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Original Research Article

A MORPHOMETRICAL STUDY OF FORAMEN MAGNUM IN ADULT HUMAN DRIED SKULL OF SOUTH INDIAN POPULATION

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ABSTRACT

Introduction: Foramen magnum is a wide opening present in the occipital bone of the cranium. Morphometry of foramen magnum are important because vital structures pass through it and for sex determination of skulls. The aim of the present study was to conduct morphometric analysis of foramen magnum.

Materials and Methods: Completely ossified 162 adult human dry skulls of unknown age and sex were taken from the Department of Anatomy of Gadag institute of medical sciences, Gadag. The skull samples which were deformed were excluded from the study. The antero-posterior and transverse diameters were measured using a digital vernier caliper graded upto 0.01mm. The statistical analysis was carried out and the results were tabulated.

Results: The longitudinal diameter of the foramen magnum in the present study was between 31 – 36 mm with a mean of 33 mm ± 1.4 (Mean ± SD). The transverse diameter was between 25 mm -30 mm with a mean of 27 mm + 1.6.

Conclusion: Knowledge of foramen magnum measurements are useful for anatomists, neurosurgeons, radiologists, and also anthropologists. The data obtained will be useful to the neurosurgeon in understanding the anatomy of craniovertebral junction in a newly described transcondylar approach for brain stem lesion particularly in preoperative assessment.

KEY WORDS: Skull, Foramen Magnum, Morphometry.

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INTRODUCTION

Foramen magnum term is derived from the Latin word called as 'Great hole'. Foramen magnum is a wide opening present in the occipital bone of the cranium. It is placed anteromedially in the occipital bone[1]. Various shapes of foramen magnum have been noted like oval, rounded, tetragonal, pentagonal, hexagonal, and irregular. Among this oval shape is the commonest one [2,3].

The boundary of foramen magnum is formed by all parts of occipital bone that is two condylar parts, squamous part and occipital part. Antero-posterior diameter of foramen magnum is more than the transverse diameter. Anteriorly on each side of foramen magnum oval occipital condyles are present, which project downwards to articulate with the superior articular facets on the lateral masses of the atlas. Occipital condyle is placed obliquely so that anterior end is nearer

to median plane than the posterior end. Above the anterior part of the occipital condyle hypoglossal canal lies which transmit hypoglossal nerve, meningeal branch of ascending pharyngeal artery[1].

Alar ligament of dens divides the foramen magnum into anterior osseo-ligamentous compartment and posterior neurovascular compartment. Vital structures passing through the foramen magnum are medulla oblongata with the meninges, fourth part of vertebral arteries, anterior and posterior spinal arteries and spinal roots of accessory nerves and occasionally cerebellar tonsil may project on each side of the brain stem[1].

In a conditions like achondroplasia, foramen magnum brain herniation, meningiomas and atlanto-occipital fusion the vital structure that pass through it may be compressed, so the dimensions of the foramen magnum are clinically important. Transverse diameter of foramen magnum will be increased in Arnold chiari malformation. Knowledge of foramen magnum measurement is important clinically[4]. With the advance in neuroimaging technique craniovertebral abnormalities diagnosis is increased which has increased the interest of neuro surgeons to do cranio vertebral surgeries.

The measurements are helpful for neurosurgeons for performing lateral transcondylar surgical approaches for reaching lesions in the middle and posterior part of cranial base[5]. Hence, the present morphometric study of foramen magnum among south Indian population has been undertaken. It is hopeful that the data will be valuable particularly for the neuro-surgeons, radiologists and orthopae-dicians particularly in preoperative assessment.

MATERIALS AND METHODS

Completely ossified 162 adult human dry skulls of unknown age and sex were taken from the Department of Anatomy of Gadag institute of medical sciences, Gadag. The skull samples which were deformed were excluded from the study.

The anteroposterior and transverse diameters were measured using a digital vernier caliper graded upto 0.01mm. Measurements were done using following bony landmarks on the skull. Basion middle point of the anterior margin of foramen magnum) and Opisthion (Opisthion is middle point of posterior margin of foramen magnum). Anteroposterior diameter of foramen magnum is the distance measured between Basion and opisthion. Transverse diameter of foramen magnum is the distance measured at right angles to anteroposterior diameter of foramen magnum.

Other parameters recorded as follows

1. Anterior intercondylar distance- distance between anterior tips of right and left occipital condyles.

2. Posterior intercondylar distance- distance between posterior tips of right and left occipital condyles.

The Statistical methods: Results were expressed as mean ± standard deviation and range. Unpaired't' test was used to compare between right and left. P value of 0.005 or less was considered for statistical significance.

OBSERVATIONS AND RESULTS

The statistical analysis was carried out and the results have been tabulated and represented in the form of bar diagrams.

Table 1: The mean antero-posterior, transverse diameter of foramen magnum along with standard deviation.

Number of skulls-162	Anteroposterior diameter of Foramen magnum (mm)	Tranverse diameter of foramen magnum (mm)
Mean	33.7	27
Standard deviation	1.4	1.6
Minimum	31	25
Maximum	36	30

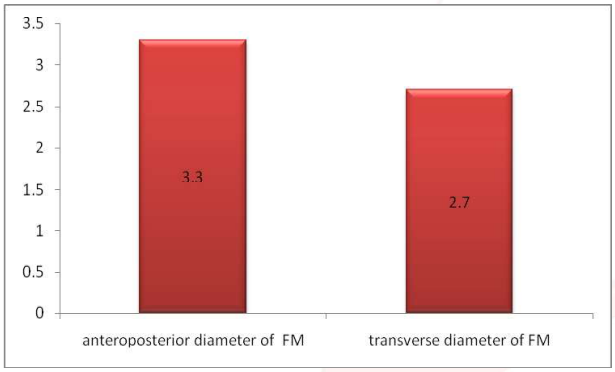
The longitudinal diameter of the foramen magnum in the present study is between 31 mm – 36 mm with a mean of 33 mm $\pm$ 1.4 (Mean $\pm$ SD). The transverse diameter is between 25 mm – 30 mm with a mean of 27 mm + 1.6

Table 2: Mean length of anterior and posterior intercondylar distance along with SD.

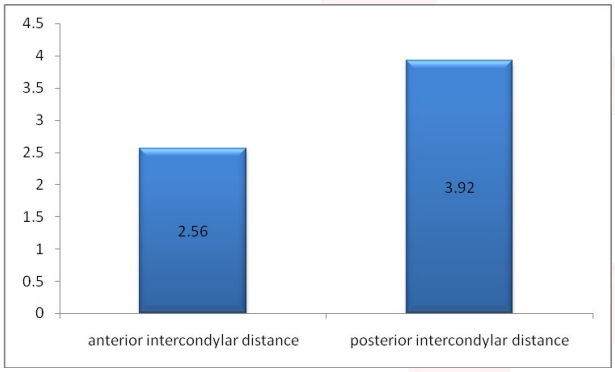
	Number of skulls	Mean in mm	Minimum in mm	Maximum in mm	Standard deviation
Posterior intercondylar Distance	162	31.63	29	42	2.93
Anterior intercondylar distance	162	15.78	14	19	1.266

The present study indicates that, the mean anterior intercondylar distance between two condyles in 162 skulls was found to be 15.78 mm with a range of 14 -19 mm and a standard deviation of 1.26. Mean posterior intercondylar distance between the two condyles in 162 skulls was found to be 31.63 mm ranging from 19 – 42 mm having a standard deviation of 2.93.

Graph 1: Anteroposterior and transverse diameter of foramen magnum.



Graph 2: Anterior and posterior intercondylar distance.



DISCUSSION

Foramen magnum is a major opening in the posterior cranial fossa of the skull, many vital structures passes through it. Morphometrical study of foramen magnum and occipital condyle was done in the 162 human skulls.

In the present study the mean longitudinal diameter of foramen magnum was 33mm which is similar to Muthukumar et al and Muralidhar et al study was done on Karnataka human skulls [5,6]. However the values are slightly lower than the observations made by Radhika et al and Sanjukta et al which were also done on south Indian population. The mean value of antero-posterior diameter in their study is 35 mm and transverse diameter is 29 mm[3,6].

Berge and Bergmann reported an average sagittal diameter of 34 mm and an average transverse diameter of 29 mm[7]. Philipp Gruber, in his study on skulls from Western Europe found the sagittal diameter ranges 30 mm to 43 mm with mean of 36.6 mm. The transverse diameter ranges from 25 mm to 39 mm with the mean of 31.1 mm[8].

In the Morphometric analysis of the foramen magnum in human skulls of Brazilian individual found that mean antero-posterior diameter of foramen magnum was 35.7 mm in male and 35.1 mm in female. The transverse diameter was 30.3 mm in male, 29.4 mm in female[9].

Table 3: The anteroposterior and transverse diameter of foramen magnum of present study were compared with previous studies.

Authors	Anteroposterior Diameter (mm)	Transverse Diameter (mm)
Muralidhar et.al (2014) [14]	33.4	27.4mm
Muthukumar et.al (2005) [5]	33.3	27.9
Suazo, G. et.al (2009) [18]	36.05	30.05
Avci et. al (2010) [15]	34.5	29
Kizilkant et. al (2006) [11]	34.8	29.6
Murshed et.al (2003) [2]	35.9	30.45
Tubbs et. al (2010) [16]	31	2.7
Manoel et. al (2009) [19]	35.4	29.85
Osunwoke E.A (2012) [17]	36.1	29.5
Radhika et. al (2014) [6]	35.3	29.4
Sanjukta et. al (2015) [13]	35.3	29.49
Present study	**33**	**27**

In a study conducted at St.John Medical College, Bangalore on 350 skulls (175 males, 175 females) for foramen magnum dimensions showed. In male skulls antero-posterior diameter of foramen magnum was varied from 2.8 - 4.1 cm with a mean of 3.42 ± 0.24 cm, transverse diameter was varied from 2.3 - 3.6 cm with a mean of 2.85 ± 0.23 cm and the area of foramen magnum was varied from 5.6 - 11cm with a mean of 7.69 cm. In female skulls antero posterior diameter of foramen magnum was varied form 2.2 - 3.3 cm with a mean of 2.8 ± 0.22 cm and area of the foramen magnum was varied from 5.1 – 10 cm with a mean of 7.8 ± 0.98 cm[2].From the above data, it can be stated that there is significant difference between anteroposterior and transverse diameters. The anteroposterior diameter is generally larger than transverse diameter.

Occipital condyles converge ventrally. There is significant difference between anterior and

posterior intercondylar distance. This leads occipital condyle to have different anterior and posterior angles. This difference in the anterior and posterior intercondylar distance reflects the asymmetry in the orientation of occipital condyles which may affect the lateral approach. According to recent studies, condylectomy provides the wider angle of exposure.

Naderi in his metrical study of occipital condyles found that the mean anterior intercondylar distance and posterior intercondylar distance as 21.0 ± 2.8 mm and 41.6 ± 2.9 mm, respectively[10]. Kizilkanat studied the occipital condyles, hypoglossal canal and foramen magnum in 59 Turkish-Caucasian skulls. In his study, the anterior and posterior intercondylar distances were 22.6 mm and 44.2 mm respectively[11]. Ozer MA demonstrated a study where morphological analysis of 704 sides of occipital bones of adult skulls was done. The mean anterior intercondylar distance and posterior intercondylar distance were found to be 20.9 ±3.6 mm and 43 ± 4 mm respectively[12].

Sanjukta et al found that in their study the mean anterior intercondylar distance between two condyles was 20.31 mm with a range from 11 - 34 mm. and a standard deviation of 3.431.The Mean posterior intercondylar distance between two condyles was found to be 41.17 mm with the range being 32 – 49 mm and a standard deviation of 3.759[13].The results of present study is not similar to other studies done previously as depicted in table3.

CONCLUSION

Craniovertebral junction is formed by foramen magnum, occipital bone with its condyles. Many vital structures pass through it. It is clinically important for physicians to have a thorough knowledge of cranio vertebral junction.

In our present study we found that the mean vertical and transverse diameter 33mm and 27 mm respectively. Anterior intercondylar distance and posterior intercondylar distance is 16 mm and 32 mm respectively.

Morphometrics of occipital condyle and foramen magnum is especially important for newly described transcondylar approach. The above said parameters will be useful for neurosurgeons, orthopaedicans and radiologists in planning surgical procedures involving the skull base.

Conflicts of Interests: **None**

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