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MORPHOMETRIC AND MORPHOLOGICAL STUDY OF FORAMEN MAGNUM

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Abstract

Background: The foramen magnum, which translates to "great hole" in Latin, is a significant anatomical feature situated in the base of the skull. This large, oval-shaped opening in the occipital bone serves as the passage for the spinal cord as it exits the cranial cavity. Additionally, it transmits various structures including the vertebral arteries, spinal arteries, tectorial membranes, alar ligaments, and the accessory nerve. In bipedal mammals, the foramen magnum plays a crucial role and is associated with changes in posture and locomotion

Aims: The present study aims in performing the morphometric analysis foramen magnum and to classify it based on its shape.

Materials and methodology the present was conducted on 100 dry human skull in the anatomy department A.S.J.S.A.T.D.S. Medical College Fatehpur, with associated anatomy department of ASMC , Pratapgarh

Results: In our present study we observed that the most common shape of foramen magnum is oval which is 43% Antero-posterior diameter: we observed the mean antero- posterior diameter was 32.47±1.65 mm with maximum diameter 40.48 mm and minimum it was 26.48, Transverse diameter: the mean transverse diameter was 26.49±12 mm with maximum diameter 35.85 mm and minimum it was 24.45mm. Foramen magnum area: the mean area of foramen magnum was 749.04±101.45 mm2 Foramen Magnum index: the index of foramen Magnum was 1.45±0.

Conclusion: The morphological and morphometric analysis of the foramen magnum and its variations is crucial for anatomists, neurosurgeons, anesthetists, orthopedicians, and radiologists. With advancements in imaging technology such as computed tomography and magnetic resonance imaging, these variations have gained significance in the field of diagnostic medicine. This study also holds importance for forensic medicine experts as comparing ethnic variations may assist in identifying different races when analyzing populations from various ethnic regions

Keywords: Foramen Magnum, Morphometry, Meningioma, Antero-Posterior Diameter, Transverse Diameter, Foramen Magnum Area,

Introduction

The foramen magnum, which translates to "great hole" in Latin, is a significant anatomical feature situated in the base of the skull. This large, oval-shaped opening in the occipital bone serves as the passage for the spinal cord as it exits the cranial cavity. Additionally, it transmits various structures including the vertebral arteries, spinal arteries, tectorial membranes, alar ligaments, and the accessory nerve. In bipedal mammals, the foramen magnum plays a crucial role and is associated with changes in posture and locomotion.[1] The forward shift of the foramen magnum, attributed to the shortening of the cranial base, is a distinctive feature observed in bipedal hominins, including modern humans and certain ancient hominins such as Australopithecus africanus and Paranthropus boisei[2]. This characteristic has been used as an argument to suggest bipedalism in early hominins such as Sahelanthropus tchadensis. Anatomically, the foramen magnum is an opening bounded by the basiocciput anteriorly, the supraocciput posteriorly, and the occipital condyles laterally. It can be divided into an anterior smaller compartment and a posterior larger compartment by the alar ligament, which attaches to the tubercle of the occipital condyle on each side[3].

Material and Method

Material

the present was conducted on 100 dry human skull in the anatomy department A.S.J.S.A.T.D.S. Medical College Fatehpur, with associated anatomy department of ASMC, Pratapgarh

Inclusion criteria: Completely ossified dry human skull bones irrespective of age and sex.

Exclusion criteria: Skull of children, incomplete, damaged were excluded. Skull showing gross deformity were considered for bony variation but excluded for morphometry.

Method

All measurements were recorded using the Digital Vernier Calliper with with least count of 0.01mm by the same observer to eliminate inter-observer variability. Two measurements were taken and then averaged, in case of difference of more than 0.1mm, a third reading was done.

1) Antero-posterior diameter: Maximum distance in the mid-Sagittal plane between the median point on the anterior margin (Basion) to the median point in the posterior margin (Opisthion).

2) Transverse diameter: maximum distance between the two lateral margins at the point of greatest lateral curvature.

3) Foramen magnum area: calculated using the Radinsky formula: where = mathematical constant, 22/7 w = transverse diameter h = antero-posterior diameter

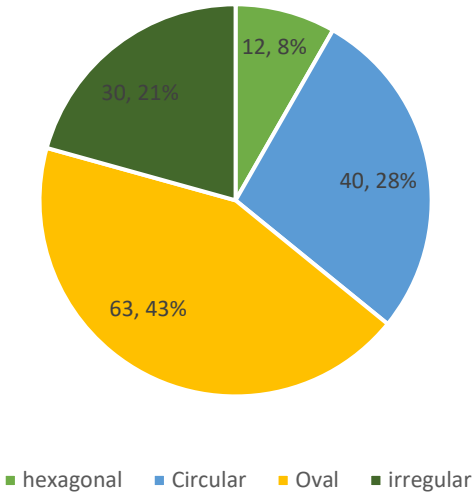
4) Foramen Magnum index: transverse diameter x 100/Antero-posterior diameter.

5) Shape of foramen magnum:- The shapes of Foramen Magnum were classified as Hexagonal, Circular and Oval shaped.

Result

In our present study we observed that the most common shape of foramen magnum is oval which is 43% in our study as given below table number 1

S. No	Shape of foramen magnum	Number of skull	percentage
1	hexagonal	12	8
2	Circular	40	28
3	Oval	63	43
4	irregular	30	21



Pie chart No 1 showing the variation in shape of foramen magnum

1) **Antero-posterior diameter:** we observed the mean antero- posterior diameter was 32.47±1.65 mm with maximum diameter 40.48 mm and minimum it was 26.48
2) **Transverse diameter:** the mean transverse diameter was 26.49±12 mm with maximum diameter 35.85 mm and minimum it was 24.45mm.
3) **Foramen magnum area**: the mean area of foramen magnum was 749.04±101.45 mm^2
4) **Foramen Magnum index:** the index of foramen Magnum was 1.45±0.15.

Table no 1 shows the result of Antero-posterior diameter Transverse diameter, Foramen magnum and Foramen Magnum index

S. No	Parameters	Mean	St. Deviations	Minimum	Maximum
1	Antero-posterior diameter	32.47±1.65	1.65	26.48	40.48
2	Transverse diameter	26.49±12	0.12	24.45	35.85
3	Foramen magnum area	749.04±101.45	101.45	646.15	841.15
4	Foramen Magnum index	1.45±0.15	0.15	1.01.21	1.98.11

Discussion

In our current study we observed the most common shape of foramen magnum is oval which is 43%. While comparing our study with Archana Singh[4] The most common shape of foramen magnum was oval in 40 (33.3%) skulls; followed by tetragonal in 20 (16.6%) skulls and hexagonal in 20 (16.6%) skulls. Round shaped foramen magnum was present in 16 (13.3%) skulls, pentagonal foramen magnum in 16 (13.3%) and pear shaped foramen magnum was present in 8 (6.6%) skulls also similar with our study. Another study of Dalvinder Singh[5] oval shape in 29.76% of cases, round in 26.19%, tetragonal in 16.67%, egg shape in 10.71%, irregular in 5.95%, hexagonal in 5.95% and pentagonal in 4.76% of the cases similar with our study, another study of Devesh K Sharma[6] the foramen magnum shape were determined as oval in 22.67 % egg- shaped 12% round 14.67 tetragonal 14.67 % pentagonal 9.33 hexagonal 16 % and irregular 10.67% which was similar with our study. **Intkhab C Hashmi** [7] he observed that Oval shape foramen magnum was observed in 52 number of skulls and the incidence was 33.76%, tetragonal shape was observed in 31 number of skulls and the incidence was 20.12%, hexagonal shape was observed in 18 number of skulls and the incidence was 11.68%,

round shape was observed in 26 number of skulls and the incidence was 16.88%, pentagonal shape was observed in 13 number of skulls and the incidence was 8.44% and pear shape was observed in 14 number of skulls and the incidence was 9.12%.

In our current study we observed the mean value Antero-posterior diameter: we observed the mean antero- posterior diameter was 32.47±1.65 mm with maximum diameter 40.48 mm and minimum it was 26.48, Transverse diameter: the mean transverse diameter was 26.49±12 mm with maximum diameter 35.85 mm and minimum it was 24.45mm. Foramen magnum area: the mean area of foramen magnum was 749.04±101.45 mm2, Foramen Magnum index: the index of foramen Magnum was 1.45±0.15 while comparing our study with R Shane Tubbs [8] the mean surface area of the foramen magnum was 558 mm, the mean anteroposterior diameter was 3.1 cm, and the mean horizontal diameter was 2.7 cm. For comparison, surface areas were classified into 3 types based on size. Type I foramina were identified in 20.8% of the dry skulls (15 skulls) and exhibited a surface area of less than 500 mm2. Type II (66.6%, 48 skulls) was applied to foramina of an intermediate size with surface areas ranging between 500 to 600 mm2. Type III (12.5%, 9 skulls) was applied to large foramina with surface areas of more than 600 mm2. Another study of Rajani_Singh[9] Mean antero-posterior diameter and transverse diameter of foramen magnum are 33.8 ± 02.5 mm and 28.2 ± 02.6 mm, respectively. The minimum, maximum and mean areas of foramen magnum in assorted skulls are 434 mm^2, 902 mm^2 and 648.5 ± 112.2 mm^2, respectively. Foramen magnum index in assorted skulls vary from 1 to 1.45 another study Devesh K Sharma[6] they observed the mean anteroposterior diameter was 35.11±3.12mm, the transvers diameter was 29.35±3.48 mm are was 813.94±146.40 mm^2 , index was 1.208±0.150 which is similar with our study.

Conclusion

The morphological and morphometric analysis of the foramen magnum and its variations is crucial for anatomists, neurosurgeons, anesthetists, orthopedicians, and radiologists. With advancements in imaging technology such as computed tomography and magnetic resonance imaging, these variations have gained significance in the field of diagnostic medicine. This study also holds importance for forensic medicine experts as comparing ethnic variations may assist in identifying different races when analyzing populations from various ethnic regions.

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