

## Morphometry of Occipital Condyle in adult Indian population and its clinical importance

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### Abstract:

**Introduction:** The occipital condyles are located lateral to anterior half of foramen magnum. Being the important component of craniovertebral region, occipital condyles are exposed to variety of clinical conditions. These clinical conditions may need surgical interventions for their treatment. In transcondylar approach to craniovertebral junction lesions partial occipital condylectomies are done commonly. It has been reported after such condylectomies that there have occurred post-operative atlanto occipital joint instability and hypoglossal nerve palsies. These post-operative complications have been attributed to population specific variations in the occipital condyles. Hence it is important to have meticulous knowledge of the occipital condyles.

**Aims:** The aim of this study was to measure the morphometric parameters of the occipital condyles like length, width, height, anterior intercondylar distance (AID) and posterior intercondylar distance (PID) of the Indian population and to compare them with the other populations.

**Materials and Methods:** The study was conducted in Government Medical College Srinagar, J&K, India, on 198 occipital condyles (76 occipital bones and 23 articulated skulls). Measurements were done with the help of Vernier's calliper. Mean and standard deviation of the morphometric parameters were analysed and comparison was done.

**Results:** The length of occipital condyles on the right side was  $22.86 \pm 3.05$ mm and on the left side it was  $22.76 \pm 2.80$  mm with the mean of  $22.81 \pm 2.92$ mm. The width on the right side was  $12.23 \pm 1.51$ mm while on the left side it was found to be  $11.43$ mm  $\pm 1.36$ mm with the mean of  $11.83 \pm 1.43$ mm. the height of the occipital condyles on the right side was found to be  $9.37 \pm 1.29$ mm and on the left side it was  $9.16 \pm 1.15$ mm with the mean of  $9.27 \pm 1.22$  mm. the mean anterior intercondylar distance (AID) was found to be  $19.57 \pm 2.81$ mm while the mean value of posterior intercondylar distance (PID) was found to be  $39.62 \pm 4.23$ mm.

**Conclusion:** the mean values of all the parameters in the study showed side variations values were found more on the right side than that of left side. there was also difference in these values between the Indian and the other populations for successful surgeries on the occipital condyles, the surgeon must take care of these variations. The study thereby forms the morphometric reference to the surgeons to carry out successful surgeries.

**Keywords:** Occipital condyle, condylectomy, transcondylar, craniovertebral, morphometry.

**Introduction:**

The occipital condyle is a distinctive bony structure which has an oval surface being convex to articulate with concave elongated articular process of Atlas. The occipital condyles are located lateral to the anterior half of foramen magnum. Lateral to the anterior part of occipital condyle is the outer opening of hypoglossal canal (1). The occipital condyle links the skull with the vertebral column (2). The stability of the Atlanto occipital joint is maintained by congruence of articular surfaces, capsule of atlanto occipital joint and ligaments attached to it (3). Occipital condyles can be involved in several clinical conditions like infections, tumours, trauma, congenital malformations and degenerative conditions which can lead to occipito-cervical instability, the restoration of structural integrity and stability of atlanto-occipital joint is important (4). Over the past few decades, the surgical intervention with fixation of occipito-cervical instability which is done with occipital plate-rod-screw instrumentation has advanced a lot and is most widely used method (5-7). Owing to complex anatomical location and important neurovascular neighbourhood viz. vertebral canal, spinal cord, vertebral arteries, occipital condyles were not used for screw placement surgeries by spine surgeons (8). But with the discovery of advanced neuro-imaging, there has been increased interest in finding fixation points in areas which were previously considered dangerous to access. Two novel techniques of occipito-cervical fixation are being used nowadays which include direct occipital condyle screw fixation and occipito-atlas transarticular screw fixation techniques (9-11).

**Aims:**

The aim of this study was to measure the morphometric parameters of the occipital condyles like length, width, height, anterior intercondylar distance (AID) and posterior intercondylar distance (PID) of the Indian population and to compare them with the other populations.

**Materials and Methods:**

The present study is descriptive cross-sectional study and was conducted in Government Medical College Srinagar, J&K, India on 198 occipital condyles (76 occipital bones and 23 articulated skulls). The occipital bones and articulated skulls that were damaged were excluded from the study. Measurements were done with the help of Vernier's calliper. Mean and standard deviation of the morphometric parameters were analysed and comparison was done. The linear measurements were taken as follows.

The length of occipital condyles: maximum distance between anterior and posterior tips of occipital condyles



The width of occipital condyle: maximum transverse distance between medial and lateral borders of occipital condyles



The height of the occipital condyles: maximum vertical distance between the upper and lower borders of the medial margin of occipital condyle.



The anterior inter-condylar distance(AID) : distance between the anterior tips of right and left occipital condyles.

Posterior inter-condylar distance (PID) : distance between the posterior tips of right and left occipital condyle.



**Statistical analysis:** the mean and the standard deviation of the above parameters were calculated and comparison was done on right and left side.

**Result:** The length of occipital condyles on the right side was  $22.86 \pm 3.05$ mm and on the left side it was  $22.76 \pm 2.80$ mm with the mean of  $22.81 \pm 2.92$ mm . the width on the right side was  $12.23 \pm 1.51$ mm while on the left side it was found to be  $11.43 \pm 1.36$ mm with the mean of  $11.83 \pm 1.43$ mm. the height of the occipital condyles on the right side was found to be  $9.37 \pm 1.29$ mm and on the left side it was  $9.16 \pm 1.15$ mm with the mean of  $9.27 \pm 1.22$ mm; the mean anterior intercondylar distance (AID) was found to be  $19.57 \pm 2.81$ mm while the mean value of posterior intercondylar distance (PID) was found to be  $39.62 \pm 4.23$ mm.

Table 1: shows length, width and height of occipital condyles

Parameter	Right side	Left side	mean
Length	$22.86 \pm 3.05$ mm	$22.76 \pm 2.80$ mm	$22.81 \pm 2.92$ mm
Width	$12.23 \pm 1.51$ mm	$11.43 \pm 1.36$ mm	$11.83 \pm 1.43$ mm
Height	$9.37 \pm 1.29$ mm	$9.16 \pm 1.15$ mm	$9.27 \pm 1.22$ mm

Table 2: shows the mean value of anterior intercondylar and posterior intercondylar distances.

PARAMETER		MEAN
ANTERIOR INTERCONDYLAR DISTANCE(AID)		<b>19.57 ± 2.81mm</b>
POSTERIOR INTERCONDYLAR DISTANCE(PID)		<b>39.62 ± 4.23mm.</b>

### Discussion:

The present study which was conducted in the department of anatomy, Govt. Medical College, Srinagar aimed to measure the different morphometric parameters of occipital condyles as occipital condyles forms the important landmarks to carry out different surgical procedures around the craniovertebral region . these surgical procedures which are done via lateral approach may include the partial transcondylar approach or the complete transcondylar approach. In these approaches partial or complete condylectomies of occipital condyles may be necessitated. Thus it is important to know the dimensions and the orientation of occipital condyles which may affect the surgical approach for the lesions around this areas (12,13). Our study will help to check the feasibility and safety of these surgical approaches in Indian population. Numerous studies have been done internationally and nationally on the morphometry of occipital condyles and variations have been reported. these variations may be because of different methods of data collection and genetic makeup of different population. Some studies were conducted on CT scans but most of the studies were done on occipital condyles of dry occipital bones which may lead to variations (14-18).

In our study, the values of the length, width and height were found to be more on the right side than that of the left side which is consistent with the study of Saluja et al., 2016 (19).

Anterior and posterior intercondylar distance shows us convergence and position of occipital condyle which is importantly needed for screw placement during surgery on occipital condyle. These two parameters were found to be less in Indian population as compared to that of other population of world. Ozer et al., 2011 (12) in Turkish population found AID to be 20.9mm and PID to be 43.1mm while as Naderi et al (2005) (2), found AID to be 21mm and PID to be 41.6mm. In other indian study, the AID and PID were found to be as follows.

STUDY	AID	PID
Saluja S et al (19)	<b>17.81mm</b>	<b>38.91mm</b>

Tale AK et al (20)	21.28mm	40.61mm
Sahoo S et al (21)	20.31mm	41.17mm
Kalthur SG et al (22)	21.00mm	39.00mm
Present study	19.57 $\pm$ 2.81mm	39.62 $\pm$ 4.23mm.

Shorter AID and PID may pose difficulties during surgeries via lateral approach.

In our study, mean value of length of occipital condyle was found to be 22.81mm which is consistent with the findings of Bozbuga M et al (14) who found the length of occipital condyle to be 23.10mm in Turkish population and Lang J et al (23) who found length of occipital condyle to be 22.9mm in German population. While comparing the values of the length of occipital condyle in Indian population, Saluja S (19) and Sahoo S (21) found similar results as ours. But some investigators found length of occipital condyles shorter than our results. These are:

STUDY	POPULATION	MEAN VALUE OF LENGTH OF OCCIPITAL CONDYLES
SALIH AM et al (24)	Sudanese	20.66mm
YU Z et al (15)	Chinese	21.53mm
Wen HT et al (25)	American	21.00mm

Other studies like Kizilkanat ED et al (16) in Turkish population found mean value of length of occipital condyle to be 24.5mm, Dowd GC et al (26) in American population found mean value to be 30.00mm and Oliver GE (17) found mean value of length of occipital condyle to be 23.7mm in French population. These three studies reported higher values than that of ours.

The mean width in our study was found to be 11.83  $\pm$  1.43mm. Similar results were reported by Oliver GE (17) in French population (11.5mm), Ozer MA (12) In Turkish population

(11.3mm) , Tale AK et al (20) in Indian population (11.25mm) . some studies reported higher values of width of occipital condyles than that of our study. These includes:

STUDY	POPULATION	MEAN WIDTH
Saluja S et al (19)	Indian	12.97mm
Sahoo S (21)	Indian	12.73)
Salih AM (24)	Sudanese	12.81mm

Others who reported lesser value of width include

STUDY	POPULATION	MEAN WIDTH
Naderi S et al (2)	Turkish	10.5mm
Kalthur SG et al (22)	Indian	11.00mm

The height of occipital condyle is also an important surgical issue; greater the height of occipital condyle, more are the chances of good screw fixation during the occipito-cervical procedures. The mean height in our study was found to be  $9.27 \pm 1.22$ mm which is consistent with the study of Saluja S et al (19) who found mean height to be 9.21mm in Indian population, Naderi et al (2) in Turkish population found mean height to be 9.22mm and Kalthur SG et al (22) in Indian population found mean height to be 9.00mm, Le TV et al (13) reported higher value of mean height of occipital condyles to be 9.9mm in American population.

**Conclusion:**

The mean values of all the parameters in the study showed side variations values were found more on the right side than that of left side. there was also difference in these values between the Indian and the other populations for successful surgeries on the occipital condyles , the surgeon must take care of these variations. The study thereby forms the morphometric reference to the surgeons to carry out successful surgeries and to avoid neurovascular injuries . it will also help in designing implants of appropriate shape and size to be used in surgeries on occipital condyles.

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