

Original Research Article

MORPHOMETRIC STUDY OF FORAMEN MAGNUM AND ITS FORENSIC IMPORTANCE

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ABSTRACT

Background: The foramen magnum is the largest foramen in the skull. It is a wide opening in the posterior cranial fossa connecting the cranial cavity with the vertebral canal. It allows the passage of vital structures of brain through it. It is oval in shape, wider behind and the largest diameter is antero-posterior. It contains lower end of medulla oblongata, meninges, cerebro-spinal fluid, vertebral arteries and veins, and spinal accessory nerve. The dimensions of the foramen magnum are clinically important because the vital structures passing through it may endure compression such as in cases of foramen magnum herniation, foramen magnum meningiomas and foramen magnum achondroplasia. The present study was conducted to evaluate morphological morphometric analysis of foramen magnum.

Materials and Methods: We are conducted study with 67 adult dry skulls. We have measured anterior- posterior diameter and traverse diameter of foramen magnum. Antero-posterior diameter was measured from basion to opisthion in the sagittal plane. Transverse diameter was measured perpendicular to antero-posterior diameter at maximum point in coronal plane. We have observed shapes of foramen magnums and categorized as round, oval, tetragonal, pentagonal.

Results: We found round shaped, oval shaped, tetragonal shaped and pentagonal were found. We found anteroposterior diameter of foramen magnum was 35.72 ± 3.42 mm with range of 28- 42mm, transverse diameter was 31.36 ± 2.26 mm with range of 23-34 and index of foramen magnum was 1.26 ± 0.12 mm with range of 1.16- 1.42mm.

Conclusion: The present study findings may be helpful neurosurgeons, anaesthetists and radiologists. These variations have become significant because of newer imaging techniques such as computed tomography and magnetic resonance imaging in the field of diagnostic medicine. This study will also be a help to forensic medicine experts.

Keywords: Foramen Magnum, Medulla, Vertebral artery, Basilar Artery.

INTRODUCTION

The foramen magnum is a large opening located at the base of the skull, belonging to the occipital bone. Its borders are very variable in shape and are formed by the anatomical regions of the occipital bone. The anterior border of the foramen magnum consists of the basilar process, the lateral border is formed by the right and left occipital condyles, and the posterior border is composed by the supraoccipital portion. Numerous noble and hard-to-access

structures enter the skull through this foramen, the main ones being the medulla bulb, the spinal cord, the meninges, the vertebral arteries, and some spinal nerve roots. In addition, other structures essential for the support and for the movement of the skull in relation to the spine are associated with the limits of the foramen magnum, such as the complex that forms the atlanto-occipital joint and the membranes associated with it.^[1,2,3] The morphometric study of the human skull is a common practice among anatomists, anthropologists, and forensic practitioners, as it is a structure of great interest since

it possesses sexual dimorphic characters and ethnic differences. The foramen magnum is an anatomic region of vital importance, as it is protected from injuries such as fire, explosions, and mutilations, this is due to the strong muscles and ligaments that are present in this region. Furthermore, the cranium seems to be less affected by factors such as nutrition and they are more genetically driven. It is also known that the morphological features of the foramen magnum went through evolutionary changes, thus, conferring this region a special anthropological interest.^[1,4,5]

Four primary cartilaginous centers, the anterior basioccipital, the lateral exoccipitals and the posterior supraoccipital. The mendosal suture runs horizontally between the developing inferior supraoccipital and superior interparietal bones. Fetuses at 9 weeks gestation have an ossification center around the hypoglossal canal in each exoccipital part and a single median ossification center in the basioccipital cartilage. At 12 weeks gestation, a pair of ossification centers in the supraoccipital cartilage fuse together to form the supraoccipital bone. At 14 weeks, ossification of the basioccipital occurs and advances laterally into the ventral portion of the condylars, while concurrently the ventral portions advance into the dorsal portions. By the 16th week of fetal development, all intramembranous ossification centers are generally fused forming a lattice of trabeculae overlaying the external surface of the occipital squama. The exoccipitals remain separated from both the basioccipital and the supraoccipital segments by synchondroses and will not fuse until between 2 and 4 years of age.^[6,7,8]

The applications of morphometric analyses of the foramen magnum are quite diverse. For instance, the length and breadth of the foramen magnum is clinically relevant in patients with achondroplasia; the cervicomedullary junction may be compressed as a result of marked foramen magnum stenosis, resulting in neurologic manifestations. In addition, foramen magnum morphometry is relevant in forensic medicine. For example, sex determination based on foramen magnum morphometry.^[9] The present study was conducted to find morphometric analysis of the foramen magnum, it is a forensic practice that can help identify the sex of a deceased person when other methods are not possible.

Medico legal Importance- The foramen magnum dimensions can be used to estimate a person's gender, age, stature, and ethnicity. This is especially useful in cases of severe trauma, fire, or explosions, when other parts of the skull may be damaged. The foramen magnum's size and shape can provide insights into a population's history and ancestral links. For example, analysing the foramen magnum in Central Indian skulls can help shed light on the region's past migrations and population admixtures. Hanse thorough understanding of the foramen magnum's anatomy is essential.

MATERIALS AND METHODS

Our present study was conducted in MPMC, Kalaburagi. We are conducted study with 67 adult dry skulls. We have collected skulls in forensic and anatomy departments and also from medicine students. We have included only full complete skulls, damaged and broken skulls were excluded from study. We have carefully examined the base of skull for study of foramen magnum and which have clear foramen magnum included in study. We have measured anterior- posterior diameter and traverse diameter of foramen magnum, these measurements were measured with measured using digital vernier calipers. Antero-posterior diameter was measured from basion to opisthion in the sagittal plane. Transverse diameter was measured perpendicular to antero-posterior diameter at maximum point in coronal plane. We have also observed the morphological shapes of foramen magnums and categorized as round, oval, tetragonal, pentagonal(Fig.1). All the morphometric measurements were analyzed and expressed in the form of Mean+SD.

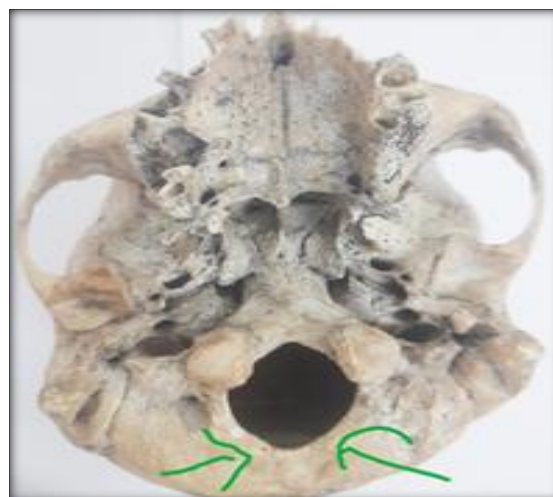


Figure 1: Showing the oval shape foramen magnum

RESULTS

In present study we observed shapes of foramen magnum and classified as round, oval tetragonal and pentagonal. Out of 67 skulls we found round shaped 18(26.86%) , oval shaped were 37(55.22%), tetragonal shaped were 5(7.47%) and pentagonal were found in 7 skulls(10.45%). We have measured anterior posterior diameter and transverse diameter of foramen magnum with digital vernier calipers, we found anteroposterior diameter of foramen magnum was 35.72+3.42mm with range of 28- 42mm, transverse diameter was 31.36+2.26mm with range of 23-34 and index of foramen magnum was 1.26+0.12mm with range of 1.16- 1.42mm.

Table 1: Shapes of foramen magnum

Shape	Number (%)
Round	18(26.86%)
Oval	37 (55.22%)
Tetragonal	5(7.47%)
Pentagonal	7(10.45%)
Total	67(100%)

Table 2: Morphometric measurements foramen magnum

Variables	Range (mm)	Mean+SD(mm)
APD (mm)	28- 42	35.72+3.42
TD (mm)	23- 34	31.36+2.26
FM Index	1.16- 1.42	1.26+0.12

DISCUSSION

The anatomical variance of the foramen magnum may have some impact on certain surgical procedures such as vertebral artery and posterior inferior cerebellar artery aneurysm repairs, foramen magnum meningioma resections, and foramen magnum decompression among others. In an ovoid type foramen magnum, it is difficult for a surgeon to adequately expose the anterior portion of the foramen. Additionally, the occipital condyle and jugular tubercle are the main bony prominence obstructing the anterolateral portion of the foramen magnum. Extension of the occipital condyles into the foramen magnum may indicate the need for more extensive bony removal in certain procedures.^[6,11] Foramen magnum is morphologically variable osteological feature in the skull which has undergone evolutionary changes.^[12,13]

In present study we observed shapes of foramen magnum, predominant shape was oval shaped were 55.22%, next major shape found was round shaped 26.86%, followed by pentagonal 10.45% and tetragonal shaped 7.47%. We found anteroposterior diameter of foramen magnum was 35.72+3.42mm with range of 28- 42mm, transverse diameter was 31.36+2.26mm with range of 23-34 and index of foramen magnum was 1.26+0.12mm with range of 1.16- 1.42mm.

Chethan P,^[14] study was report similar finding as our present study, they conducted with 53 skulls and reported round shape in 22.6% of cases, egg shape in 18.9%, tetragonal in 18.9%, oval in 15.1%, irregular in 15.1%, hexagonal in 5.6% and pentagonal in 3.8% of the cases. In 20.7% of skulls, the occipital condyle was observed to protrude into the foramen. The mean antero-posterior and transverse diameter of the foramen magnum was determined as 31 ± 2.4 mm and 25.2 ± 2.4 mm respectively. The average foramen magnum index was 1.2 ± 0.1. Cirpan S,^[15] study with 150 skulls reported the mean antero-posterior diameter and transverse diameter of anteroposterior diameter by transverse diameters were found as 34.38 ± 2.38 and 28.95 ± 2.19, respectively. According to estimated foramen magnum index of the 150 adult dry skulls, 87 (58%) of skulls were described as being round in

shape and 63 (42%) of skulls were described as being oval in shape.

Yataco-Wilcas CA,^[16] reported the average measurements of the skull base revealed a foramen magnum with a mean length of 33.80 mm and a width of 28.70 mm, along with right condyles measuring 25 mm in length and 14.10 mm in width, and left condyles measuring 23.80 mm in length and 13.90 mm in width. Degno S,^[17] study found the mean values of anteroposterior and transverse diameters of the foramen magnum were 35.19 and 30.17 mm, respectively, and the mean area of the FM was 853.36 mm². The shapes of FM were determined as round in 22.2%, oval in 18.5%, egg like in 20.4%, triangular in 3.7%, pentagonal in 11.1%, hexagonal in 7.4%, irregular in 13%, and rectangular in 3.7% of the cases. Sharma DK,^[18] study found the mean anteroposterior diameter was 35.11 ± 3.12 mm, the transverse diameter was 29.35 ± 3.48 mm, area was 813.94 ± 146.40 mm², and the foramen magnum index was 1.208 ± 0.150. The foramen magnum shapes were determined as oval (22.67%), egg-shaped (12.00%), round (14.67%), tetragonal (14.67%), pentagonal (9.33%), hexagonal (16.00%), and irregular (10.67%).

CONCLUSION

The foramen magnum dimensions can be used to estimate a person's gender, age, stature, and ethnicity. This is especially useful in cases of severe trauma, fire, or explosions, when other parts of the skull may be damaged. The foramen magnum's size and shape can provide insights into a population's history and ancestral links. For example, analyzing the foramen magnum in Central Indian skulls can help shed light on the region's past migrations and population admixtures. A thorough understanding of the foramen magnum's anatomy is essential for guiding surgical interventions.

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