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Morphometric Study of Foramen Magnum in Human Skulls

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ABSTRACT

Background: Foramen magnum is a vital landmark present at the base of the skull. Its morphometric analysis is clinically significant as it transmits the medulla and the spinal cord. **Objective:** The aim was to identify different shapes of the foramen magnum in human skulls and to evaluate its transverse and antero-posterior diameter. The foramen magnum index was also recorded. **Study Design:** Cross Sectional Observational Study. **Settings:** Anatomy Department, Postgraduate Medical Institute, Lahore Pakistan. **Duration:** 2 months from November 01, 2020 to January 01, 2021. **Methods:** Thirty-five human skulls were studied. The foramen magnum was visually analyzed for its shape. The osteometric data including the transverse and antero-posterior diameter was recorded with vernier calliper. **Results:** The most common shape observed was oval (45%). The mean antero-posterior diameter was 32±24 mm. While, the average transverse diameter was 26±14 mm. Foramen magnum index was 81.25±10. **Conclusion:** Knowledge about the dimensions of foramen magnum is helpful for the radiologists and neurosurgeons while planning and performing surgeries.

Keywords: *Foramen magnum, Medulla, Spinal cord, Diameter, Foramen magnum index.*

INTRODUCTION

The osteomorphometrical features of bones are of great help while determining the age, sex and race of unidentified individuals during forensic investigations and anthropological studies.[1]

Skull being the vital part of the human skeleton serves as a valuable landmark for such studies.[2] At the base of the skull, there is a three-dimensional opening called the foramen magnum.[3] Foramen magnum transmits vital structures including lower half of medulla, spinal cord along with its meninges and blood vessels.[4] The location of the foramen magnum in humans is unique as compared to other mammals. In humans it has moved forward in the occipital bone from the back of the skull, to a position just below the center of the skull and the brain.[5] Many specialties of medicine hold keen interest in the foramen magnum. The variations in the shape of the foramen has strong radiological, clinical, forensic significance.[6] The dimensions of the foramen magnum can help in identification of clinical conditions including Arnold-Chiari malformation, foramen magnum meningioma, basilar invagination, plagiocephaly, achondroplasia, and other cranial malformations.[7,8,9] Males have a larger diameter of foramen magnum than the females. This information can be of use to identify the gender in the situations such as aircraft accidents and explosions.[10]

Although foramen magnum holds great clinical significance, there are only few anatomical reports about its morphology in the literature. The study was planned to assess the variations in the shapes of foramen magnum and to calculate the mean diameters of the foramen in human skulls.

METHODS

This was a cross sectional observational study conducted in Anatomy Department, Postgraduate Medical Institute, Lahore Pakistan with the duration of 2 months from November 01, 2020 to January 01, 2021.

The sample size of the study was 35 dried human skulls by using non-probability sampling technique.

Normal skulls with normal foramen magnum were included in the study. Broken skulls and skulls having any pathology were excluded from the study.

35 human skulls were issued from the Department of Anatomy, Postgraduate Medical Institute, Lahore and

King Edward Medical University, Lahore. The age and sex of skulls was unknown. Various shapes of the foramen magnum were observed. They were listed as round, oval, tetragonal, pentagonal, hexagonal and irregular. To avoid bias, the observations of all researchers were taken into consideration. Vernier caliper was used to measure the dimensions. For antero-posterior diameter measurement was recorded from basion to opisthio. The transverse diameter was recorded from the level of highest concavity on right to the left margin. The foramen magnum index (FMI) was noted by dividing the transverse diameter by the antero-posterior diameter.[11]

$$\text{FMI} = \frac{\text{Transverse diameter}}{\text{Antero-posterior diameter}} \times 100$$

The data for the shapes of foramen was noted as frequencies. The diameters were recorded as mean ± SD. SPSS version 20 was used to analyze the data.

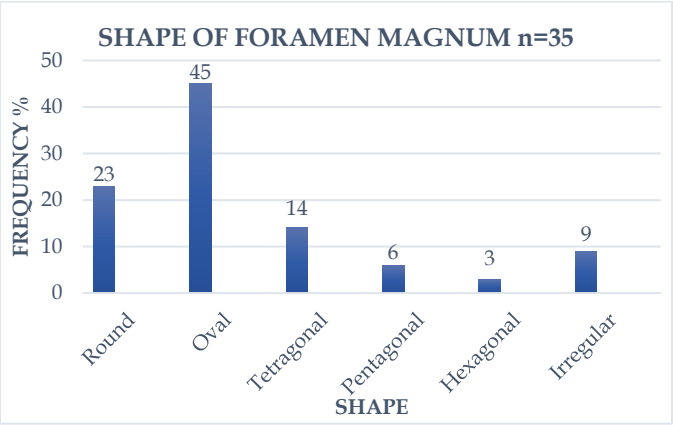
RESULTS

The various shapes of foramen magnum in skulls was tabulated (Table 1) and frequency was shown in graphical representation (Figure 1).

Table 1: Variations in the shapes of Foramen Magnum (n=35)

Shape of Foramen Magnum	Number of Skulls having the shape
Round	8
Oval	16
Tetragonal	5
Pentagonal	2
Hexagonal	1
Irregular	3

Figure 1: Frequencies of the shape of Foramen Magnum (n = 35)



The mean antero-posterior and transverse diameter of skulls was recorded using a Vernier caliper (Figure 2). The mean morphometric dimensions are shown in (Table 2).

Figure 2: Diameters of Foramen Magnum (antero-posterior AP, transverse T) being taken using a Vernier caliper.

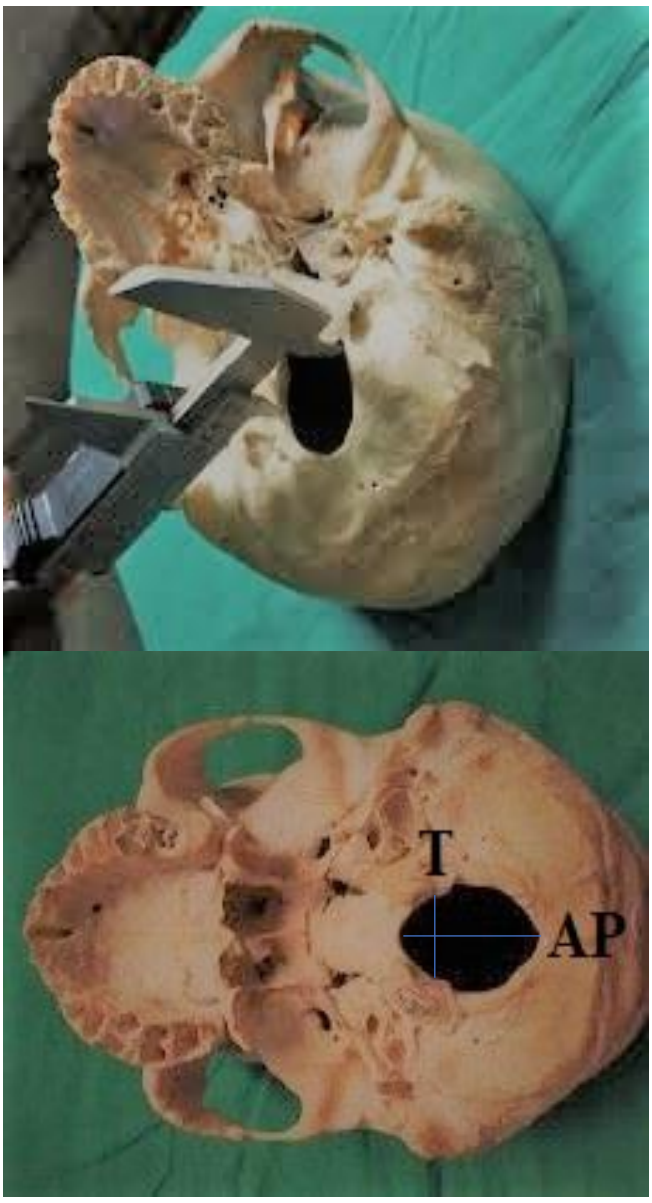


Table 2: Morphometric Dimensions of Foramen magnum

Parameter	Mean ±SD
Antero-posterior diameter (mm)	32± 24 mm
Transverse diameter (mm)	26 ± 14 mm
Foramen magnum index	81.25± 10

DISCUSSION

The results of the present study revealed that the foramen magnum was oval (45%) in most of the skulls. It coincides with the study conducted by Singh *et al*.[12] Research by Zaidi *et al*, also reported oval shaped foramen magnum to be the most common (64%), followed by hexagonal shaped foramen magnum (24.5%).[13] Radhika *et al*, also suggested oval shape was the most common (40%).[14] However, the study result of Chethan *et al* , showed that round shape was the most common (22.6%).[15] Murshad *et al*, also found round shape to be the most common (21.8%) and proposed that oval shape was present in only 8.1% of the cases.[16] The different morphologies of the foramen magnum serve as a guide during neurological interpretation. Anatomical variants may be a result of development related to bones and soft tissues at the base of skull.[17] Irregular shape is often associated with the developmental anomalies at the craniovertebral junction.[18] Average antero-posterior of foramen magnum in the present study was 32 ± 24 mm. Mean transverse diameter was 26 ± 14 mm. These results coincide with the study results of Tubbs *et al*[19] and Muthukumar *et al*.[20] However Sharma *et al*, found the antero-posterior and transverse diameters of the foramen magnum to be 47.70 mm and 40.80 mm respectively.[21]

Morphological examination of foramen magnum is valuable while planning surgical interventions at the base of cranium. According to the present research, antero-posterior dimensions of foramen magnum are more than its transverse dimensions. Greater antero-posterior diameter allows easier approach during condylar surgeries.[20]

The foramen magnum index in the present study was 81.25± 10. Burdan *et al*, in their research found the foramen magnum index to be 89.34.[22] The study conducted by Jouin *et al*, showed that the index was 86.6.[23] As per the result of Sharma *et al*, the foramen magnum index was 87.68.[21]

CONCLUSION

The present study throws light on the morphology and morphometry of the foramen magnum. The anatomical variations of the foramen magnum is helpful not only anatomists but also to radiologists and surgeons.

LIMITATIONS

The gender, age and race of the bones were not identified.

SUGGESTIONS / RECOMMENDATIONS

Further study can be conducted to observe the variations of foramen magnum among the skulls of male and female subjects.

CONFLICT OF INTEREST / DISCLOSURE

There is no conflict of interest involved.

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