ORIGINAL ARTICLE

MORPHOMETRIC EVALUATION OF THE FORAMEN MAGNUM USING COMPUTED TOMOGRAPHIC IMAGES IN NEUROPSYCHIATRIC HOSPITAL MAIDUGURI, NORTHEASTERN NIGERIA

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ABSTRACT

Background: The foramen magnum (FM) is an important landmark of the skull base. It is of particular interest in anthropology, anatomy, surgery and other medical fields because of its shape, relations and the structures it transmits. Knowledge of the anatomy of the FM and the structures around it is significant in sex determination and in surgical operations involving the basic ranium. The present study was aimed at the analysis of the antero-posterior diameter (APD), mid-transverse diameter (MTD), and the different shapes of the FM in the sample population. Method: The sample population for the present study which comprised of basicranial Computed Tomographic (CT) images of 110 patients (60 males and 50 females) with an average age of 18-65 years were obtained from the Federal Neuropsychiatric Hospital, Maiduguri, Borno State-Nigeria. Results: Males subjects showed higher mean value of APD (34.80 mm) compared to females (30.50 mm) and the differences observed was statistically significant at $p<0.001$. Similarly, males showed higher mean value of MTD of FM (31.60 mm) when compared to females (29.20 mm) and the differences observed was statistically significant at $p<0.001$. The study showed oval-shaped foramen magnum as most common (63% in males and 64% in females). The present study also observed the spherical and round shapes which constituted 22% and 25% in male and female respectively, in the sampled population. Pea-shaped and kite-shaped Foramen magnum was 3.3% occurrence in males and zero percent in females. Conclusion: The results of the present study revealed that, measurements of for amenmagnum is a valuable tool and is suitable for sex identification when other methods are not applicable.

Key words: Morphometric Evaluation, Foramen Magnum, Ct Images, Northeast Nigeria

INTRODUCTION

The foramen magnum (FM) is an important landmark of the basicranium and is a useful tool in anthropology, anatomy and other medical fields.[1] The FM contains the medulla oblongata and is narrowed anteriorly by the two occipital condyles.[2] The FM is a point of transition between the spine and the skull and serves as an important landmark in the basicranium because of its relationship to important structures such as the spinal cord.

FM forms a wide communication between the posterior cranial fossa and the vertebral canal and it transmits the vertebral arteries as well as the spinal accessory nerve.[2] Since the FM transmits important

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neuroanatomical structures, lesions of these structures in the region of FM will require surgical operation. In such situations, the decision of the most appropriate surgical techniques to use requires careful planning that is mainly based on the size of the FM in order to avoid injury to these neurological structures.[3]

Analysis of FM diameter is of great significance because of its contents, as well as its relationship to important structures. The FM dimensions have significant clinical implications because the vital neurovascular structures that pass through it may suffer compression. Longer antero-posterior diameter of FM permits greater contralateral surgical exposure for condylar resection. As a result, the focus of several studies has been the analysis of the anatomic and radiologic values of FM dimensions and their variability between the sexes.[4]

The present study was aimed at the analysis of the antero-posterior diameter (APD), mid-transverse diameter (MTD), and the different shapes of the FM in the sampled population and to check for possible sexual dimorphism.

MATERIALS AND METHODS

Materials: The sample population for this study comprised of basicranial CT images of 110 patients (60 males and 50 females) aged 18–65 years obtained by purposive sampling technique from the archive in the work station of the Department of Radiology, Federal Neuropsychiatric Hospital, Maiduguri, Borno State-Nigeria.

Exclusion Criteria

Images of patients below 18 or above 65 years of age were not included in this study. Poorly produced CT images were also exempted from the study.

The images used for this study, were made by 16-slice bright speed CT scanner. (Model No. 227892HM7 and manufactured by General Electronic (GE), Chicago, USA).

METHOD

The parameters measured are the antero-posterior diameter (APD) and mid-transverse diameter (MTD) of the FM, and the readings of the measurements were taken and recorded in millimetre (mm) and approximated to two decimal places. Measurements were conducted on the CT images according to following protocols:

1. The APD was taken as the maximum foramen magnum internal length along the midsagittal plane.
2. The MTD was taken as the maximum foramen magnum internal width perpendicular to the midsagittal plane.[5]

The data obtained was subjected to statistical analysis using Instat GraphPad (version 3.05). The level of significance for the parameters tested was placed at $p<0.05$.

Index for sexual dimorphism (ISD) was used to assess whether the parameters measured are sexually dimorphic or not. ISD was calculated thus:

ISD = male mean value × 100

Females' mean value

ISD is expressed as a percentage and a value greater than 100% indicates sexual dimorphism while value less than 100% is considered not sexually dimorphic.

RESULTS

Table 1 recorded the means of the APD and MTD for both males and females together with the ISD. Table 2, shows the various shapes of FM. The oval shaped FM has the highest occurrence in both sexes whilethe tetrahedral, pea and kite shaped FM have the least occurrence in males.While in females; tetrahedral, has the least occurrence with zero occurrences of pea and kite shaped FM.

Table 1: Mean values of the Antero-posterior and mid-transverse diameters of the foramen magnum and index for sexual dimorphism.

Parameters	Sex (N)	Mean±SD (mm)	ISD (%)	P value
APD	Males (60)	34.5±3.3	87.64	<0.001
	Females (50)	32.8±3.5		
MTD	Males (60)	31.6±2.2	175.59	<0.001
	Females (50)	29.2±3.6		

Table 1: Mean values of the Antero-posterior and mid-transverse diameters of the foramen magnum and index for sexual dimorphism.

APD = antero-posterior diameter, MTD = mid-transverse diameter, SD = standard deviation, mm = millimetre, ISD = index for sexual dimorphism.

Table 2: Different shapes of foramen magnum and their occurrence in males and females

Serial Number	Shapes of foramen magnum	Occurrence in males	Occurrence in females
1	Oval	26	32
2	Round	15	8
3	Spherical	13	6
4	Tetrahedral	2	4
5	Pear	2	0
6	Kite	2	0

DISCUSSION

The foramen magnum is a prominent structure in the base of the skull, and it shows morpho metric differences between males and females.[5]A statistical difference in the morpho metric diameters between males and females from computerized tomography images was reported in Poland reported. The antero-posterior and mid-transverse diameters in males and females was (37.06±3.07 mm) and (35.47±2.60 mm), respectively.[6] The present study revealed that the mean antero-posterior diameter in males (34.50±3.30 mm) was greater than females (32.80±3.50 mm). The mid-transverse diameter in males (31.60±2.20 mm) is also greater than females (29.20±3.60mm). Many authors reported sex dimorphism in both morpho metric diameters of the foramen magnum, with the greater diameters present in males.[7,8,9]

Many studies analyzed the antero-posterior, mid-transverse diameters and area of the foramen magnum.[9,10, 11] These parameters are important for forensic investigations and anthropological examinations of unknown individuals.[7, 12]A morphometric analysis of the antero-posterior and mid-transverse diameters in the present study revealed values of (34.8±3.5 mm)and (37.1 mm, 23.75 mm), respectively. The overall mean antero-posterior diameter (35.15±2.74 mm) was found to be greater than the mean transverse diameter in this study (28.86±2.35 mm). Similar findings were reported in a series of other studies.[8,13, 14, 15].

In this study, statistical significance in sex was found in both the antero-posterior diameter ($p < 0.05$) and the mid-transverse diameter($p<0.001$). However, other studies reported that only the transverse diameter showed statistical significance between males and females.[12,16]In another study,it has been observed that the antero-posterior and mid-transverse diameters in males (4±0.65 cm, 3.8±0.7 cm) were greater than females (3.4±0.65 cm, 2.8±0.7 cm), respectively.[14] However, no statistical significance was found between males and females[14]. ISD for APD and MTD wererespectively 87.64 and 175.59. This result indicates that APD and MTD are sexually dimorphic in the sample population.

Many researchers observed varyingshapes of the foramen magnum.[14, 15, 17,18]The present study observed six varying shapes of theforamen magnum in the sampled population. Theseshapes were reported as oval, round, tetrahedral, spherical, pea and kite.Recent studies reported that the morphologicalvariations of the foramen magnum are indicative of ancestral variability.[12] However, standardtextbooks describe the foramen magnum as oval in shape.[19]A few recent studies reported that the oval shape was most common in different populations.[9, 18]Similarly, the present study reports the oval-shape (63% in males and 64% in females) foramen magnum asmost common. The present study also observed the spherical and round shapes which constituted 22% and 25% in male and female respectively, in the sampled population. Pea-shaped and kite-shaped Foramen magnum was3.3% occurrence in males and zero percent in females.

CONCLUSION The results of the present study revealed that, measurements of for a men magnum is a valuable tool and is suitable for sex identification when other methods are not applicable.

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