https://doi.org/10.26682/sjuod.2023.26.1.42
Journal of University of Duhok., Vol. 26, No.1 (Pure Engineering Sciences),Pp 433-438, 2023

COMPUTED TOMOGRAPHY FOR FORAMEN OVALE EVALUATION

HAVEEN **H**AJI **K**URDO[*], **S**OHAIB **H**ASAN **A**LI and **M**AYSALOON **S**HAMAN **S**AEED[**]
[*]Dept. of oral and maxillofacial dentistry, College of dentistry, University of Duhok, Kurdistan Region-Iraq
[**]Dept. of Radiology, College of medicine, University of Duhok, Kurdistan Region-Iraq

(Received: October 19, 2022; Accepted for Publication: January 5, 2023)

ABSTRACT

Introduction: Foramen ovale (FO) is a significant foramen located in the greater wing of the sphenoid bone, It is one of the foramen that form the base of the skull, which is an important anatomic structure of the skull's anatomy. Computed tomography (CT) is used to evaluate the foramen ovale.

Objectives: The axial plane of computed tomography was utilized to measure the foramen ovale's dimensions (length and width) and observe the variations in its shape.

Patients and Methodes: A total of one hundred foramen ovale were evaluated from fifty computed tomographies (CTs). The axial image shows the bilateral FO of one patient. The length and width on both sides were measured. The information was gathered from the radiology department at Vajeen Private Hospital in Duhok, Kurdistan, Iraq.By using the RadiAnt DICOM viewer, we measured the anterioposterior diameter (length), transverse diameter (width), and shape of the foramen ovale on both sides. The significant level of difference was determined by a p-value <0.05.

Results: The mean (SD) length of the foramen ovale on the right side was 6.98 (1.04) mm and on the left side was 6.83 (1.10) mm, and the mean width of foramen ovale was 3.87 (0.78) mm on the right side and 4.16 (0.70) mm on the left side. The foramen ovale was typically oval in 63 cases (28 on the right and 35 on the left), almond in 15 cases (11 on the right and 4 on the left), irregular in 14 cases (9 on the right and 5 on the left), and round in 8 cases (2 right, 6 left).

Conclusion: Variations are commonly seen in the dimensions of the foramen ovale, which is usually used in different diagnostic and therapeutic procedures. The width of the foramen ovale significantly differed between the left and right sides (P<0.05), although the length of the ovale did not differ significantly (P > 0.05). Comparing this study to other research, there was no visible variation in the foramen ovale's shape.

KEYWORDS: Computed tomography, Foramen ovale , Variation, Skull.

INTRODUCTION

Foramen ovale (FO) is a significant foramen located in the sphenoid bone in (the greater wing part). It is one of the foramen that form the base of the skull (Stozitzky Muñoz and Rueda-Esteban, 2016; Saurjyaranjan *et al*., 2018) through which the infratemporal fossa communicates with the middle cranial fossa (Kanyata *et al*., 2015; Srikantaiah and Shetty, 2019). The FO is found on the infratemporal surface of the greater wing of the sphenoid bone, which is posterolateral to the foramen rotundum and lateral to the lingual and posterial end of the caroted groove. It is located towards the lateral pterygoid plate's upper end (Desai *et al*., 2012; Nelluri, 2013; Murugan and Saheb, 2014). The foramen is located on the lateral side of the lacerum foramen and the anterior side of the Eustachian tube, as well as the external aperture of the carotid canal and the skull's spinous foramen (Akcay *et al*., 2021). It serves as a path for the lesser petrosal nerve, accessory meningeal artery, mandibular nerve, and emissary veins (Skrzat *et al*., 2006; Saurjyaranjan *et al*., 2018; Shankar and Muthukumaravel, 2019).

The shape of the foramen ovale is often oval compared to another foramen of the skull (Ashwini and Venkateshu, 2017). However, there are variations, such as typically oval, almond-shaped, typically round, and irregularly shaped (somesh *et al*., 2011). Abnormal ossification or overgrowth of the surrounding bones near the foramina at the base of the skull can result in abnormal bony outgrowths like spines, bony spurs, tubercles, and bony plates, which can cause ischemia, necrosis, and even paralysis of the body parts it supplies, drains, or innervates (somesh *et al*., 2011; Nelluri, 2013).

The foramen ovale on the right side of the human cranium is significantly smaller than the foramen ovale on the left side, according to anatomical and radiological research (Erbagci *et al*., 2010; Bokhari *et al*., 2017).

The foramen ovale is crucial in many neurosurgical and giagnostic procedures involving the middle cranial fossa (Rao *et al*., 2017; Chanda *et al*., 2020). During surgical techniques, understanding the topography and variability of the FO can help prevent damage to the trigeminal nerve (Ashwini and Venkateshu, 2017). Given the limited access to clinical evaluation of this foramen, computed tomography (CT) plays a crucial role in the diagnostic evaluation, treatment planning, and follow-up of lesions and abnormalities in the FO. It improves average osseous detail and is quick and simple to use for a variety of medical teams and physicians (Al-Sharify *et al*., 2020).

High-resolution computed tomography (CT) appears particularly well-suited to illustrate the wide range of anatomic variation of foramina in the middle cranial fossa due to its outstanding bone delineation. It is essential to comprehend these variations in order to distinguish between normal and potentially pathological structures (Ginsberg *et al*., 1994). In the current study, we assessed FO in healthy individuals using computed tomography (CT).

PATIENTS AND METHODS

The present study was conducted on 100 foramen ovale of 50 adult patients, of those, 27(54%) were male and 23 (46%) were female. The mean age of the patients was between 43.84 (18.50) and (19-90) years.

Computed tomography images of the brains of patients were collected from the department of radiology, Vajeen Private Hospital, Duhok, Kurdistan of Iraq. The study was conducted from December 2021 until September 2022.

Radiological information of 50 individuals was collected as they had headaches or sinusitis; non of patients had multiple sclerosis, plaques, tumors, or abnormalities of the skull base.

Every patient received a routine thinsection, 16-slice CT scan of the skull base. The CT scans in this study were performed on a CT device (Siemens sensation CT, Siemens, Germany) at Vajeen Private Hospital evaluating the foramina using a reformatted image of the base of the skull and an axial plane bone window. A standard exposure and patient positioning strategy were used to capture all CT images without the use of contrast. Imaging was done on a scanner with 16 detector rows. A plane parallel to the infraorbitomeatal line was used to capture images in a helical method. This includes axial CT scans with slices that were 1.5 mm thick, exposed at 120 kV, at 250 mAs, at 0.417 pitch values, had a 6x0.75 mm collimation, and had 512X512 matrixes.

By using the RadiAnt DICOM viewer, version 2022.1 (32-bite), the measurements were taken by placing the pointer on the border of FO anteriorly and extending to the posterior border to measure the length of the foramen. Perpendicular to this, both sides were determined to have the same width (transverse diameter) (Fig.1) The measurements were recorded in millimeters. And using a pencil from the viewer to draw the border of FO to appear in the shape of a foramen.

STATISTICAL ANALSIS

The mean (SD) and number (%) of the patients' general data were displayed. An independent t-test was used to assess the patient data. On a CT scan of a patient, the anteroposterior (length) and transverse (width) diameters of the right and left foramen ovale were measured. An independent t-test or Pearson chi-squared tests were used to analyze the results. A p-value of <0.05 was used to identify the difference as being significantly different. Using JMP Pro 14.3.0, the statistical calculations were carried out.

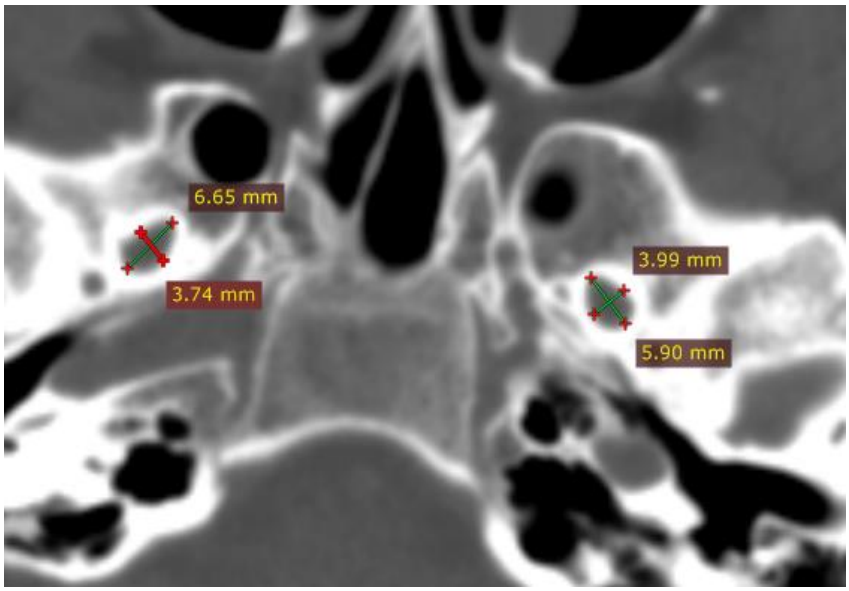

Fig. (1): A CT scan axial image of a male 29-year-old. It shows the dimentional measurements of both sides of FO. Right FO: 6.65 x 3.74 mm, left FO: 5.90 x 3.99 mm.

RESULTS

In In the current study, the anterioposterior dimention (length) was 6.98 (1.04) mm on the right side and 6.83 (1.10) mm on the left side, while the maximum and minimum lengths on the right and left sides, respectively, were 10.6 mm, 4.6 mm and 10.6 mm, 4.63 mm.

The mean (SD) transverse dimension (width) was 3.87 (0.78) mm on the right side and 4.16 (0.70) mm on the left. The maximum and minimum widths were 5.32 mm and 2.23 mm on the right side, respectively, and 6.15 mm and 2.62 mm on the left side.

The foramen ovale's width was significantly different between the right and left sides ($P<0.05$), while the foramen ovale length was not significantly different ($P > 0.05$) (Table 1).

Table (1): Shows the mean, range, standard deviations (SD), and p-value of the foramen ovale parameters in the right and left sides

Measurement (mm)	Mean (SD)	p-value	Range (Min-Max)
Right length	6.98 (1.04)	0.5477	4.6-10.6
Left length	6.83 (1.10)		4.63-10.6
Right width	3.87 (0.78)	0.0345	2.23-5.32
Left width	4.16 (0.70)		2.62-6.15

The foramen ovale's shape was oval in 63 (63.00) sides, 28 (56.00) right, 35 (70.00) left, almond in 15 (15.00) sides, 11 (22.00) right, 4 (8.00) left, irregular in 14 (14.00) sides, 9 (18.00) right, 5 (10.00) left, and round shaped in 8 (8.00) sides, 2 (4.00) right, 6 (12.00) left (Fig. 2, 3 & 4).

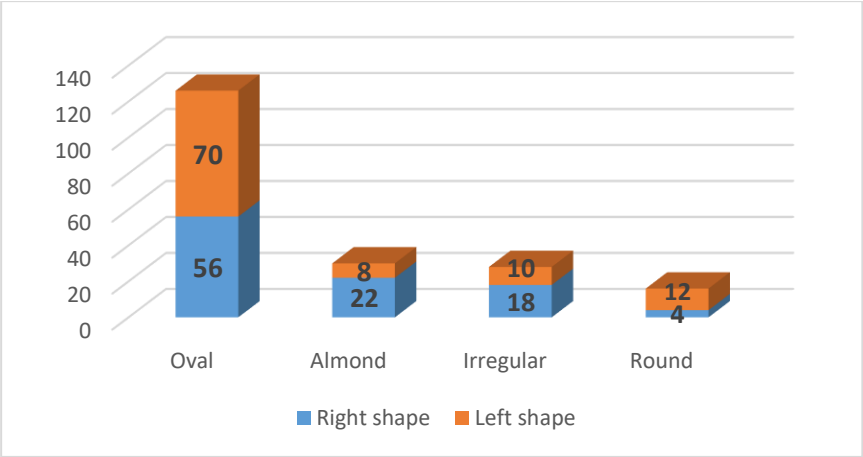

Fig. (2): Bar chat displaying the left and right foramen ovale shapes

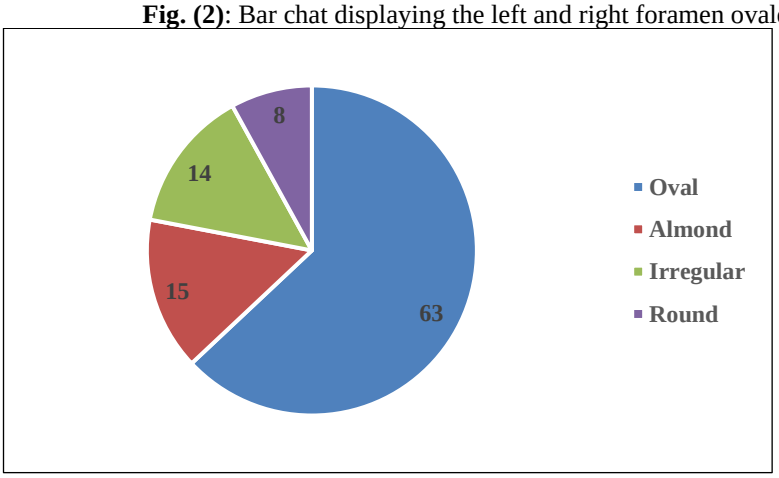

Fig. (3): A pie chart depicting the overall shape of Foramen ovale.

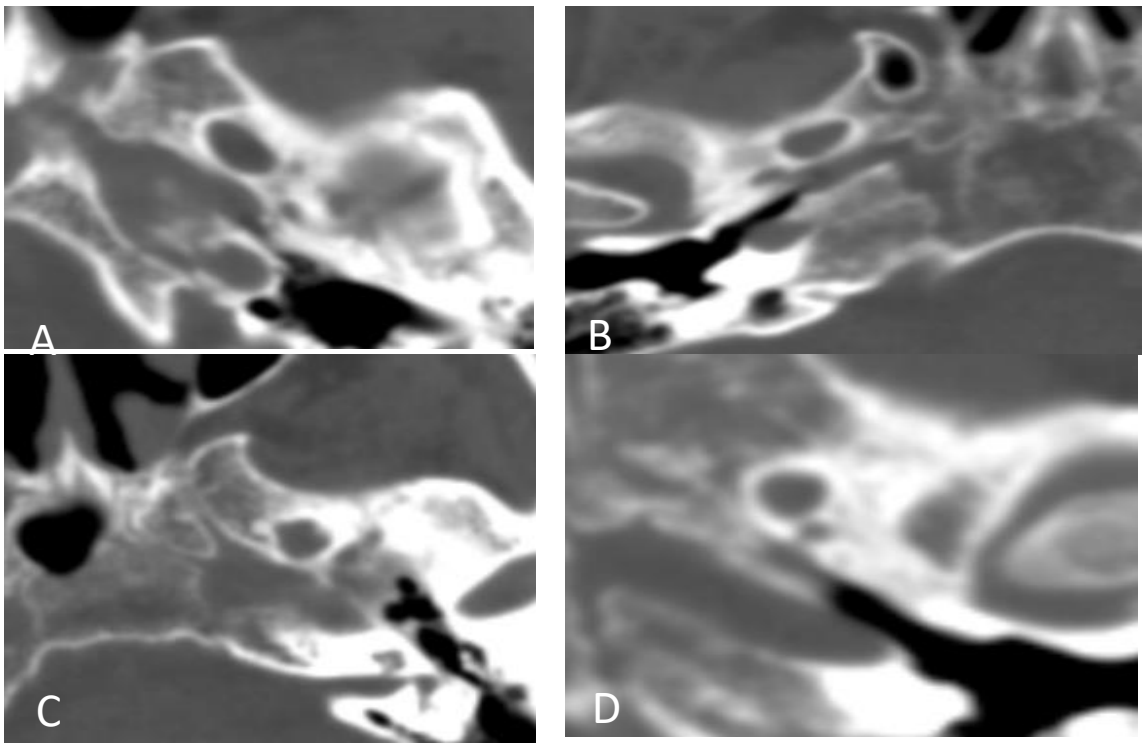

Fig. (4): Axial thin-slice CT images seen as a variation in the shape of foramen ovale; (A) Ovale-type, (B) Almond- type, (C) Irregular- type, (D) Round- type.

DISCUSSION

Foramen ovale is critical for radiologists, neurosurgeons, maxillofacial and oral surgeons, and anesthetists (Senol *et al*., 2016) who undertake several invasive procedures on the head and neck. (Prakash *et al.,* 2019). To avoid structural damage in invasive treatments and surgical interventions aimed at FO (Senol *et al*., 2016).

Although the foramen typically has an oval form, there is a large variety in both its size and shape (Chanda *et al*., 2020), To identify meningioma, squamous cell carcinoma, and tumor growth utilizing fine needle aspiration employing a transfacial approach, among other invasive surgical and diagnostic techniques involving the middle cranial fossa, it is crucial to be aware of the morphology and morphometry of FO (Woolfall & Coulthard, 2001; Rao *et al*., 2017; Saurjyaranjan *et al*., 2018). such as percutaneous biopsies of cavernous sinus tumors, micro-vascular decompression by percutaneous trigeminal rhizotomy for TN, and electroencephalographic seizure analysis for patients having selective amygdalohippocampectomy (Boduç and Öztürk, 2021).

In the current study, the length and width of the foramen ovale (FO) were measured by CT to estimate the size of the FO. On the right side, the maximum and minimum lengths were 10.6 mm and 4.6 mm; on the left, they were 10.6 mm and 4.63 mm. The mean (SD) length of FO was 6.98 (1.04)mm on the right side and it was 6.83 (1.10) mm on the left. Despite the fact that the right FO's length was longer than the left's, there was no significant difference between the two sides ($p>0.05$). Wherease, the mean length of FO in the axial plane of high-resolution computed tomography for a 30-volunteer group (Liu *et al*., 2016) was 7.56 (1.55) mm on the rigth and 7.66 (1.44) mm on the left side, which was greater than in the current study. In agreement with a study by Shankar and Muthukumaravel (2019) that involved 200 sides in 100 dry adult skulls, the mean length of FO on the right side was 6.62 (1.11)mm and on the left side was 6.72 (1.08) mm. Furthermore, Lang *et al*. (1984) reported that the mean length of the FO is 7.2 mm, whereas in a laser tagetting of the FO that was helped by fluoroscopy, the FO was 6.9 mm on the right and 6.8 mm on the left, similar to our results.

In our results, on the right side of the FO, the maximum and minimum widths were 5.32 mm and 2.23 mm, respectively. On the left side, they were 6.15 mm and 2.62 mm. On the right, The mean (SD) FO width was 3.87 (0.78) mm on the right, it was 4.16 (0.70) mm on the left. The difference was statistically significant ($p = 0.0345$), despite the fact that the right side was narrower than the left. The results of Akcay *et al*. (2021) support our findings, the research was done on 80 hemicrania of dry adult skulls inTurkey, the mean FO width was 4.16 (0.79) mm on the right side and 4.15 (0.50) mm on the left side. In another study (Bokhari *et al*., 2017), closed results were given. The mean width was 4.15 (0.92) mm on the right and on the left was 3.99 (0.86) mm. 2019's (Shankar and Muthukumaravel, 2019) the right and left had respective mean widths of 3.78 (0.89) mm and 3.89 (0.73) mm. According to Kumar *et al*. (2018), the mean width of the foramen ovale was 3.53 (0.59) mm on the right and 3.51 (0.58) mm on the left respectively.

In the current study, the degree of variance in FO shape was evaluated. Oval was the most prevalent shape (63%), followed by almond (15%), irregular (14%), and round (8%). Our findings are comparable to those of the study by Natsis *et al*. (2018), which focused at the shapes of FO and found that 56.1% were oval, 19.1% were almond, 16.5% were irregular, and 8.3% were round. (Naqshi *et al*., 2017) examined 40 foramina in 20 dry skulls and discovered that 70% of the foramina were oval, 18% were almond, 10% were round, and 2% were slit-shaped. In addition to the study by Prakash *et al*. (2019), which was indicated in their investigations, the shape of FO was oval (60.4%), followed by almond (28.22%), round (6.4%), and irregular (3.2%).

CONCLUSION

Clinicians must have a comprehensive understanding of anatomy and morphology, including variations in foramen ovale, as demonstrated in the current study, in order to identify and treat a variety of disorders that require for a microneurosurgical and microvascular approach. The mandibular branch of the trigeminal nerve,which is the target of the trigeminal radiofrequency rhizotomy, can travel through the FO.

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