



Morphometric Analysis of Foramen Magnum and Occipital Condyles in Human Skull Among Eastern Population - A Case Study

KEYWORDS

foramen magnum, occipital condyles, morphometry

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ABSTRACT

The morphometric study of foramen magnum and occipital condyles are valuable aid for anatomical studies. The measurements are helpful for neurosurgeons for performing lateral transcondylar surgical approaches for reaching lesions in the middle and posterior part of cranial base¹. These are also used by radiologist to diagnose Craniovertebral abnormalities². Therefore the assessment of morphometrics of foramen magnum and occipital condyle is essential. The knowledge of foramen magnum diameters is needed to determine some malformations such as Arnold Chiari syndrome, which shows expansion of foramen magnum^{3,3}The stability of craniovertebral junction depends largely on the morphometric data of the occipital condyles. 4,5 Therefore the assessment of morphometrics of foramen magnum and occipital condyle is essential. The aim of the study was to determine dimensions of foramen magnum and occipital condyles, and morphometric asymmetry between right and left condyles and with respect to foramen magnum. 60 dry human skulls were studied and necessary diameters were measured using verniers callipers.

INTRODUCTION- Craniovertebral abnormalities have been recorded for many years in morphological and clinicoradiological studies². Anomalies of Craniovertebral junction are of interest not only to an anatomist but also to the clinicians because many of these deformities produce clinical symptoms. The occipital bone is the main site of these variations⁶. Craniovertebral junction refers to the occipital bone that surrounds foramen magnum and atlas and axis vertebrae⁷. Abnormalities of this area can be classified as congenital, developmental, acquired, traumatic, tumors, inflammatory, occurring either alone or in combination. Distance between anatomic landmarks and the sites where a number of vital structures have their entrance or exits are very important for clinical application. The measurements are helpful for neurosurgeons for performing lateral transcondylar surgical approaches for reaching lesions in the middle and posterior part of cranial base. Therefore the assessment of morphometrics of foramen magnum and occipital condyle is essential⁷ Knowledge of condylar anatomy helps the surgeon in making important decisions regarding the extent and direction of condylar drilling and minimizing injury and retraction of neural structures⁸. Condylar drilling is an important step in the transcondylar extension of the far lateral approach.⁹

Craniovertebral abnormalities have been recorded for many years in morphological and clinicoradiological studies². Anomalies of Craniovertebral junction are of interest not only to an anatomist but also to the clinicians because many of these deformities produce clinical symptoms. The occipital bone is the main site of these variations⁶. Abnormalities of this area can be classified as congenital, developmental, acquired, traumatic, tumors, inflammatory, occurring either alone or in combination. Understanding the pathology of these abnormalities and their treatment is simplified if one has the knowledge of bony anatomy, biomechanics and embryology of this region.

NORMAL ANATOMY-

Foramen magnum is Latin word meaning largest aperture in skull. Foramen magnum lies in anteromedian position. it is oval and wider behind, with its greatest diameter antero-posterior. It contains lower end of medulla oblongata, meninges, vertebral arteries and spinal accessory nerve.

Anteriorly, margins of foramen magnum are overlapped by the occipital condyles, that project downwards. Each condyle is oval and oriented obliquely, so that anterior end lies nearer the midline than posterior end. Hypoglossal canal lies posterior and deep to each occipital condyle. A jugular process is situated lateral to each condyles.¹⁰



OBJECTIVES-

1. To analyse foramen magnum and occipital condyles morphometrically.
2. To find morphometric asymmetry between right and left occipital condyles.
3. To find the position of occipital condyles with respect to foramen magnum.

MATERIALS & METHODS-

60 ossified dry adult human skulls available in the department of Anatomy and collected from medical and dental students were studied, and cross sectional study was conducted, in department of anatomy, KIMS, Bhubaneswar. All measurements will be recorded using digital vernier-caliper. Parameters are recorded as follows: [Refer to accompanying diagram].

- Anteroposterior diameter of foramen magnum: between Basion and opisthion.
- Transverse diameter of foramen magnum: measured

at right angles to anteroposterior diameter of foramen magnum.

- Anterior intercondylar distance: distance between anterior tips of right and left occipital condyles.
- Posterior intercondylar distance: distance between posterior tips of right and left occipital condyles.
- The length of occipital condyle: from its anterior tip to posterior tip
- The width of occipital condyle: maximum distance measured at the right angles to the line joining its anterior and posterior tip.

With these measurements following indices will be calculated:

- Foramen magnum index is calculated by dividing anteroposterior diameter of foramen magnum with transverse diameter of foramen magnum.
- Condylar index is calculated for right and left occipital condyle respectively by dividing length of occipital condyle with the width of occipital condyle.

Statistical Analysis was done and the descriptive study statistics of all the morphometric occipital condyles and foramen magnum were analysed.



OBSERVATION-

60 dried human skulls were measured by verniers calipers, and dimension of foramen magnum and occipital condyles were noted in cm. Measurements are depicted in table-

PARAMETERS	FM[in cm]	ROC[in cm]	LOC[in cm]
Maximum TD	3.90	1.80	1.80
Minimum TD	2.60	0.90	0.90
Maximum APD	4.20	3.00	3.10
Minimum APD	3.00	1.80	1.90
Mean TD±SD	3.22±0.29	1.33±0.18	1.35±0.20
Mean APD±SD	3.60±0.29	2.44±0.25	2.43±0.24
Mean Index±SD	1.13±0.27	4.12±1.86	1.79±0.38

TD= transverse diameter, APD= anterior-posterior diameter, FM= foramen magnum, ROC= right occipital condyle, LOC= left occipital condyle, SD= standard deviation.

Anterior intercondylar distance was measured as

2.00±0.8cm, and posterior intercondylar

distance was measured to be 4.13±0.38cm.

DISCUSSION-

Morphometry of foramen magnum is clinically significant as large number of vital structures pass through it. In present study, mean APD of foramen magnum was found to be 3.60±0.29cm, and mean TD of foramen magnum was found to be 3.22±0.29cm. In previous study conducted by Roma Patel et.al, mean APD of FM was measured as 3.37cm[less than value of present study], while mean TD was measured as 3.33cm.¹¹ Mean diameters measured by Muthukumar & Swaminathan¹² were less than present study. In study done by Tubbs RS¹³, mean APD of FM was 3.1cm, while mean TD was 2.7cm, and Catalina-Herrera found mean APD of FM as 3.52cm and TD as 3.03cm.¹⁴ Even study done by Berge and Bergman¹⁵, reported average saggital diameter as 3.4cm and transverse diameter as 2.9cm, which is markedly less than diameters measured in present study. A study on Brazilian skull, showed that there is no morphological difference of Foramen magnum between genders and ethnic groups[Caucasian and negroid].¹⁶ Meticulous planning based mainly on FM sizes, may be needed to choose the most appropriate microsurgical techniques used for treating the lesions of neuroanatomic structures passing from FM.¹⁷

Anatomy of occipital condyles play a important role in decision making regarding degree and direction of condylar drilling with minimal injury. Condylar drilling is an important step in the transcondylar extension of the far lateral approach.⁸ Relationship of occipital condyles to foramen magnum[eg. Overriding of occipital condyles in foramen magnum], and relationship of condyles to important structures like hypoglossal canal is also valuable.¹⁸

In present study, as depicted from above tables, mean length of LOC and ROC is nearly 2.44±0.25cm, and no significant difference found between two sides. This measured length is comparable to what was found by Fathy Ahmed Fetouh et al¹⁹, Naderi et al²⁰, Muthukumar et al¹² and Kizilkanat²¹ who reported the length as 2.75cm, 2.36 cm, 2.36 cm and 2.45 cm respectively, but far-away from the result obtained by Dowd et al²² who reported the length as 3.0 cm. Mean width of LOC and ROC is nearly 1.34±0.20cm. This value is comparable to result found by Fathy Ahmed Fetouh et al¹⁹ and Kizilkanth²¹ who reported mean width as 1.35cm and 1.31cm, but away from result obtained by Muthukumar et al¹² and Naderi et al²⁰ who reported width as 1.47cm and 1.06cm respectively.

The transcondylar approach provides access to the lower clivus and premedullary area. The partial transcondylar approach is performed to treat lesions located predominantly anterior to the spinomedullary junction and the complete transcondylar approach is performed to treat extradural lesions.¹⁹ In present study, anterior and posterior intercondylar distances have been measured and mean values are 2.0±0.28cm and 4.13±0.30cm respectively. These parameters can be very important while planning neurosurgical procedures like transcondylar resection, suboccipital craniotomy, condylar drilling, etc. . These measured distances are comparable to the results obtained by Fathy Ahmed Fetouh et al¹⁹ who reported them as 2.06 and 4.14 cm respectively, and Naderi et al²⁰ who reported these distances as 2.1 and 4.16 cm respectively and away from the results obtained by Kizilkanath²¹ who

reported them as 2.26 and 4.42 cm respectively. This wide difference between the anterior and posterior intercondylar distances leads the occipital condyle to have different anterior and posterior angles. The anteroposterior orientation and narrow intercondylar space would require a more bony removal.²²

CONCLUSION-

Knowledge of dimensions of Foramen magnum is clinically important because large number of vital neurovascular structures pass through it, and to determine radiological malformations [Alnord chiari malformation]. Condylar drilling is frequently performed for exposure of brainstem pathologies and also to conduct transcondylar surgical procedures. Morphometric parameters measured along with available new radiological techniques can be applied for estimation of extent of condylar removal in neurosurgical procedures.

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