

## THE ANATOMY OF OCCIPITAL CONDYLES AND FORAMEN MAGNUM AND THEIR SURGICAL IMPORTANCE: A MORPHOMETRIC STUDY

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### ABSTRACT

**Background:** Skull is the most complex osseous structure in the body. Foramen magnum is oval shaped and situated in an anteromedian position. Occipital condyles flanking the foramen magnum articulate with the superior articular facets of atlas vertebra. The dimensions of foramen magnum and the axial length of occipital condyles are very important for surgical exposure, such as in cases of tumor resection from foramen magnum area. Keeping in mind the importance of skull base in Anatomic, neurosurgical, medico legal and anthropological procedures, present study aims at performing morphometric analysis of occipital condyles and foramen magnum, two of the most prominent structures at the skull base.

**Materials and Methods:** Present study was conducted on 80 dry adult human skulls (42 males and 38 females). They were obtained from department of Anatomy, Govt. Bundelkhand Medical College, Sagar and NSCB Medical College, Jabalpur, (M.P.). Measured parameters were: Axial length of occipital condyles, Anterior intercondylar distance, Anteroposterior diameter of foramen magnum, Transverse diameter of foramen magnum. The parameters were measured by digital sliding vernier caliper in mm. scale. Data was statistically analyzed.

**Results:** The mean axial length of occipital condyle was found to be greater on left side as compared to right side but the difference was not statistically significant. The measurement was found to be greater in male skulls than female skulls for both sides and the difference was highly significant. Average intercondylar distance was found greater in female skulls than male skulls but the difference was not statistically significant. The average Anteroposterior diameter of foramen magnum was found to be greater in males as compared to females but the difference was not statistically significant. Similarly transverse diameter of foramen magnum was also found greater in males than that of females with statistically insignificant difference. The mean foramen index was found to be greater in males than females but the difference was not statistically significant.

**Conclusion:** The purpose of the present study was to get an insight into the morphology of the base of skull especially bilateral and gender based differences in the basicranium. For better understanding of skull base morphology and possible anatomical variations, similar studies with larger sample size and use of advanced techniques like computer assisted image analysis system would be more enlightening.

**KEY WORDS:** Skull Base, Morphometry, Occipital Condyles, Foramen Magnum.

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## INTRODUCTION

Skull is the most complex osseous structure in the body. Occipital bone forms much of the back and base of cranium. It is trapezoid and encloses foramen magnum. Foramen magnum is oval shaped and situated in an anteromedian position. Occipital condyles flanking the foramen magnum articulate with the superior articular facets of atlas vertebra. The condyles are oval or reniform, their long axis converging anteromedially. The hypoglossal canal is situated anteriorly above each condyle [1].

The dimensions of foramen magnum and the axial length of occipital condyles are very important for surgical exposure, such as in cases of tumor resection from foramen magnum area [2-4]. Space occupying lesions ventral to the spinal canal at the level of foramen magnum can be reached using a ventral or dorsal approach [5]. As the ventral approach is dangerous and has a high rate of morbidity, the dorsal approach is preferred to reach the space occupying lesion ventral to spinal cord at the craniovertebral junction [6,7]. Far lateral transcondylar surgical approaches have been used to reach lesions at ventrolateral clivus and jugular foramen. Partial resection of occipital condyle is done during transcondylar surgical approach [8,9].

As per Gapert, Black and Last [10] base of skull is by far best preserved in the process of decomposition and damage as it is well protected by large mass of soft tissue. Bass [11] states that skull is probably the second best choice of the whole of skeleton to be studied for sex determination.

Therefore keeping in mind the importance of skull base in Anatomic, neurosurgical, medico legal and anthropological procedures, present study aims at performing morphometric analysis of occipital condyles and foramen magnum, two of the most prominent structures at the skull base.

## MATERIALS AND METHODS

Present study was conducted on 80 dry adult human skulls (42 males and 38 females). They were obtained from department of Anatomy, Govt. Bundelkhand Medical College, Sagar and

NSCB Medical College, Jabalpur, (M.P.). They were fully ossified and free from deformity. The measured parameters were:

### Axial length of occipital condyles (ALOC):

Calculated between the anterior and posterior tips of occipital condyles.

### Anterior intercondylar distance (AICD):

Calculated between the anterior tips of occipital condyles.

### Anteroposterior diameter of foramen magnum (ADFM):

Between basion and opisthion.

### Transverse diameter of foramen magnum (TDFM):

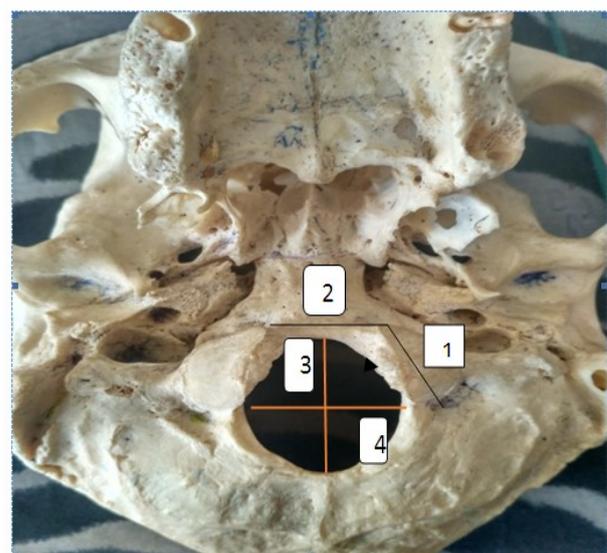
Between outermost lateral points of foramen magnum.

### Foramen magnum index (MI):

Calculated by dividing the anteroposterior diameter of foramen magnum with transverse diameter of foramen magnum.

The parameters were measured by digital sliding vernier caliper in mm. scale. Data was statistically analyzed. Mean and standard deviation was calculated. Mean values of different values were compared using unpaired t-test. The p value of < 0.05 was considered as significant.

Fig. 1: Measurements at the base of skull:



- (1) Axial length of occipital condyles (ALOC),
- (2) Anterior intercondylar distance (AICD)
- (3) Anteroposterior diameter of foramen magnum (ADFM)
- (4) Transverse diameter of foramen magnum (TDFM)

## OBSERVATION AND RESULT

The results obtained are shown in Table 1 and 2

**Table 1:** Showing mean SD of the parameters.

Parameter	Mean	
	Males	Females
<b>ALOC Rt.</b>	22.25±1.78	19.77±2.38
<b>ALOC Lt.</b>	22.29±1.67	19.81±2.31
<b>AICD</b>	18.11±2.19	18.77±1.97
<b>ADFM</b>	32.37±1.94	31.52±2.16
<b>TDFM</b>	27.58±1.52	27.17±1.93
<b>MI</b>	1.18±0.11	1.16±0.07

**Table 2:** Showing statistical inference.

Result	p-value	Inference
ALOC Lt>ALOC Rt.	0.74	Not significant
ALOC male skulls >ALOC female skulls	<0.0001	Highly significant
AICD female skulls>AICD male skulls	0.13	Not significant
ADFM male skulls>ADFM female skulls	0.08	Not significant
TDFM male skulls >TDFM female skulls	0.29	Not significant
MI male skulls> MI female skulls	0.33	Not significant

**ALOC-** Axial lengths of occipital condyles,  
**AICD-** Anterior intercondylar distance measured between the anterior tips of the occipital condyles,  
**ADFM-** Anteroposterior diameter of foramen magnum,  
**TDFM-** Transverse diameter of foramen magnum,  
**MI-** Foramen magnum index

## DISCUSSION

**Occipital condyles:** The mean axial length of occipital condyle was found to be greater on left side as compared to right side but the difference was not statistically significant ( $p=0.74$ ). The measurement was found to be greater in male skulls than female skulls for both sides and the difference was highly significant ( $p<0.0001$ ).

Average intercondylar distance was found greater in female skulls than male skulls but the difference was not statistically significant ( $p=0.13$ ). Lang [12] reported average length of occipital condyles on both right and left sides of 22.9mm. AynurEmineCicekcibasi et al [13] showed mean right ALOC 24.36mm and mean left ALOC 24.01mm. Vishal Ramesh Jasuja et al [14] found mean right ALOC 22.72mm and mean left ALOC 22.86mm. The insignificant difference between right and left axial length is in accordance with the studies of Lang [12] and Vishal Ramesh Jasuja et al [14]. Significantly greater

ALOC in male skulls found in present study is in accordance with the results obtained by AynurEmineCicekcibasi et al<sup>(13)</sup> and Vishal Ramesh Jasuja et al [14].

Lang [12] reported mean AICD of 23.6mm, AynurEmineCicekcibasi et al [13] reported mean AICD of 16.09mm in male skulls and 14.68mm in female skulls and the difference was statistically significant whereas Vishal Ramesh Jasuja et al [14] found mean AICD of 18.23mm in male skulls and 19.11mm in female skulls and the difference was statistically insignificant which is in agreement with the present study.

**Foramen magnum:** In present study, anteroposterior diameter of foramen magnum was found to be greater in males as compared to females but the difference was not statistically significant ( $p=0.08$ ). Similarly transverse diameter of foramen magnum was also found greater in males than that of females with statistically insignificant difference ( $p=0.29$ ). The mean foramen index was found to be greater in males than females but the difference was not statistically significant ( $p=0.33$ ).

Muthukumaret al [15] reported mean anteroposterior diameter of foramen magnum as 33.3mm and mean transverse diameter as 27.9mm. Kizilkanat et al [16] observed mean anteroposterior diameter of foramen magnum as 34.8mm and mean transverse diameter as 29.6mm. Ivan Claudio SuazoGaldames et al [17] documented maximum transverse diameter in males and females as 30.6mm and 29.5mm ( $p=0.001$ ) and maximum anteroposterior diameter in males and females as 36.5 and 35.6mm ( $p=0.008$ ) respectively. KhalilAwadhMurshed et al [18] reported sagittal and transverse diameters of foramen magnum to be significantly greater in males than females ( $p<0.001$ ). Vishal Ramesh Jasuja et al [14] found ADFM greater in male skulls and TDFM greater in female skulls but their difference was not statistically significant. Therefore mean ADFM of male skulls more than that of female skulls found in present study is in agreement with the studies done by Ivan Claudio SuazoGaldames et al [17], KhalilAwadhMurshed et al [18] and Vishal Ramesh Jasuja et al [14]. On the other hand, as suggested by present study, mean TDFM of male skulls being more than that of female skulls is

in accordance with the results as obtained by Ivan Claudio SuazoGaldames et al [17] and Khalil AwadhMurshed et al [18] but contradictory to that of Vishal Ramesh Jasuja et al [14]. Foramen magnum index found to be more in male skulls as compared to female skulls in present study matches the result as obtained by Vishal Ramesh Jasuja et al [14].

## CONCLUSION

The purpose of the present study was to get an insight into the morphology of the base of skull using occipital condyles and foramen magnum as bony landmarks especially bilateral and gender based differences in the basicranium. These findings are very valuable in the field of anatomy, neurosurgery, anthropology and forensic analysis. For better understanding of skull base morphology and possible anatomical variations, similar studies with larger sample size and use of advanced techniques like computer assisted image analysis system would be more enlightening.

**Conflicts of Interests: None**

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