

FORAMEN MAGNUM – A STUDY ON ITS MORPHOMETRY AMONG THE SOUTH INDIAN POPULATIONMONICA DIANA¹, NUVEEN AK², PANAMPARAMBIL RAMAKRISHNAN REMITH¹, BINI MARKOSE¹¹Department of Anatomy, Amala Institute of Medical Sciences, Thrissur, Kerala, India. ²Department of Anatomy, Government Medical College, Wayanad, Kerala, India.

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ABSTRACT

Objective: Foramen magnum is an oval opening present in the median region of the posterior cranial fossa of the occipital bone. The lower end of the medulla, meninges, spinal arteries, and spinal roots of accessory nerve pass through the foramen. Morphometry of the foramen magnum is studied for better learning of the structure, but this study helps in planning a safe surgery and exploration in the head-and-neck region. Various surgical approaches of the foramen provide access to the foramina on the base of the skull and prevent broad retraction of the neurovascular structures passing through them, so the morphometric study plays an important role in transcondylar approach.

Methods: Fifty dry human skulls available in the Department of Anatomy, Amala Medical College and Hospital, and also at Jubilee Medical College and Hospital, Thrissur were studied for this research work, and results were statistically analyzed.

Results: The most common shape of the foramen magnum was oval, the mean of anteroposterior diameter was greater than the mean of transverse diameter, p-value of the diameters was found to be significant, p-value of the mean of foramen magnum index was significant.

Conclusion: This study will help the surgeons to effectively plan a surgery at the head and neck site

Keywords: Posterior cranial fossa, Occipital condyles, Transcondylarapproach, Foramen magnum, Neurovascular.

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INTRODUCTION

The foramen magnum is the largest foramen of the skull. The foramen magnum is of interest for various scientific disciplines: forensic and physical anthropology; comparative anatomy; biology; surgery of the foramen structures and for the craniovertebral junction. There are morphological differences between men and women. The foramen is located in the most inferior portion of the cranial fossa as a part of the occipital bone. Bone defects and fractures can be caused by Vitamin D deficiency [1], Morphometrical studies help in identifying bone defects [2]. The contents of the foramen include the medulla oblongata, meninges, spinal root of cranial nerve XI, vertebral arteries, anterior and posterior spinal arteries, the tectorial membrane, and alar ligaments [3].

METHODS

The study was conducted on 50 dry human skulls of unknown gender obtained from the Department of Anatomy, Amala Medical College and Jubilee Medical College, Thrissur, India

All the skulls used were dry and complete and showed normal anatomical features, skulls with deformed and broken foramen were excluded from the study.

The shape of the foramen magnum was noted.

The following parameters were measured using a vernier caliper, which has a minimum error of 0.01 mm.

Red line-anteroposterior diameter, yellow line-transverse diameter. Anteroposterior diameter (APD) was measured from basion to opisthion in the sagittal plane (Figs. 1 and 2).

Transverse diameter (TD) was measured perpendicular to anteroposterior diameter in a coronal plane at a point where it was maximum (Figs. 1 and 3).

Foramen magnum index (FM) was calculated using the formula: $(TD/APD) \times 100$

Statistical analysis

Data were calculated as mean \pm SD (SPSS, v 23, IBM, US). Significant differences between the groups were done using an unpaired t-test. $p < 0.05$ is considered significant.

RESULTS AND DISCUSSION

Among the shapes of the foramen magnum, the oval was seen in 76% and a circular was seen in 24% of the skulls, as shown in Fig. 4, Table 1.

The mean of anteroposterior diameter was 33.11 mm, the standard deviation was 2.65 mm for oval shaped and the mean of anteroposterior diameter was 32.17 mm, the standard deviation was 2.48 mm for circular; $p < 0.0001$, as shown in Table 2.

The mean of the transverse diameter was 26.90 mm, the standard deviation was 1.91 mm for oval shaped and the mean of the transverse diameter was 27.97 mm, the standard deviation was 1.68 mm for circular; $p < 0.0001$, as shown in Table 3.

The mean of the foramen magnum index was 1.23 mm, the standard deviation was 0.09 mm for oval shaped and the mean of the foramen magnum index was 1.15 mm, the standard deviation was 0.10 mm for circular, the p value was 0.0119, as shown in Table 4.



Fig. 1: Diameters of foramen magnum



Fig. 2: Measurement of Anteroposterior diameter



Fig. 3: Measurement of transverse diameter

Shape of foramen magnum

In the study conducted by Dalvindarsingh *et al.*, oval shape accounted for 29.76% and round shape was 26.19%, other shapes, such as tetragonal, egg, hexagonal, irregular; and pentagonal were also found among them [4], similar to this in our study circular or round shape accounted for 24%.

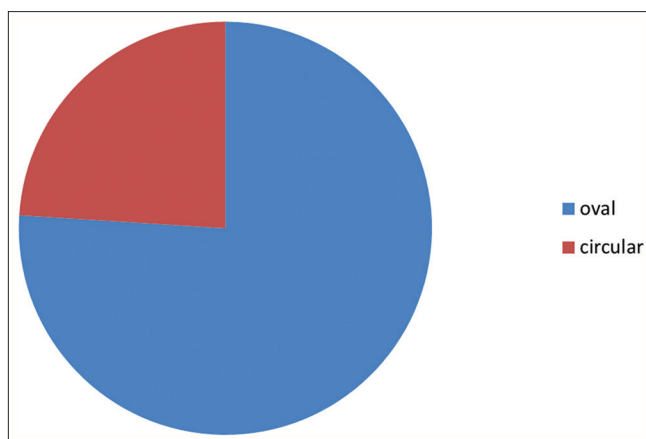


Fig. 4: The frequency of distribution of shapes of foramen magnum

Table 1: Frequency of distribution of shape of foramen magnum (n=50)

Shape	Frequency, n (%)
Oval	38 (76)
Circular	12 (24)

Table 2: Anteroposterior diameter of foramen magnum (mm)

Shape	n	MEAN±SD
Oval	38	33.11±2.65
Round	12	32.17±2.48

Values are mean±SD, n=50, unpaired t-test, p<0.0001. SD: Standard deviation

Table 3: Transverse diameter of foramen magnum (mm)

Shape	n	Mean±SD
Oval	38	26.90±1.91
Round	12	27.97±1.68

Values are mean±SD, n=50, unpaired t-test, p<0.0001. SD: Standard deviation

Table 4: Foramen magnum index (mm)

Shape	n	FM index	SD
Oval	38	1.23	0.09
Round	12	1.15	0.10

Values are FM index±SD, n=50, unpaired t-test, p=0.0119. SD: Standard deviation, FM: Foramen magnum index

Amit Singhbharati *et al.* found a round shape in 32.5% and an oval in 35% of skulls, tetragonal and hexagonal shapes were also noted [5], and in our study, oval shape was found in 76% of the skulls.

Rajanisingh *et al.* in their study noted oval shapes in 22.5% and round in 17.5% of their specimens [6].

Sanjaykumarrevankar *et al.* found foramen magnum of egg shape, tetragonal, pentagonal, hexagonal, and even irregular shapes [7].

Anshu Sharma *et al.* found oval, egg-shaped, hexagonal, round, pentagonal, and also irregular shapes [8].

Shifankandey *et al.* found mostly oval or circular FM in their study, which is similar to our study [9].

Arjun Kumar *et al.* along with the normal shapes found diamond-shaped FM in their study [10].

Morphometry of FM

We included AP, TD, FM index, and area in our study; all readings were expressed in mm.

Similar parameters were studied by other authors also, In the study done by Dalvindersingh *et al.*, the AP diameter mean was 33.57 mm, SD 2.82 mm, range was 29.20–39.10 mm, TD mean was 27.49 mm, SD 2.61 mm, range 21.11–31.80 mm, FM index mean was 69.79 mm, SD 7.04 mm range was 69.79–93.53 m [3]; these readings were similar to our study, AP diameter mean was 33.11 mm, SD 2.65 mm, TD 26.90 mm, SD 1.91 mm.

Roma Patel *et al.* in the study found that AP diameter mean was 33.7 mm, the range was 26–40.2 mm, the TD mean was 28.29 mm, range of 33.5–21.5 mm, [11], which was similar to our study.

Sanjuktasahoo *et al.* in their study found that the AP diameter mean was 35.3 0 mm, SD 2.709 mm, the range was 27–43 mm, TD mean was 29.49 mm, SD 2.572 mm, the range of 24–35 mm, FM index mean was 1.202 mm, SD 0.107 mm range was 1.01-1.71 mm [12], these readings were higher compared to our study.

Amit Singh Bharati *et al.* found that AP diameter mean was 30 mm, SD 2.35 mm, the range was 24–37 mm, the TD mean was 26.1 mm, SD 2.13 mm, the range was 23–29 mm, FM index mean was 87.332 mm, SD 8.20 range was 75–100 mm, [5] and these readings were lesser than the readings in our study.

Rajanisingh *et al.* noted in their study that the AP diameter mean was 33.8 mm, SD 2.5 mm, mode was 34 mm, median was 35 mm, TD mean was 28.2 mm, SD 2.6 mm, mode was 28 mm median was 30 mm, FM index mean was 1.21 mm, SD 0.11 mm [6], and comparatively these readings were similar to our study.

Sanjaykumarrevankar *et al.* in their study found that AP diameter mean was 34.36 mm, SD 3.13 mm, the range was 38.11–38.87 mm, TD mean was 28.48 mm, SD 3.97 mm, range 16–27 mm, FM index mean was 1.23 mm, SD 0.18 mm range was 0.97–1.921 mm [7].

Manoel *et al.* found that AP diameter mean was 35.1 mm, SD 0.33 mm, TD mean was 29.4 mm, SD 0.23 mm among female skulls, AP diameter mean was 35.7 mm, SD 0.29 mm, TD mean was 30.3 mm, SD 0.20 mm among male skulls, p-value of AP diameter was 0.261 mm, and TD was 0.008 mm [13].

Muralidhar P Shepur *et al.* in their study among male skulls the AP diameter mean was found to be 33.40 mm, SD 2.6 mm, range was 26.70–39.80 mm, TD mean was 28.50 mm, SD 2.20 mm, range 24.30–37.70 mm, Among female skulls, AP diameter mean was 33.10 mm, SD 2.70 mm, range was 28.00–39.3 mm, TD mean was 27.30 mm, SD 2.00 mm, range 23.50–33.60 mm [14].

Anshu Sharma *et al.* in their study found that AP diameter mean was 34.44 mm, the TD mean was 30.46 mm, and FM index mean was 88.44 mm [8].

Shifankandey *et al.* found that AP diameter mean was 3.68 cm, TD mean was 3.09 cm [9].

Arjun Kumar *et al.* found that AP diameter mean was 34.08 mm, SD 2.25 mm, the range was 32.25–36.25 mm, TD mean was 28.17 mm,

SD 2.85 mm, the range of 25.75–30.75 mm, p-value of APD < 0.001 mm, p-value of TD < 0.0 mm [10].

FM index was calculated in our study; the mean was 1.23414 mm, SD was 0.095318 mm, these readings were similar to Sanjuktasahoo *et al.*, Rajanisingh *et al.*, and Sanjaykumarrevankar *et al.*

CONCLUSION

Variations of morphometry of foramen magnum are important as it helps surgeons, radiologists, and anesthetists to plan the procedure better; this study may serve as a tool to avoid complications of surgeries involving the head and neck.

CONFLICTS OF INTEREST

Nil.

AUTHORS CONTRIBUTION

All authors have contributed equally.

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Nil.

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