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Morphological and Morphometric Study on Foramen Spinosum and its Clinical importance.

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Abstract

Background: The foramen spinosum was given its name because of its proximity to the spine of the sphenoid bone. It is an opening located in the greater wing of the sphenoid bone as part of the middle cranial fossa. Vascular and nervous structures emerge through this foramen, including the middle meningeal artery and the meningeal branch of the mandibular nerve, or the nervous spinous, which originates in the sensory portion of the trigeminal nerve. The venous component, which is the middle meningeal vein that connects the cavernous sinus with the pterygoid venous plexus, also passes through this foramen. The present study aims to find morphological variations and morphometric measurements of foramen spinosum.

Materials and Methods: The present study conducted with 96(192 sides) adult dry skull. All the skulls were examined carefully and identified the gender and separated, we have observed right and left sides of all the skulls to find out the foramen spinosum. We have observed the morphological shapes round, oval and irregular. We measured Length, width of foramen and calculated Area. All the measurements were expressed in the form of Mean+SD and tabulated.

Results: The present study carried out with 96(192 sides) adult dry skulls. The round shape foramen spinosum found in 62.5% sides, oval was in 32.3% sides and irregular was 5.2% sides. We have measured the Length(mm), it was 2.64+0.52mm, Width(mm) was 2.12+0.26 mm and Area(mm²) was 4.39+0.11 mm² and range was 1.22 - 8.38 mm².

Conclusion: The results of foramen spinosum may be helpful to neurosurgeons, it may also useful in practice of forensic medicine and anthropology.

Keywords: Foramen Spinosum, Middle Meningeal Artery, Nervous Spinous, Sphenoid Bone.

Introduction

Foramen spinosum is an important opening located in the infratemporal surface of greater wing of sphenoid bones which lies posterolateral to foramen ovale and anteromedial to the spine of sphenoid. It transmits middle meningeal vessels and nervus spinosus. The foramen spinosum also transmits venous component, middle meningeal vein which connects cavernous sinus with pterygoid venous plexus. The foramen spinosum pierces the spinous process of the sphenoid bone either at apex or medial aspect, hence the name "foramen spinosum or canalis spinosus"[1]. The foramen spinosum is mostly round in shape with an average adult diameter of 2.63 mm and transmits the middle meningeal vessels from the infratemporal to the middle cranial fossa. The middle meningeal artery arises from the first portion of the maxillary artery, enters the skull through the foramen spinosum, travels laterally through a middle fossa bony ridge, and curves over the anterior greater wing of the sphenoid, irrigating the bone and dura mater during its trajectory. This artery consists

of two branches, including an anterior frontal branch that passes through the inner surface of the pterion and curves to the apex of the skull and another posterior parietal branch that runs along the posterior surface of the skull. However, an abnormal morphology of the foramen spinosum can result in anatomical variations of the middle meningeal artery which directly interfere with surgical interventions involving the middle cranial fossa. Vasodilation of the middle meningeal artery and other intracranial blood vessels has been indicated as a trigger of migraines; therefore, knowledge of their anatomical variations associated with the morphology of the foramen spinosum is essential [2,3,4,5].

The foramen spinosum is a landmark in middle cranial fossa surgery. Surgeons need to be familiarized with these concepts because anatomical variations in the cranial foramina accompanied by possible alterations of the trajectory of associated nervous and vascular structures are common in the population and data are not always readily available. The lack of such knowledge can lead to misinterpretation during clinical evaluation of the middle cranial fossa by computed tomography, which can be confused with abnormalities or diseases. Hence, knowledge of the foramen spinosum is important in diagnostic medicine. With clinical relevance, the foramen spinosum is an easily identifiable landmark in middle cranial fossa microsurgery, and knowledge of its anatomical variations is very important for neurosurgeons, radiologists, and anatomists, along with the help of currently available imaging tests. In this way, clinicians can be assisted in diagnosing any aneurysm or other form of vascular injury to the cranial cavity, and this knowledge is useful for neurosurgeons to identify and preserve neurovascular structures when planning approaches to the middle cranial fossa [6,7,8,9]. The present study was conducted to find morphological variations and morphometric analysis of foramen spinosum.

Materials and Methods

The present study conducted with 96(192 sides) adult dry skull, which were collected from departments of Anatomy of multiple medical and dental institutions. All the skulls were examined carefully and identified the gender and separated, we found 52(104 sides) skulls as male and sides 44(88 sides) skulls as female [10]. We have observed right and left sides of all the skulls to find out the foramen spinosum. The posterior part of greater wing of sphenoid was carefully examined for to identify the foramen spinosum and the damaged skulls were excluded. The antero-posterior diameter considered as length and perpendicular to this, transverse diameter considered as width of the foramina. The measurements were carried out by Digital Vernier callipers with a precision of 0.1 mm. Each dimension was measured thrice and the mean figure recorded. The data collected was checked for errors prior to analysis. From this obtained values area of the foramina spinosum was calculated using the formula $[(3.142 \times L \times B) / 4]$ [11]. We have observed the shape of foramen spinosum carefully and categorised into, Round, Oval and Irregular shapes(Figure 1).

Results

The present study carried out with 96(192 sides) adult dry skulls. We have measured the Length(mm), it was 2.64 ± 0.52 mm and range was spread between 1.35 mm - 3.62 mm, Width(mm) was 2.12 ± 0.26 mm and range was 1.16 - 2.95 mm and Area(mm^2) was 4.39 ± 0.11 mm^2 and range was 1.22 - 8.38 mm^2 . The length of foramen spinosum in males was 2.82 ± 0.61 mm and in females it was 2.24 ± 0.53 mm, width in males was 2.06 ± 0.36 mm and in females it was 1.96 ± 0.28 mm and Area in males was 4.56 ± 0.17 mm^2 and in females it was 3.44 ± 0.11 mm^2 . Foramen spinosum length on right side was 2.72 ± 0.42 mm and left was 2.56 ± 0.56 mm. Width was 2.16 ± 0.29 mm on right and left was 2.56 ± 0.56 mm, area was 4.61 ± 0.09 mm^2 on right and 4.17 ± 0.12 mm^2 was on left. The round shape foramen spinosum found in 62.5% sides, oval was in 32.3% sides and irregular was 5.2% sides.

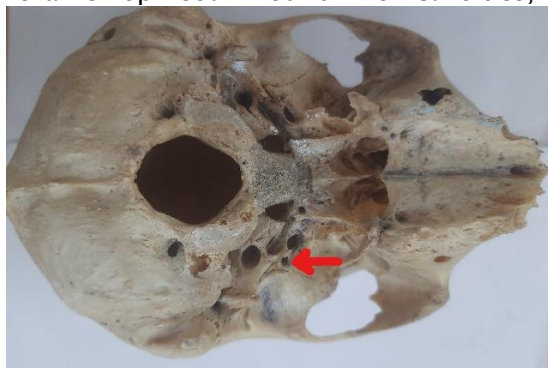


Figure 1. Base of skull with foramen spinosum(Marked) – Round shape.

Table 1. Morphological and Morphometric parameters of Foramina Spinosum

| Dimensions of Foramen Spinosum | | |
|---|-----------|-------------|
| Foramen Spinosum | Mean +SD | Range |
| Length(mm) | 2.64+0.52 | 1.35 - 3.62 |
| Width(mm) | 2.12+0.26 | 1.16 - 2.95 |
| Area(mm ²) | 4.39+0.11 | 1.22 - 8.38 |
| Dimensions of Foramen Spinosum according to Gender | | |
| Foramen Spinosum | Male | Female |
| Length(mm) | 2.82+0.61 | 2.24+0.53 |
| Width(mm) | 2.06+0.36 | 1.96+0.28 |
| Area(mm ²) | 4.56+0.17 | 3.44+0.11 |
| Dimensions of Foramen Spinosum according to Side (right and left) | | |
| Foramen Spinosum | Right | Left |
| Length(mm) | 2.72+0.42 | 2.56+0.56 |
| Width(mm) | 2.16+0.29 | 2.08+0.22 |
| Area(mm ²) | 4.61+0.09 | 4.17+0.12 |
| Shapes of Foramen Spinosum | | |
| Round | 62.5% | |
| Oval | 32.3% | |
| Irregular | 5.2% | |

Discussion

The foramen spinosum of the skull is an opening located in the greater wing of the sphenoid bone at the base of the skull, and it includes the middle meningeal vessels and the meningeal branch of the mandibular trigeminal nerve. The foramen spinosum is commonly used as an anatomical landmark in neurosurgical procedures and neuroimaging of the middle cranial fossa because of its relationship with other cranial foramina and surrounding vascular and nervous structures. The assessment of foramen spinosum anatomical variation is critical, as it may serve as a reference point for the various surgical procedures in the middle cranial fossa[12]. Fractures in the middle cranial fossa frequently occur in accidental injuries, with head trauma from road traffic accidents or direct impacts on the temporal bone potentially causing middle meningeal artery disruption at the foramen spinosum, leading to epidural hematoma formation. Therefore, a more comprehensive understanding of the foramen spinosum and its relationship to surrounding structures could aid in the middle cranial fossa surgical approaches and trauma surgery, where exploration of the foramen may be necessary to achieve proper haemostasis[13]. The aim of this study was to provide further details on the morphology of the foramen spinosum of the skull by evaluating its topographic and morphometric relationships and correlating the findings with clinical practice.

In present study we observed shapes of foramen spinosum, round shape foramen spinosum found in 62.5% sides, oval was in 32.3% sides and irregular was 5.2% sides. in present study the Length(mm), it was 2.64+0.52mm and range was speared between 1.35mm - 3.62mm, Width(mm) was 2.12+0.26 mm and range was 1.16 - 2.95 mm and Area(mm²) was 4.39+0.11 mm² and range was 1.22 - 8.38 mm². In study of Sink Z [13] observed the mean length and width of the FS were 2.45 ± 0.65 mm and 2.03 ± 0.53 mm on the right side and 2.49 ± 0.61 mm and 2.08 ± 0.48 mm on the left side. The most frequently observed shape was round (56.7%), followed by oval (28.2%), irregular (8.7%) and drop shaped (6.3%). In study of Somesh M.S[11] the values for the right side were 3.425± 0.637 mm, 2.687± 0.487 mm and 7.357 ± 2.195 mm² and for the left side the values were 3.339 ± 0.660 mm, 2.675 ± 0.465 mm and 7.110± 2.103 mm² respectively, for the mean length, mean breadth and mean area of the Foramen Spinosum. Also, the shape of the Foramen Spinosum was typically round in most of the skulls studied (53.65%).

In study of Desai S D[14] conducted in total 125 skulls. Foramen spinosum found as round shape in 52%, oval shape in 42% and irregular in 6%. The maximum diameter of foramen spinosum was 2.92+0.65mm and 2.12+0.45mm was minimum in males, in females maximum was 2.67+0.62mm and 1.79+0.41mm as minimum. The findings of Osunwoke EA et al[15] study were the maximal length of foramen spinosum was 4.0mm and minimal length was 1.0mm, in majority cases the lengths of the foramen spinosum ranges between 2.0 to 2.5mm. The maximal width of foramen spinosum was 2.0mm and the minimal width was 1.0mm, some of the foramen spinosum were partially divided into two components by bony spurs. The same author studied about the shape of foramen spinosum, the results were oval, circular and triangular. The study of Misganaw[16]

observed the mean anteroposterior diameter of the foramen spinosum was 3.72 ± 1.33 mm and 3.37 ± 1.26 mm on the right and left sides. The mean transverse diameter was 3.3 ± 1.19 mm on the right side and 2.97 ± 1.9 mm on the left side. In same study an independent t-test proved no significant difference between the sides of the skulls and anteroposterior or transverse foramen spinosum diameters. In a similar study by Bhattarai R[17] the mean length, width, and area of foramen spinosum was 2.38 ± 0.36 mm, 1.94 ± 0.30 mm, and 3.69 ± 0.95 mm², respectively. The foramen spinosum was present bilaterally in 90% of the skulls. The mean sizes on the right and left sides were 2.54×0.8 mm and 1.97×0.7 mm. The study concludes that the present study results may be helpful in neurosurgery practice, the knowledge of foramen spinosum will help to assess accurately during the radiological procedures in the region of base of skull.

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