International Journal of Health Sciences and Research
www.ijhsr.org ISSN: 2249-9571

Original Research Article

A Study on Foramen Spinosum

Manavalan Mahima Sophia[1], Ramachandran Kalpana[2]

[1]Assistant Professor, [2]Professor and Head,
Department of Anatomy, Sri Muthukumaran Medical College and Research Institute, Chennai, India.

Corresponding Author: Manavalan Mahima Sophia

Received: 06/01/2015 *Revised: 28/01/2015* *Accepted: 29/01/2015*

ABSTRACT

Aim: The foramen spinosum is an opening located in the greater wing of sphenoid bone in the base of skull and it transmits middle meningeal artery to the middle cranial fossa. The aim of the present study is to do morphometric measurements of the foramen spinosum and also to study its variation in shape, number and position of the foramen spinosum in relation to spine of sphenoid.
Materials and Methods: The study was done on 40 dry adult human skulls (80 sides) available in the Department of Anatomy, Sri Muthukumaran Medical College & Research Institute, Chennai. Variation in size, shape, number and position of foramen spinosum in relation to spine of sphenoid was noted.
Results: The shape of the foramen spinosum was round in 52.5 %, oval in 30 %, irregular in 12.5 % and pin-hole type in 2.5%. The foramen spinosum was absent in two skulls (2.5 %) on the left side and duplicated in three skulls (3.75%). The mean length of foramen spinosum was 3.96 ± 0.60 on right side and 4.25± 0.67 on left side and the mean width of foramen spinosum was 2.21±0.28 on right side and 2.18±0.34 on left side. The position of foramen in relation to spine of sphenoid was noted.
Conclusion: The study on foramen spinosum will be helpful for neurosurgeons during intraoperative procedures in the middle cranial fossa for better preservation of surrounding neurovascular structures.

Key words: Foramen spinosum, middle meningeal artery, spine of sphenoid

INTRODUCTION

Foramen spinosum (FS) 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. [1] 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". [2] Embryologically the proper ring shaped formation of foramen spinosum is observed early by 8th month after birth and later by 7 years after birth. [3] The foramen spinosum acts as an important landmark in skull base surgeries especially in middle cranial fossa and infratemporal fossa. [4] The location of foramen spinosum is clinically important in surgeries using middle meningeal artery as a

graft in bypass surgeries such as anastomosis of middle meningeal artery with petrous part of internal carotid artery or with posterior cerebral artery. [5,6] The information about the size and shape of foramen is also increasingly important in diagnostic medicine due to higher imaging techniques such as Magnetic Resonance Imaging (MRI) and Computed Tomography (CT). [7] Hence the aim of the present study is to determine the morphometry and location of foramen spinosum in relation to spine of sphenoid and to stress its clinical implications.

MATERIALS AND METHODS

This study was conducted on 40 dry adult human skulls (80 sides) available in the Department of Anatomy, Sri Muthukumaran Medical College & Research Institute, Chennai. The foramen spinosum was observed from the extracranial view of the skull base. The types of foramen spinosum were noted as per the classification given by Anju et al [7] such as round, oval, irregular and pin-hole shapes. Anatomic variations of the foramen were also noted. The anteroposterior and transverse diameters of foramen spinosum were measured using vernier callipers. The position of foramen spinosum in relation to spine of sphenoid was noted.

RESULTS

The present study was conducted on 40 dry human adult skulls (80 sides). Following are the various findings of our study

I .Types of foramen spinosum

Table 1: Types of foramen spinosum

Shape of foramen	Total Sides (%)	Right Side (%)	Left side (%)	Unilateral (%)	Bilateral (%)
Round	42 (52.5)	21 (26.2)	21(26.2)	12 (15)	15(18.75)
Oval	24 (30)	14 (12.5)	10(12.5)	6(7.5)	9(11.25)
Irregular	10 (12.5)	4 (5)	6 (7.5)	6(7.5)	2(2.5)
Pin-hole	2 (2.5)	1(1.25)	1 (1.25)	-	1(1.25)

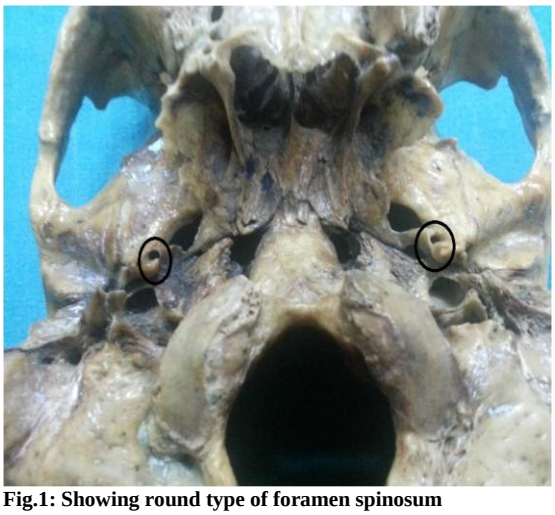

Fig.1: Showing round type of foramen spinosum

The incidence of types of foramen spinosum has been shown in Table 1. The most frequent type observed was round shape (52.5%) [Fig.1] followed by oval (30%) [Fig.2], irregular (10%) [Fig.3] and pin-hole (2.5%) [Fig.4]. Foramen spinosum was round in shape on both sides in 15 skulls (18.75%) and oval in shape on both sides in 9 skulls (11.25%).

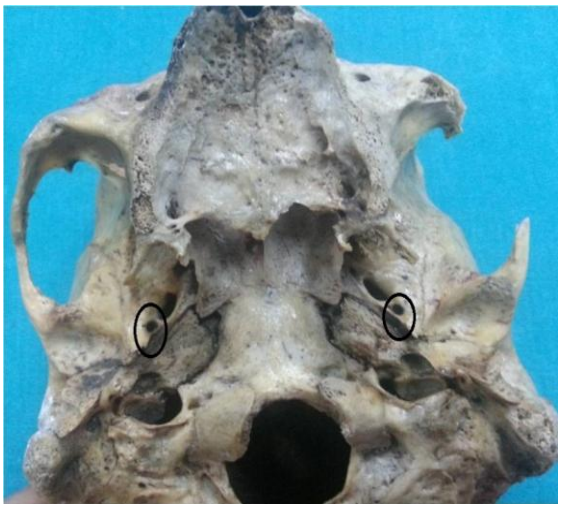

Fig.2: Showing oval type of foramen spinosum

Fig.3: Showing irregular type of foramen spinosum

Fig.4: Showing pin-hole type of foramen spinosum

II. Absent and duplicated foramen spinosum

The foramen spinosum was absent in two skulls (2.5%) both on the left side (Fig.5). The duplication of foramen spinosum was observed in three skulls (3.75%) one on the right side and two on the left side (Fig.6).

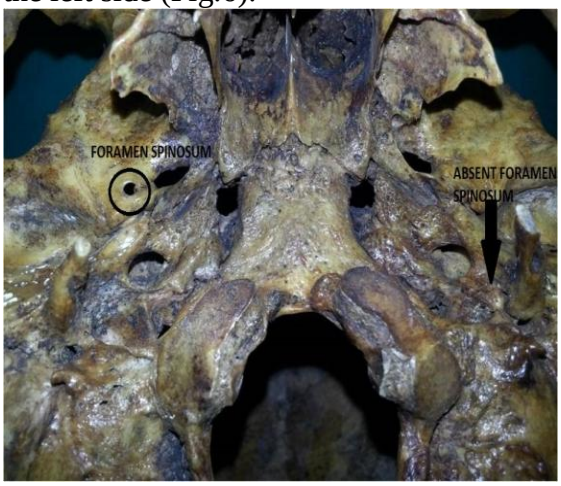

Fig.5: Showing absent foramen spinosum

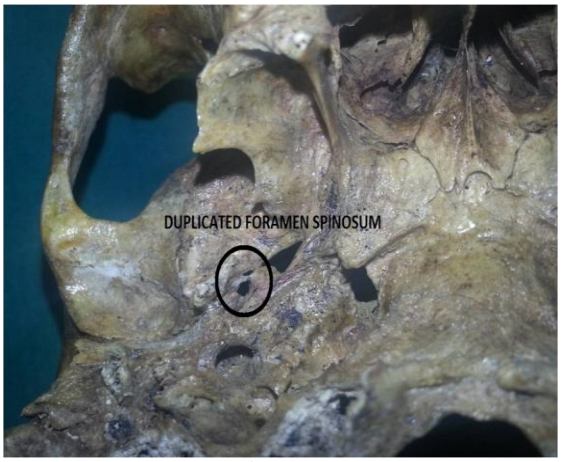

Fig.6: Showing duplicated foramen spinosum

III .Position of foramen spinosum:

Table 2: Position of foramen spinosum in relation to body of sphenoid

Number of skulls	Normal position			Lateral to spine of sphenoid		Medial to spine of sphenoid	
	Bilateral	Right side	Left side	Right side	Left side	Right side	Left side
40(80 sides)	20(25%)	24(30)	27(33.75)	13(16.25)	8(10)	2 (2.5)	1(1.25)

The position of foramen spinosum in relation to body of sphenoid has been summarised in Table 2. The foramen spinosum was observed bilaterally in normal position (anteromedial to the spine of sphenoid) in 25 % of total skulls, 30% on the right side and 33.75 % on the left side. The foramen spinosum was found lateral to the spine of sphenoid in 26.25% of skulls and medial to the spine of sphenoid in 3.75 % of skulls.

IV. Morphometry of foramen spinosum:

Table 3: Length of foramen spinosum

Value	Right side (mm)	Left side (mm)
Minimum	0.94	1.17
Maximum	3.96	4.25
Mean	2.37	2.32
S.D	0.60	0.67

Table 4: Width of foramen Spinosum

Value	Right side (mm)	Left Side (mm)
Minimum	0.92	0.92
Maximum	2.21	2.18
Mean	2.32	1.73
S.D	0.28	0.34

The length and width of foramen spinosum has been summarised in Table 3 and 4. The mean length of foramen spinosum was 2.37 mm on the right side and 2.32 mm on the left side. The mean width of foramen spinosum was 2.32 mm on the right side and 1.73 mm on the left side.

DISCUSSION

The foramen spinosum is an important opening located in the greater wing of sphenoid which provides communication between infratemporal fossa and middle cranial fossa. The foramen spinosum is a permanent element in majority of cases sometimes it may be absent (0.4%) when middle meningeal artery (MMA) arises from ophthalmic artery or unilateral (1%) or incompletely separate from the foramen ovale (2%) or duplicated. [8-10]

The foramen spinosum is smaller than foramen ovale and is commonly round or oval in shape. [1,11]

Many studies have been done on the foramen spinosum regarding shapes(Table 6).In the study conducted by Anju et al [7] on 35 skulls, the most frequent type observed was round (57%) followed by oval (34.2 %), pin-hole (5.7%) and irregular (2.8%).In another study of Kwathai et al [12] on 103 skulls of Thai origin, three shapes were observed – round (49.5%), oval (39.8%) and irregular (10.7%). In yet another study of Desai et al [13] on 125 skulls, the most common type observed was round (52%) followed by oval (42%) and irregular (6%). In the present study the majority of skulls were round in shape (52.5%) followed by oval (30%), irregular (12.5%) and pin-hole (2.5%).

Following is the comparison between our study and previous studies regarding types of foramen spinosum

Table 5: Comparison of various studies regarding types of foramen spinosum

Author	No.of.skulls	Round (%)	Oval (%)	Irregular (%)	Pin-hole (%)
Anju et al [7]	35	57	34.2	2.8	5.7
Kwathai et Al [12]	103	49.5	39.8	10.7	-
Desai et al [13]	125	52	42	6	-
Present study	40	52.5	30	12.5	2.5

In the study done by Anju at al [7] on 35 skulls, foramen spinosum was absent in two skulls (2.85%) and duplicated in two skulls (2.85%). In another study of Khaimar at al [14] on 100 skulls, foramen was absent in one skull (0.5%) and duplicated in six skulls (3%). In the study of Mandavi et al [15] on 312 skulls of Japanese Population, foramen spinosum was bilaterally absent in one skull and duplicated in 8 skulls. In yet another study done by Osunwoke at al [16] on 87 skulls of Southern Nigerian Population, he failed to find even single skull with absent foramen spinosum. In the present study foramen spinosum was absent in two skulls (2.5%) and duplicated in three skulls (3.75%).

Following is the comparison between our study and previous studies regarding absent and duplicated foramen spinosum (Table 6)

Table 6: Comparison of various studies regarding absent and duplicated foramen spinosum

Author	No of skulls	Absent FS (%)	Duplicated FS(%)
Anju et al [7]	35	2.85	2.85
Khaimar et al [4]	100	0.5	3
Mandavi et al [15]	312	0.3	2.56
Khan et al [17]	25	2	2
Kulkarni et al [18]	100	2.5	-
Osunwoke et al (Southern Nigerian Population) [16]	87	-	-
Present study	40	2.5	3.75

The absence of foramen spinosum is usually a normal variation as it is seen upto 3% of skull base CT studies [19] which may be due to abnormal development and different course of MMA. In such cases, MMA arises from ophthalmic artery instead of maxillary artery and enters the skull through superior orbital fissure. Foramen spinosum may be hypoplastic or absent in case of rare congenital vascular anomaly known as persistent stapedial artery. [20] Duplication of the foramen spinosum may be due to early division of middle meningeal artery into anterior and posterior divisions. [21]

Mandavi et al [15] reported that frequency of location of foramen spinosum is more on the lateral side of spine of sphenoid than on medial side of the spine on Japanese skulls. In the present study 20% of skulls showed bilaterally normal position, 26.25 % of skulls present lateral to spine of sphenoid and 3.75 % of skulls present medial to spine of sphenoid. The position of foramen spinsoum is important for neurosurgeons while approaching through the base of skull due to bleeding of middle meningeal artery and its accompanying dural venous sinuses. Mandibular nerve may also be lesioned with the artery and venous sinuses which is present anteromedial to the spine of sphenoid. [15] The foramen spinosum acts as a landmark for superior pertrosal triangle which localise the bony tegmen over the head of malleus. Identification of head of malleus during middle cranial fossa surgery optimises surgeon confidence operating in this region. [22]

According to the German study of Lang et al [23] on post natal enlargement of foramen spinosum and its topographical changes, the length of foramen spinosum was 2.25 mm in newborn and 2.56 mm in adults and width extends from 1.05 mm in newborn to 2 mm in adults. [23] In the present study the mean length of foramen spinosum ranged between 0.9 to 3.9± 0.60 mm on the right side and 0.9 to 4.2± 0.67 mm on the left side and about 62 % of length of foramen spinosum falls between 2.0 to 2.5 mm. The maximal width of foramen spinosum was about 2.1 mm and minimal width was about 0.9 mm and about 85 % of the width of foramen spinosum of the 40 dry skulls observed was between 1-1.5 mm. These findings were within the range reported by Lang et al [23] and Osunwoke et al. [16]

The foramen spinosum transmits so many important structures hence any variation in the foramen and structures passing through it should be known to radiologists and neurosurgeons.

CONCLUSION

The knowledge of the variation in relation to shape, size and position is helpful for radiologists in distinguishing normal from abnormal foramina during radiological investigations and neurosurgeons to perform proper surgical procedures approaching the middle cranial fossa.

REFERENCES

1. Susan Standring. Gray's Anatomy; The Anatomical Basis of Clinical Practice. Thirty ninth Edition. Elsevier Churchill Livingstone. 2005; pp.462-463, 465-467.
2. Wood-Jones F. The non-metrical morphological characters of the skull as

criteria for racial diagnosis. Part I: General discussion of the morphological characters employed in racial diagnosis. J Anat. 1931 Jan ;65:179-95.
3. Yanagi S Developmental studies on the foramen rotundum, foramen ovale and foramen spinosum of the human sphenoid bone. The Hokkaido journal of medical science 1987;62 (3):485-96.
4. Krayenbuhl N, Isolan GR, Al-Mefty O. The foramen spinosum: a landmark in middle fossa surgery. Neurosurg Rev. 2008 Oct; 31(4):397-401.
5. Ustun ME, Buyukmumcu M, Seker M, Karabulut AK, Uysal, II, Ziylan T. Possibility of middle meningeal artery-to-petrous internal carotid arterybypass: an anatomic study. Skull Base. 2004 Aug;14(3):153-6.
6. Ustun ME, Buyukmumcu M, Ulku CH, Guney O, Salbacak A.Transzygomatic-subtemporal approach for middle meningeal-to-P2 segment of the posterior cerebral artery bypass: an anatomical and technical study.Skull Base.2006; 16(1):39-44.
7. Anju L R, Nirupama G, Rachna R. Anatomical Variations of foramen spinosum Innovative Journal of Medical and Health Sciences 2012; 2(5):86-88
8. Berge JK, Bergman RA. Variations in size and in symmetry of foramina of the human skull. Clin Anat. 2001 Nov; 14(6):406-13.
9. Berry AC. Factors affecting the incidence of non-metrical skeletal variants. J Anat.1975; 120(Pt 3):519-35.
10. Saxena SK, Dalal BL, Chowdhary DS, Jain SP. A non-metrical study of Nigerian cranium. Anat Anz. 1986; 162 (3):171-4.
11. Chummy S. Sinnatamby. Last's Anatomy: Regional and Applied. Tenth Edition. Churchill Livingstone.1999.
12. Kwathai L,Namonta K Rungnang T. Anatomic and Morphometric consideration for external landmarks of Foramen spinosum in Thai dry skulls Suraj Med J. 2012;64 (1) :26-29
13. Desai S D, Hussain SS, Muralidhar P S, Thomas ST, Mavishettar GF, Haseena S Morphometric analysis of Foramen spinosum in South Indian Skulls.IJ Pharm.Sci & Res. 2012;4(12):2022-2024
14. Khaimar KB, Surekha DJ, Umarji BN, Pati RJ, Ambali MP Foramen ovale and Foramen Spinosun: A Morphometric study Anatomica Karnataka 2013; 6(3):68-72.
15. Mandavi S, Mishra A .Varying position of Foramen spinosum in relation to spine of sphenoid J.Anat Soc India 2009;58(2)144-148.
16. Osunwoke EA, Mladugha CC, Orish Cn Oghenemavwe EL, Ukash CJ .A morphometric study of foramen ovale and foramen spinosum of the human sphenoid bone of southern Nigerian Population Journal of Applied Biosciences 2010; 26:1631-1635
17. Khan AA Mohd AA, Asma H . Anatomical variants of Foramen Ovale and Spinosum in Human Skulla Int J Morphol 2012;30(2):445-449.
18. Kulkarni SP, Nikade VV A morphometric study of Foramen ovale and Foramen spinosum In Dried Indian Human Skulls. International Journal of Recent Trends in Science and Technology. 2013;7(2):74-75.
19. Manjunath KY. Anomalous Origin Of The Middle Meningeal Artery-a reviewJ Anat Soc India. 2001;50:179-183
20. Dilenge D, Ascherl GF Jr. (1980): Variations of the ophthalmic and middle meningeal arteries: relation to the embryonic stapedial artery. AJNR Am J Neuroradiol 1980;1: 45–54 .
21. Ginsberg LE, Pruett SW, Chen MY, Elster AD. Skull-base foramina of the middle cranial fossa: reassessment of normal variation with high-resolution CT. American Journal of Neuroradiology 1994; 15 (2): 283–91.
22. Miller RS, Pensak ML The superior petrosal triangle as a costant anatomical landmark for subtemporal fossa

orientation. Laryngoscope 2003; 113: 1327-1331
23. Lang J, Maier R, Schafhauser O. Postnatal enlargement of the foramina rotundum, ovale spinosum and their topographical changes. Anatomischer Anzeiger 1984; 156 (5): 351- 87.

How to cite this article: Sophia MM, Kalpana R. A study on foramen spinosum. Int J Health Sci Res. 2015; 5(2):187-193.

****