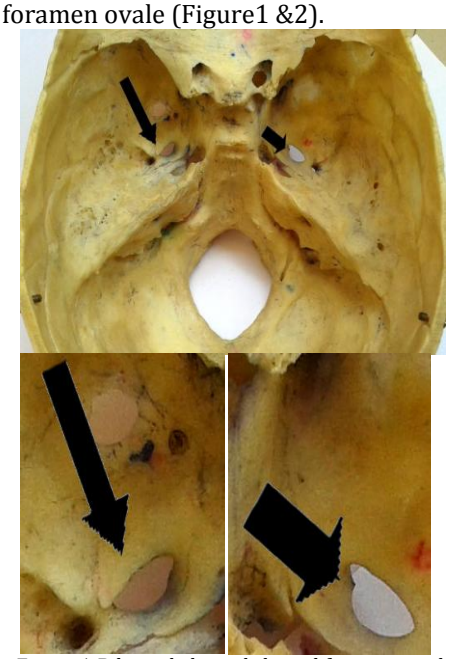

Figure 1:Bilateral almond shaped foramen ovale. Left FO showing a plate superiorly.
Right FO having a spine on its medial margin(refer to zoomed view)

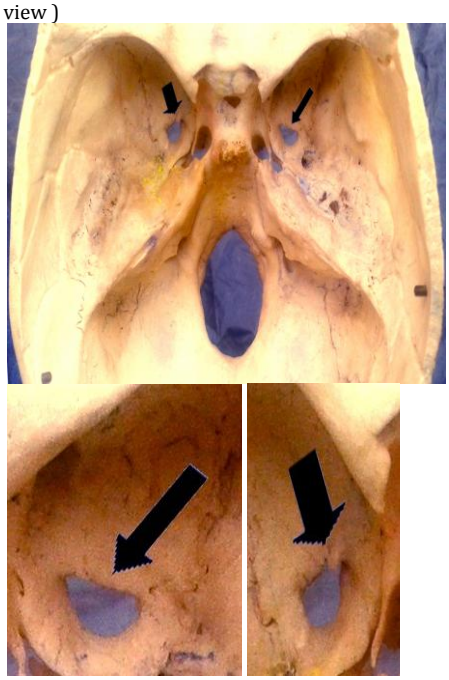

Figure 2:Bilateral altered shaped foramen ovale. Left FO having a tubercle on its superomedial margin. Right FO showing a plate superiorly. (refer to zoomed view)

***Table I*:** Length and width in mm on two sides (Right & Left)

Values	Length		Width	
	Right	Left	Right	Left
Maximum	9.2	9.0	5.1	6.0
Minimum	4.1	3.2	3.0	2.5
Mean	7.228	6.485	3.57	3.50
Standard deviation	1.139	1.31	0.70	0.751
p-value	P > 0.05		P > 0.05	

***TableII*:** Length and width in mm in male & female

Values	Length		Width	
	Male	Female	Male	Female
Maximum	9.2	9.1	6.0	4.2
Minimum	4.1	6.0	3.0	2.5
Mean	6.80	6.95	3.61	3.30
Standard deviation	1.30	1.27	0.76	0.65
p-value	P > 0.05		P > 0.05	

***Table III*:** Variations in appearance of foramen ovale

Shape of foramen ovale	Percentage Distribution		
	Right	Left	Total
Oval	57.14	51.43	54.29
Almond	40.00	31.43	35.71
Round	2.86	14.29	8.57
Slit	0.00	2.86	1.43

DISCUSSION

The FO is an important landmark for middle cranial fossa surgery. The venous segment of FO anastomoses with venous plexus of sinus cavernosus or of foramen spinosus [7]. The accuracy of percutaneous biopsy of cavernous sinus tumours through FO is required before making any decision to indicate open surgical, radiosurgical or radiotherapeutical treatment was reported to be 84% by Sindou M et al in 1997 [6].Similar to other foramina, the FO differs in shape and size throughout the life. The perfect ring shaped formation of the FO was observed in the 7th fetal month and the latest in 3 years after birth [8]. In a developmental study the length of FO was 3.85mm, 7.2mm in new born and adult respectively with average maximum and minimum length was 7.48mmand 4.17mm in adults. The width extends from1.81mm in the newborn to 3.7mm in adults [8,9].

In the present study mean length of FO was 7.228mm+/-1.13 on right side and 6.485mm+/ -0.77 on left side. Though FO on right side was longer than on left side the difference was not statistically significant (p>0.05). In a study conducted in Loni, Maharashtra the mean length of FO was 6.60mm and 6.26mm on right and left side while in a study on 82 skulls conducted in Mangalore mean length was 7.64mm+/-1.194 and7.56mm+/-1.12 on right and left side [10,11]. In a morphometric study done in south Nigerian population maximal and minimal length was 9.5mmand 5.0mm, with more than 24% of skulls of 7.0mm length [12]. In a fluoroscopically- assisted laser targeting of FO conducted in New York showed length, 6.9mm on right and 6.8mm on left side, less compared to present study with range length-5.0-10.0mm;left, 6.0-9.0mm;right [13].

In the present study maximum width of FO was 5.1mm, right; 6.0mm, left with mean width 3.57±0.77mm, right; 3.50±0.75mm on left. Difference between the width of right and left side was not statistically significant (p>0.05).A German study found width 1.81mm and 3.7mm in newborn, adult respectively [9]. A study on Nigerian population showed widths of 57% of the FO were within the range of 3.0-3.5mm [12].

Variations in the shape of FO showed maximum number of foramen to be oval shaped (n=38; 54.2%) followed by almond shaped (n=25; 35.7%), round (n=6; 8.5%) and slit like (n=1; 1.4%). Developmental studies conducted in Japan also reported majority of the FO to be oval shaped [8].

A thorough understanding of fetal growth and development is the key to understanding both the completed normal anatomic structure and the abnormal variations. Most of the central skull base develops from endochondral ossification through an intermediary chondrocranium [14] .The sphenoid bone consists of the body (formed by the presphenoid and postsphenoid centres, with a contribution from the medial crus of the orbitosphenoid).The lesser and greater wings from orbitosphenoids, alisphenoids respectively [14]. Ossification of the skull progresses in an orderly pattern from posterior to anterior. The postsphenoid (14 weeks) and then presphenoids (17 weeks) of the sphenoid bone ossify.

Ossification is seen laterally in the orbitosphenoid (16 weeks) and the alisphenoids (15 weeks).A CT scan study of fetal specimen with a gestational age of 22weeks 3 days showed ossification of alisphenoid (that forms greater wings) and FO seen as large defect [14] . Ossification around the large trunk of mandibular nerve takes place later. Hence the variations observed in shapes and margins of FO indicate bony outgrowth during developmental process.

FO is of great surgical and diagnostic importance. Knowledge of the variations of its anatomy may help to better identify and preserve important neurovascular structures during approaches to the middle cranial fossa because surgical treatment of TN is most commonly done by microvascular decompression by percutaneous trigeminal rhizotomy done through FO [15,16].

In a study conducted in china, 100% success rate was achieved when FO was punctured in TN radiofrequency ablation under the guidance of X-ray real time imaging [17]. Moreover electroencephalographic analysis of seizure by electrode placed at FO provided good neurophysiological information in candidates for selective amygdalo-hippocampectomy [18] .

Nasopharyngeal carcinoma frequently spreads intracranially via FO (34%) [19].The CT guided fine needle aspiration technique through FO permits biopsy of deep lesions that otherwise require open surgical biopsy or craniotomy, thus decreasing cost and patient morbidity [20,21] .

CONCLUSION

This study is of clinical, diagnostic and anatomical significance to medical practitioners in cases of trigeminal neuralgia, detection of tumours, bony outgrowth that may lead to ischaemia, necrosis and possible paralysis of the parts of the body being supplied, drained or innervated by its contents.

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