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A morphometric study of *foramen ovale* and *foramen spinosum* of the human sphenoid bone in the southern Nigerian population

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ABSTRACT
Objective: Conduct a morphometric study of foramina ovale and spinosum of the human sphenoid bone.
Methodology and results: The study was carried out using 87 dry adult human skulls obtained from cadavers in the laboratories of the Departments of Anatomy of the Universities of Port Harcourt, Nnamdi Azikiwe University, Nnewi Campus, Okofia, University of Nigeria, Enugu Campus, Niger Delta University, Amassoma, Abia State University, Uturu and University of Calabar, all in Southern Nigeria. Measurements were done using a pair of dividers to span across the anteroposterior (length) and transverse (width) margins of the foramina and then transferred to a meter rule for the readings to be taken. The lengths of right and left foramen ovale were 5.0 – 9.5mm and 5.0 – 9.0mm, respectively. The mean of the lengths of the right foramen ovale was 7.01±0.10mm while that of the lengths of the left foramen ovale was 6.89± 0.09mm. The widths of both right and left foramen ovale were 2.0 - 5.0mm. The mean of the widths of the right foramen ovale was 3.37± 0.07mm while that of the left foramen ovale was 3.33±0.07mm. There was no significant difference between the mean of the length and width of the right and left foramen ovale. The length of right and left foramen spinosum was 1.5 - 3.5mm and 1.0 - 4.0mm, respectively. The mean of the length of the right foramen spinosum was 2.34 ±0.05mm while that of the left was 2.36±0.05mm.The width of both right and left foramen spinosum was 1.0mm to 2.0mm. The mean of the widths of the right foramen spinosum was 1.66±0.03mm while that of the left foramen spinosum was 1.61±0.03mm. There was no significant difference between the mean of the length and width of the right and left foramen spinosum.
Conclusion and application: This study is of clinical and anatomical significance to medical practitioners in cases of trigeminal neuralgia and in diagnostic detection of tumors and abnormal bony outgrowths.

Key words: Foramen ovale, Spinosum, Human Sphenoid, Southern Nigeria.

INTRODUCTION
Foramina ovale and spinosum are important openings on the infratemporal surface of the greater wing of the sphenoid bone. Foramen ovale lies close to the upper end of the posterior margin of the lateral pterygoid plate. It passes through the greater wing of the sphenoid posterior to the foramen rotundum and lateral to the lingula and posterior end of the carotid groove (Standring, 2005). It transmits the mandibular nerve, the accessory meningeal artery, and sometimes, the

lesser petrosal nerve. Posterior and slightly lateral to the foramen ovale, the foramen spinosum pierces the greater wing of the sphenoid and transmits the middle meningeal artery to the middle cranial fossa. However, the foramen spinosum is much smaller than the foramen ovale and is circular (Sinnatamby, 1999, Chaurasia, 2004, Standring, 2005).

Lang *et al*. (1984) in their study of postnatal enlargement of the foramina ovale and spinosum and their topographical changes revealed that in the newborn, the foramen spinosum was about 2.25mm and in adults, about 2.56mm in length. The width of the foramen spinosum extends from 1.05 to about 2.1mm in adults. Yanagi (1987), in his developmental studies on the foramen ovale and foramen spinosum of the human sphenoid bone, also revealed that foramen ovale is about 3.85mm in the newborn and in adults, its about 7.2mm long.

In a study conducted on 100 macerated human skulls by Reymond *et al*. (2005), the foramen ovale was found to be divided into 2 or 3 components in 4.5% of the 100 macerated skulls. Moreover, the borders of the foramen ovale in some of the skulls were irregular and rough which may suggest, on radiological images, the presence of morbid changes that might be the sole anatomical variation. Concurrent with the foramen ovale were accessory foramina. The foramen spinosum occurred as a permanent element of the 100 skulls studied. The mean area of the foramina measured, excluding the foramen ovale, was not considerable, which may suggest that they play minor role in the dynamics of blood circulation in the venous system of the head.

Lindlom (1936) in his study of the vascular channels of the skull found out that the foramen spinosum was small or altogether absent in 0.4% cases. This is especially true when the middle meningeal artery arises from the ophthalmic artery. In rare cases, early division of the middle meningeal artery into an anterior and posterior division may result in the duplication of the foramen spinosum. Wood-Jones (1931) found the foramen spinosum to be more or less incomplete in approximately 44% and in 16%, the foramen in the right side was unclosed, 84% were open.

Skrzat *et al*. (2006) on a visual inspection of a dry adult human skull revealed absence of a typical foramen ovale on the left side of the cranial base. The region of the foramen ovale was covered by an osseous lamina, which was continuous with the lateral pterygoid plate and thus formed a wall of an apparent canal, which opened on the lateral side of the pterygoid process.

This study aimed at determining the exact range of measurements, the variations, e.g. asymmetry and inequality of size, seen in the foramina ovale and spinosum in the Southern Nigerian population.

MATERIALS AND METHODS

This study was carried out using 87 dried skulls obtained from the cadavers in the laboratories of the Department of Anatomy of University of Port Harcourt, Port Harcourt, Nnamdi Azikiwe University, Nnewi Campus, Okofia – Nnewi, University of Nigeria, Enugu Campus, Enugu, Niger Delta University, Amassoma, Abia State University, Uturu, University of Calabar, Calabar South, Calabar all within Southern Nigeria. The calvaria of all the skulls were cut transversely and opened with the help of a saw. The skulls were prepared by adopting the standard anatomical procedures which included dissecting out of the soft tissues as much as possible, soaking the detached heads in water at about $60^{O}C$ for 12 hours to aid the softening of the tissues. An antiseptic (Dettol) was then added to the water which was covered and left to stand at room temperature for 10 days. The skulls were then taken out of water and the soft tissues and meninges (especially dura mater) removed with the help of a sharp knife, after thorough maceration, to reveal all the foramina. The skulls were then collected and immersed in 20% caustic soda (NaOH) for 2 hours. The skulls were bleached by immersing in 10% hydrogen peroxide (H_2O_2) for 3 days, rinsed in water, dried for 2 days and then polished.

Measurements of the foramina ovale and spinosum were done by placing a pair of dividers on the anteroposterior (length) and transverse (width) diameters of the foramina and then carefully transferred to a meter rule for the readings to be taken. Results

were compared and data analyzed statistically using windows SPSS.

RESULTS

Table 1 shows the length of the right and left foramen ovale while table 2 shows the width of the right and left foramen ovale. Table 3 shows the length of the right and left foramen spinosum while table 4 shows the width of the right and left foramen spinosum.

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Table 1: Length (mm) of the right and left foramen ovale in Southern Nigerian population.

Length	Frequency	
	Right	Left
5	3	2
5.5	6	6
6	10	13
6.5	13	17
7	21	23
7.5	16	13
8	10	7
8.5	4	1
9	3	5
9.5	1	
Total	87	87

Table 2: Width (mm) of the right and left foramen ovale in the southern Nigerian population.

Width	Frequency	
	Right	Left
2	4	7
2.5	9	6
3	25	26
3.5	25	26
4	17	15
4.5	6	6
5	1	1
Total	87	87

Table 3: Length (mm) of foramen spinosum in the suthern Nigerian population.

Length	Frequency	
	Right	left
1		1
1.5	8	6
2	31	34
2.5	31	25
3	14	18
3.5	3	2
4		1
Total	87	87

Table 4: Width (mm) of foramen spinosum of the southern Nigerian population.

Width	Frequency	
	Right	Left
1	2	6
1.5	56	56
2	29	25
total	87	87

DISCUSSION

This study has revealed that the maximal length of foramina ovale was 9.5mm and minimal length was 5.0mm. This falls within the range of the research carried out by Arun (2006) in Nepal, in which the maximal length of foramina ovale of 25 unknown adult human skulls was 9.8mm and the minimal length was 2.9mm. Lang *et al*. (1984) and Yanagi (1987), in different studies, inferred that the length of foramen ovale was about 7.2mm in adults.

This value still falls within the probability limit of our findings. More than 24% of the lengths of foramen ovale, out of the 87 skulls studied, were 7.0mm. In addition, from this study, the maximal width of foramen ovale was 5.0mm and the minimal width was 2.0mm. Widths of more than 57% of the foramen ovale were within the range of 3.0 - 3.5mm and the rest were either above or below this range. However, there was asymmetry of sizes in the majority of lengths and widths of the foramen ovale of the 87 dry human skulls studied in the Southern Nigerian population. However, statistical analysis revealed that there were no significant difference between the means of the lengths and widths of both right and left sides of the foramen ovale. The shapes of the foramen ovale varied, the walls of a few of them being thick with rough edges/margins. One was partially divided into two components by a bony spur.

Moreover, the maximal length of foramen spinosum was 4.0mm and minimal length was 1.0mm. Majority of the lengths of the foramen spinosum fall within 2.0 to 2.5mm.The maximal width of foramen spinosum was 2.0mm and the minimal width was 1.0mm. This range is in proximity with the study carried out by Lang *et al.* (1984) in which they found that the width of foramen spinosum extends from 1.5mm to about 2.1mm in adults. Approximately 64% of the widths of the foramen spinosum of the 87 dry human skulls studied were 1.5mm. In addition, the widths of 2 to 6 of the foramen spinosum of the 87 skulls were 1.0mm. In addition, there was asymmetry of sizes of most of the foramen spinosum. There was no significant difference between the means of the lengths and widths of the foramen spinosum. Some of the foramen spinosum were partially divided into two components by bony spurs. Foramen spinosum of the 87 dry adult human skulls we studied were of varying shapes. Some were either oval or circular and only one of them was triangular.

However, there was no significant difference between the lengths and widths of foramen ovale and foramen spinosum of the human sphenoid bones in the Southern Nigerian population. The range of measurements of the sizes of foramina ovale and spinosum in Southern Nigeria, when compared, were not at variance with those of other races.

Hence, recognition of the foramina ovale and spinosum with structures that pass through them and their possible variations will help in distinguishing normal from potentially abnormal foramina during computerized tomography and magnetic resonance imaging examinations.

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

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