

Morphometric analysis of the foramen magnum and jugular foramen in adult skulls in southern Nigerian population

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ABSTRACT

A morphometric analysis of the foramen magnum and jugular foramen of adult skulls in southern Nigeria was carried out to demonstrate the anatomical variations in morphology. A total number of 120 dry skulls were used for this study. Measurements were performed by using a digital vernier caliper to span across the lengths and widths of the two foramina. Results revealed that the mean length and width of the foramen magnum was 36.11 ± 0.24 mm and 29.65 ± 0.24 mm respectively. The mean length of the right and left jugular foramen was 15.76 ± 0.22 mm and 13.39 ± 0.23 mm respectively, while the mean width of the right and left jugular foramen was 9.34 ± 0.18 mm and 7.54 ± 0.20 mm respectively. There was a significant difference between the right and the left jugular foramen. The right jugular foramen was found to be larger than the left in Southern Nigeria.

Key words: Morphometry, Foramen magnum, Jugular foramen, Southern Nigeria.

INTRODUCTION

The skull forms the skeleton of the head. It is rounded in shape. This part of the human body frame work is difficult to study as there are a very large number of named features on it, many of which are very difficult to identify (Singh, 2002). The bone forming the lower jaw is called the mandible. The other bones of the skull are firmly united to one another at joints called sutures. There are numerous openings in the base of the skull they are called foramina. Foramen magnum is the large opening at the lower part of the occipital bone and outlet through which the medulla and spinal cord pass from the skull to the vertebral column (McGraw-Hill, 2002). The jugular foramen is one of a pair of openings between the lateral part of the occipital bone and the petrous part of the temporal bones in the skull. (Mosby, 2009).

Hovelacque (1967) was the first to propose the subdivision of jugular foramen. The foramen is divided by a fibrous or bony septum that joins the jugular spine of the petrous bone to the jugular process of occipital bone, the anteromedial compartment (pars nervosa) and a posterolateral compartment (pars vascularis). The pars nervosa receives the 9th cranial nerve, inferior petrosal sinus and the meningeal branch of the ascending pharyngeal artery, while the remaining structures pass through the pars vascularis. Tekdemir *et al.*, (1998) observed no partition while Ekinci *et al* (1997)

found bony bridges in 20% and tripartite jugular foramen in 0.7%.

Kizilkanat *et al.*, (2006) conducted a study on the foramen magnum in relation to other structures in the posterior cranial fossa to determine the detailed morphometry of occipital condyle, hypoglossal canal, and foramen magnum in Turkish-Caucasian skulls. Measurements were taken from 59 dry skulls of unknown sex. There was no significant difference ($P > 0.05$) in measurements taken from the right and left sides. Tubbs *et al.*, (2010) carried out a research on the morphometric analysis of the foramen magnum. The objective was to further elucidate the importance of anatomic variations in morphology of the foramen magnum and associated clinical implications. Seventy-two dry skulls were used for this study. The results revealed that the mean surface area of the foramen magnum was 558 mm^2 , the mean anteroposterior diameter was 31 mm, and the mean horizontal diameter was 27 mm.

Idowu, (2004) carried out a morphometric study of 20 (40 jugular foramina) adult male Nigerian dry skulls. The study was embarked on to examine the anatomy of the jugular foramen, including its dimensions, and to discover the degree of predominance, if any. The mean length of the right and left were 13.90mm (11.6-17.0mm) and 14.11mm (9.2-20.2mm) while their widths measured 10.22mm (6.8-14.4mm) and 9.57mm (7.4-12.8mm) on the right and left respectively. The mean area on the right was

437.49mm (265.35-669.54mm) and that on the left was 419.48mm (276.46-634.60mm) side predominance of one of the jugular foramen appeared in 80% of cases. When present, the predominance of the right side was 55% with 25% on the left. There was a difference in the length and width on each side but no significant difference in the length, width and area of the jugular foramen between the two sides. There was a positive correlation between length and area on both sides but no correlation between length and width on each side. Rhoton *et al.* (1975) noted that 68% of JF were larger on the right, 12% equal and 20% smaller.

This study is aimed at establishing a database for the measurements of these two foramina, and to get the normal anatomical variants of their morphology.

MATERIALS AND METHODS

A total number of 120 non-pathological dry adult skulls were used. The skulls were obtained from the osteological collections of the Department of Anatomy in Nnamdi Azikiwe University Awka, Anambra State, University of Nigeria Enugu Campus, Enugu State, Delta State University Abraka, Delta State, University of Benin, Benin City, Edo State, Ambrose Ali University, Ekpoma, Edo State,

University of Uyo, Uyo, Akwa Ibom State, University of Calabar, Calabar, Cross River State, Madonna University, Elele, Rivers State. Measurements (length and width) of the foramen magnum and jugular foramina of the occipital bones were performed by using a digital vernier caliper. The length of the foramen magnum was measured from the anterior border (basion) through the centre of the foramen magnum until the end of the posterior border (opistio), towards the median plane while the widths were measured from the end of the right border with concavity stronger, through the centre of the foramen magnum to the opposite end of the lateral border of concavity, with transverse directions. The length of the jugular foramen runs from the anterior to the posterior end of the jugular foramen, while the width is the transverse diameter of the jugular foramen. It runs from the medial to the lateral sides. Statistical analysis was done by using SPSS for windows and Z-test.

RESULTS

The result of this study is as presented in Table 1. Table 1 shows the mean length and width of the left and right jugular foramen and the length and width of the foramen magnum. The length and width of the right jugular foramen was larger than that of the left jugular foramen ($p < 0.05$).

Table 1: Table showing the mean length and width of left and right jugular foramen and length and width of the foramen magnum

Jugular foramen	N	Mean±SD Length (mm)	Mean±SD width (mm)
Left	120	13.39±2.50	7.54±2.17
Right	120	15.76±2.36	9.34±2.00
Foramen magnum	120	36.11±2.60	29.56±2.60

N= number of foramina, SD= Standard deviation.

DISCUSSION

This study has revealed the various dimensions of the foramen magnum and jugular foramina in some adult skulls in Southern Nigeria. The skulls have large right and small left jugular foramen in terms of length and width. There were very few exceptions in the individual skulls where 24 (20%) of the skulls had jugular foramen with large left width and small right width, another 12 skulls (10%) had jugular foramen with large left length and small right length. 3 skulls (2.5%) exhibited a disproportion between the size of the foramen magnum and jugular foramen such that they had large foramen magnum and small jugular foramen. Another 3 skulls (2.5%) exhibited a disproportion between the size of the foramen

$P < 0.05$ magnum and jugular foramen in that they had smaller foramen magnum and large jugular foramen, while 114 skulls (95%) had a direct proportion in size of the foramen magnum and jugular foramen, in that those with large foramen magnum also had large jugular foramen, and those with small foramen magnum also had small jugular foramen.

The mean length and width of the right Jugular Foramen were larger than those of the left. This was statistically significant ($p < 0.05$).

The comparison of the morphometric analysis obtained in this study with the result of other studies showed that the mean length of the foramen magnum of adult Southern Nigerian skulls (36.11 ± 0.24) was larger than that gotten by Tubbs *et al.*, (2010)

(31mm). It was also larger than the Brazilian male skulls (35.7±0.29mm) and female skulls (35.1±0.33mm) (Manoel *et al.*, 2009), English male population (35.91±2.41mm) and English female population (34.71±1.91mm) Gapert *et al.* (2008), Turkish female skulls (34.6±3.16mm) Murshed *et al.*, (2003), Spanish female skulls (34.30±0.0mm) Herrera (1987), Indian males (35.5±2.8mm) and females (32.0±2.8mm), Routal *et al.*, (1984). It was however smaller than that of Turkish male population (37.2±3.43mm) Murshed *et al.*, (2003) and Spanish male skulls (36.2±0.3mm) Herrera (1987). The value obtained for the width of the foramen magnum in this study (29.56±0.24mm) was larger than that of the Brazilian female skulls (29.4±0.23) Manoel *et al.* (2009), Indian female skulls (27.1±1.6) Routal *et al.* (1984), Turkish female population (29.3±2.19) Murshed *et al.* (2003) and English female population (29.36±1.96) Gapert *et al.* (2008). It is smaller than that gotten by Tubbs *et al.*, 2010 (27mm) and Muthukumar *et al.*, 2005 (27.9mm). However, it was smaller than that of the Brazilian male skulls (30.3±0.20) Manoel *et al.* (2009), Indian male skulls (29.6±1.9) Routal *et al.* (1984), Turkish male population (31.6±2.99) Murshed *et al.* (2003), Spanish male (31.1±0.3) and Spanish female (29.6±0.3) Herrera (1987), English male population (30.51±1.77) Gapert *et al.* (2008).

The mean length of the right jugular foramen (15.76±2.36mm) in this study was larger than that obtained by Idowu, (2004) 13.90mm, while that of the left jugular foramen (13.39±2.50mm) in this study was less than that obtained by Idowu, (2004) 14.11mm. The mean width of both the right (9.34±2.00mm) and left (7.54±2.17mm) jugular foramen in this study were found to be smaller than that obtained by Idowu, (2004) 10.22mm and 9.57mm for right and left respectively. The right jugular foramen is significantly larger than the left jugular foramen ($p < 0.05$).

This study found the right Jugular foramen to be larger than the left in our population. A large foramen magnum is normally associated with a large jugular foramen. Also, a small foramen magnum is normally associated with a small Jugular foramen.

These findings will be useful to neurosurgeons, clinicians and forensic scientists.

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