ANATOMIC AND MORPHOMETRIC VARIATIONS OF FORAMEN SPINOSUM IN ADULT HUMAN SKULL IN PESHWAR PAKISTAN AND ITS CLINICAL IMPORTANCE

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ABSTRACT

Aims and Objectives: The main aim of the current study is to evaluate various shapes of FS and differences in its number, size, and position related to the spine of sphenoid bone.

Materials and Methods*:* 46 adult macerated dried skulls were used in this study. All measurements were made with a digital Vernier calipers and a screw-adjusted compass. Using the formula "A = (x L x B) /4)" = 3.14, L = length, B = breadth of FS, the area was measured. For each measurement, the mean (SD) was determined. The data was analyzed, using SPSS version 20 and a P value of 0.05 was taken as statistically significant. The mean difference in foramen spinosum length (L) and breadth (B), between both sides was measured using an independent t-test.

Results*:* On the right side, mean antero-posterior (AP) diameter of FS was 3.52 ± 1.33 mm, on left it was 3.26 ± 1.26 mm. the mean TD of the right FS was 3.3 ± 1.19 mm, whereas on the left it was 2.96 ± 1.90 mm. No significant difference was observed, through independent t-test between the AP and TD Diameters on both sides of skull.

Conclusions*:* Various shapes of foramen spinosum were noted. In comparison to data from earlier research, the foramen spinosum mean diameter was larger. Therefore, for clinicians who work on the middle cranial fossa for various surgeries, it is essential to recognize different variations of the FS.

Key words: Foramen spinosum, Foramen ovale, Middle cranial fossa, Skull Base, Greater wing of the sphenoid

INTRODUCTION

The foramen spinosum allows passage of the middle meningeal artery and the meningeal branch of the mandibular nerve. FS is situated near the base of the skull [1]. It serves as a route for the veins that link the pterygoid venous plexus and cavernous sinus. In human the greater wing of the sphenoid bone has a number of foramina [2], which house a number of arteries and nerves. [3,4] The FS is situated antero-medial to the spine of the sphenoid bone and postero-lateral to foramen ovale (FO).[5]

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During computed tomography or magnetic resonance imaging, the FS along with its structures can assist distinguish between normal and pathological structure. Clinicians should consider the clinical and anatomical implications of this study while diagnosing and treating a variety of diseases.[6] The depth of the FS is 2–4 mm .[7] Its typical diameter ranges between 1.5 and 3.0 mm. For radiologists and neurosurgeons, it can be a very useful landmark that is simple to recognize .[7,8] Occasionally, variations in the FS typical structure, like absence or duplication, are found. [9] The unusual origin of meningeal artery from the ocular artery instead of the maxillary artery is frequently linked to its absence. [10] Foramen spinosum (FS) agenesis is consistent with this unusual origin. [11, 12]

From a surgical perspective, the FS's anatomical variations are essential. [13,14] The majority of research stated that FS had oval, round , and irregular shapes. [7,10,15,16] In skull base surgical and neurosurgical procedures, it serves as an important landmark for certain injuries because of its close relationship to various cranial foramina. [16] The current study was performed to evaluate morphometric and anatomic variations of the FS.

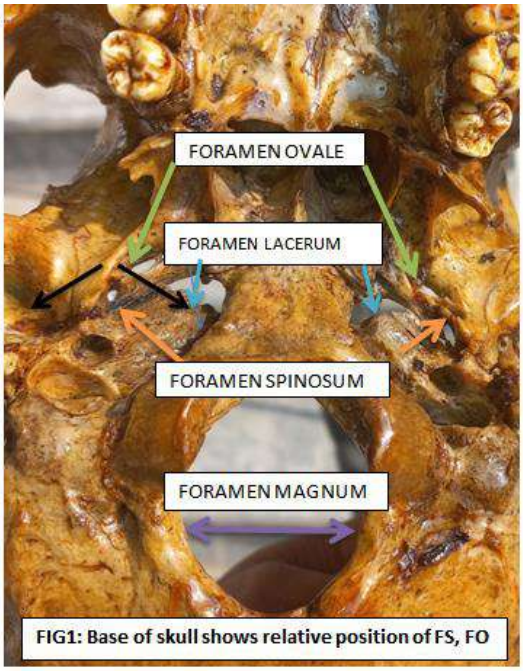

FIG1: Base of skull shows relative position of FS, FO

MATERIALS AND MEHODS

A total of 46 macerated adult human skulls from Bone Bank were examined anatomically; they had a typical morphological appearance and were completely intact. The AP and TD of FS, its different shapes, and its relationship to the spine of the sphenoid were the dependent variables. The right and the left sides of the cranium were an independent variable. The non-probability sampling approach was used to choose the samples and skulls that matched the required criteria were included.

Exclusion criteria included any apparent abnormalities in the middle cranial fossa or damage to the base of the skull. Proformas were used to record the data; Photographs were taken with Nikon D 3100. A Digital Vernier calipers was used to measure the AP and TD. EACH researcher, recorded each measurement three times, and the mean was noted. The formula, Area = x L B/4 was used to determine the area of the FS.[6]

For data entry, Epi-info software, version 7.2.2.0 was used. Before doing any statistical analysis, the equality of variance assumption and the normalcy distribution were checked. Calculation was performed with 95% CI, for the mean SD. To calculate the mean difference between the size on the left and the right sides, an independent *t* test was performed. For analysis, SPSS 20 was used.

RESULTS

50% of FS had a round form, while 31.25% had an oval shape (Figs. 1–3; Table 1). The merging of FO and FS on 2/128 sides and 1 out of 56 analyzed skulls (1.7% each). The FS was repeated in one out of 56 analyzed skulls (1.7% %) and one out of 1/112 sides (0.89%). Two of the 56 skulls (3.56%) and three of the 112 sides (2.67%) lacked foramen spinosum (Figs. 4–6).

In 106/112 sides (94.65%) and 53/56 skulls (94.65%), the FS was positioned normally. The mean antero-posterior (AP) diameter on the right was 3.52mm and 3.26 mm on the left. The mean TD on the right was 2.86 mm and on the left was 3.1 mm. The mean AP and TDs on both sides did not differ in a manner that was statistically significant. Between the RFO and RFS, there was a mean distance of 4.15 ± 2.58 mm, and on the left it was 3.58 ± 1.7 mm. An independent t-test revealed that the mean TD and AP of FS were marginally larger on the left side. This finding was statistically insignificant though (Tables 2–6).

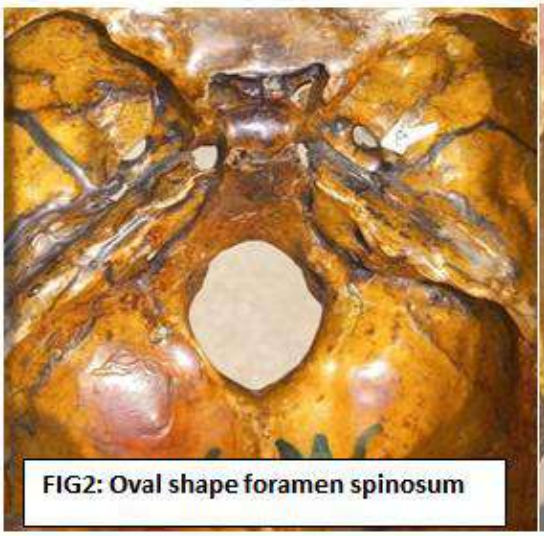

FIG2: Oval shape foramen spinosum

FIG3: Round shape foramen spinosum

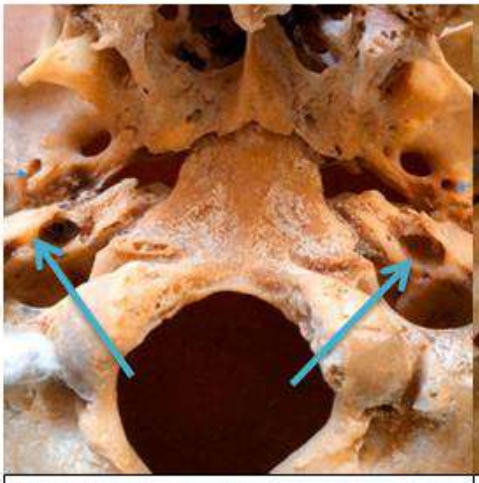

FIG 4: irregular shape foramen spinosum

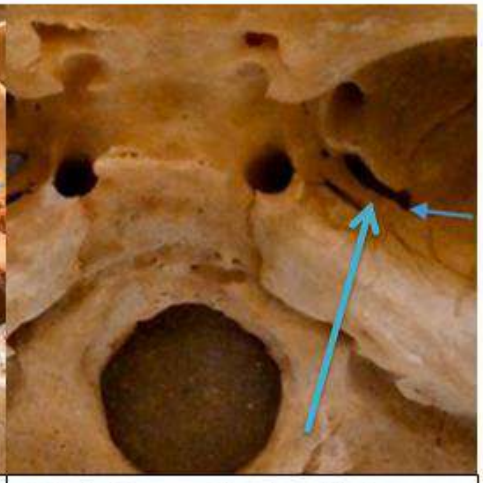

FIG5: Confluence of f ovale and f spinosum

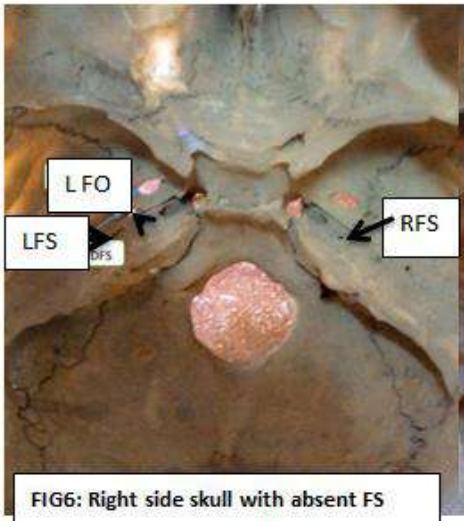

FIG6: Right side skull with absent FS

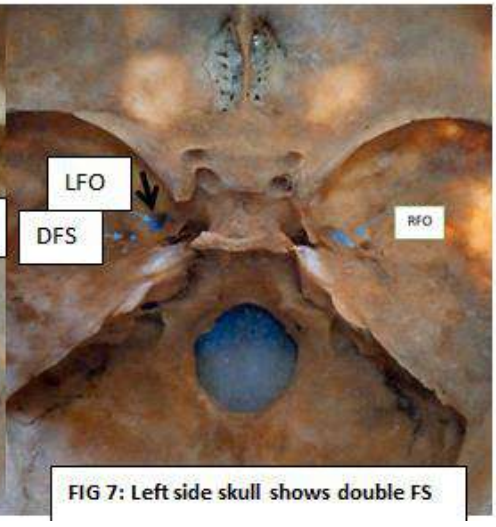

FIG 7: Left side skull shows double FS

Table 1: Showing Different shapes of the FS

Various Shapes	Right side (%), n = 64	Left side (%), n = 64	Total n = 128
Round shape	53.6% (30/56)	46.4 % (26/56)	50% (56/112)
Oval shape	30.36% (17/56)	32.15% (18/56)	31.25% (62.51/ 112)
Pinhole shape	8.3793% (5/56)	12.5% (7/56)	10.72% (12/ 112)
Irregular shape	7.15% (4/56)	7.15% (4/56)	7.15% (8/112)

Table 2: FS Relations to the body of the sphenoid bone.

	NORMAL POSITION			**LATERAL TO THE SPINE**		**MEDIAL TO THE SPINE**	
Number of skulls		**RT SIDE**	**LFT SIDE**	**RT SIDE**	**LT SIDE**	**RT SIDE**	**LFT side**
56	53	30	26	2	1	1	1

Table 3: Various Dimensions of the FS.

Variables	**Min**	**Max**	**Mean**	**Standard. Deviation**	**(95%CI for the mean Lower)**
L	50	5.30	3.5	1.29	3.04–4.00
W	(1.45)	(4.85)	(3.2)	(1.2)	(2.68–3.55)
Area	(1.60)	(20.28)	(9.8)	(6.30)	(7.4–12.14)
Distance between centers of FS and FO	(1.00)	(8.98)	(3.8)	(2.19)	(3.10–4.74)

Table 4: Mean difference of AP diameter of FS between right and left of the skull (Independent *t* test).

SIDE		**Mean**	**Standard. Deviation**	**Mean difference**	**Std. Error of the Mean**	**(P-value)**	**Mean Difference (95%CI)**
AP diameter	Right	3.52	1.33	—0.35	0.33	0.48	—1.36–0.66
	Left	3.26	1.26				

Table 5: Mean difference of TD of FS between right and left of the skull (Independent *t* test).

SIDE		Mean	Standard. Deviation	Mean difference	Std. Error of the Mean	(P-value)	Mean Difference (95%CI)
TD (Transverse diameters)	RIGHT	2.86	1.15	—0.32	0.30	0.46	—1.24–0.58
	LEFT	3.10	1.19				

Table 6: Calculation of the Mean Difference of area of FS between right and left of the skull (Independent *t* test.

SIDE		Mean	Std. Deviation	Mean difference	Std. Error Mean	p-value	Mean Difference (95%CI)
TD	Right	10.80	6.63	—1.87	1.63	**0.44**	—6.83–3.07
	Left	8.92	6.10				

DISCUSSION

It is important to evaluate the anatomical differences in FS since they might serve as a landmark for different surgical operations of the middle cranial fossa.[17] The morphometric measures of the FS varied significantly across different studies ranging from, 96.6% to 99% of population. [7,18,19] In this research, 1.6% of patients had no foramen spinosum recorded. A higher proportion of FS absence was noted in other studies done on various groups .[7, 18]

A variation in the beginning and path of the MMA can be used to explain why the FS is absent. The intracranial origin of the MMA does not allow the artery to leave the skull base. The FS does not form and is absent. [18]

In our study the average length of FS was larger than results on Nigerian and south Indian populations .[15, 21] The mean FS width in this study was 3.31 mm on the right side and 2.97 mm on the left side. It was also discovered that the AP and the TD of FS of the two sides of the skull showed no significant difference. The findings of this study were consistent with those done BY Desai .[15] In comparison to the study done by Gupta et al. the average area of the FS in the current study was lager. [22]

FS was also seen in a variety of forms in the current study. The most typical foramen spinosum shapes were round (50%) and oval (32.8%), which is consistent with several research .[5, 6, 22]. In 95% of instances, the foramen spinosum was located antero-medial to the sphenoid's spine. Based on data collected from several populations, the same conclusion was reached .[15, 17, 23, 24] various studies have noted the FS's unilateral absence. [18,26] However, a bilateral absence of the FS was noted in this investigation. Unilateral duplication of the FS was found in an Indian population research by Somesh et al. [18] However, there was also significant evidence of bilateral FS duplication .[7, 19, 25]

In this study different shapes of FS were also observed. The most typical foramen spinosum shapes were round (50%) and oval (32.8%), which is consistent with several research .[5,6,21] In 95% of cases, the foramen spinosum was located antero-medial to the sphenoid's spine. Based on data collected from several populations, the same results were obtained .[15, 17, 23, 24]

Various studies have reported unilateral absence of the FS. [18, 26] However, a complete absence of the FS on both sides was noted in our study. Unilateral duplication of the FS was found in an Indian population research by

Somesh et al. [18] However, there was also significant evidence of FS duplication on both sides .[7,19] A tiny bony plate that divides the foramen, and The early branching of the MMA, are two possible causes of FS duplication. In our study,1.56% 0f cases the FS and FO were connected to each other as was reported by Naqshi e al.[19] However it did not report an overlap of the FO and FS as reported by Worku and Naoshi.[19, 20]

CONCLUSION

In this study, the mean TD and AP of FS were larger than those found in previous studies. The most frequent variety of the FS was circular, followed by an oval shape. Thus for surgeons, it is essential to understand the anatomic variations of the FS while working on the middle cranial fossa..

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