Section: Anatomy

Original Research Article

MORPHOMETRIC AND MORPHOLOGICAL ANALYSIS OF OCCIPITAL CONDYLE AND ITS CLINICAL SIGNIFICANCE

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ABSTRACT

Background: Occipital Condyles (OC) are two bony projections located on undersurface of occipital bone at the base of skull, on either side of foramen magnum. Which articulate with atlas vertebra forming atlanto-occipital joint. **Aims & Objectives:** To assess morphometric and morphological variation of occipital condyle and its importance. **Materials and Methods:** 80 occipital condyles of 40 dry human skull of unknown age and sex were studied. Parameters included length, width, height, anterior and posterior intercondylar distance, distance from anterior tip of condyle to basion, anterior tip of condyle to opisthion, posterior tip of condyle to basion, posterior tip of condyle to opisthion were measured using digital vernier caliper and the shape of occipital condyles were visually assessed. **Results:** Mean ± SD of length, width and height of measured occipital condyles were found to be 21.12mm±2.02, 11.37mm±1.65 and 6.77mm±1.61 respectively. Mean ± SD of anterior and posterior intercondylar distances were 19.33mm±3.85 and 37.87mm±3.21 respectively. Mean ± SD distance from anterior tip of condyle to basion, anterior tip of condyle to opisthion, posterior tip of condyle to basion, posterior tip of condyle to opisthion were 9.43mm±1.59, 38.56mm±3.28, 26.44mm±2.08 and 26.64mm±2.96 respectively. **Conclusions:** Detailed knowledge will guide neurosurgeon and orthopedician in decision making regarding extent and direction of condylar drilling and minimize neurovascular injury.

INTRODUCTION

The occipital condyles (OC) are oval in shape and are situated on each side of the anterior part of the foramen magnum. They articulate with the superior articular facets of the atlas vertebra to form the atlanto-occipital joints. The hypoglossal or anterior condylar canal pierces the bone anterosuperior to the occipital condyle. The condylar or posterior condylar canal is occasionally present in the floor of a condylar fossa present behind the occipital condyle. The jugular process of the occipital bone lies lateral to the occipital condyle and forms the posterior boundary of jugular foramen.[1]

Occipital condyles are important element to maintain the head vertically. The integrity of the atlanto-occipital joint is of vital importance for the stability of the craniovertebral junction.[6,8,9] The stability of this craniovertebral junction depends largely on the morphometric data of the occipital condyles.[7-8]

There are many kinds of pathological processes that involve the craniovertebral junction. These lesions include intradural tumors such as meningiomas, neurinomas or vascular lesions such as aneurysms and arteriovenous malformations of the vertebral artery and vertebrobasilar junction, extradural tumors such as chordomas, basilar invagination and other congenital anomalies, non-traumatic (rheumatoid) and traumatic entities with C1—C2 subluxation.[7-9] Occipital condyle screws serve as an alternative fixation point in occipital cervical fusion. Their replacement requires a thorough understanding of the anatomy of the occipital condyles and associated structures.[9-10]

The present study aims to assess morphometric and morphological parameters of the occipital condyles in order to improve anatomical knowledge and support clinical applications, especially in neurosurgical and orthopaedic procedures involving the craniovertebral junction.

MATERIALS AND METHODS

The study was carried out on 80 occipital condyles (40 Right and 40 Left) of 40 dry human skulls of unknown age and sex were studied. They were obtained from Department of Anatomy, Government Medical College, Bhavnagar, Gujarat, India. All parameters were measured using digital vernier caliper with 0.01mm precision. All the data were recorded in to Microsoft excel.

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Figure 1: Digital Vernier caliper

Inclusion and exclusion criteria: All adult dry human skulls irrespective of age, gender and completely intact bones were taken for study. Broken, decalcified, unossified, deformed and pediatrics skulls were excluded.

The following parameters of occipital condyles were measured:

Figure 1: Length of Occipital Condyle (right and left): Maximum anteroposterior distance between anterior and posterior tips of OC.

Figure 2: Width of Occipital Condyle (right and left): Maximum transverse distance between medial and lateral border of OC.

Figure 3: Height of Occipital Condyle (right and left): Maximum vertical distance between upper and lower border of medical margin of OC.

Figure 4: Anterior intercondylar distance (AICD): Distance from anterior tip of right to anterior tip of left OC.

Figure 5: Posterior intercondylar distance (PICD): Distance from posterior tip of right to posterior tip of left OC.

Figure 6: Distance from anterior tip of Occipital Condyle to Basion (DAB)

Figure 7: Distance from posterior tip of Occipital Condyle to Basion (DPB)

Figure 8: Distance from anterior tip of Occipital Condyle to Opisthion (DAO)

Figure 9: Distance from posterior tip of Occipital Condyle to Opisthion (DPO)

The shape of Occipital Condyles were visually assessed.

Figures: Showing Measurements of Different Parameters of Occipital Condyle

Figure 1: Length of occipital condyle

Figure 2: Width of occipital condyle

Figure 3: Height of occipital condyle

Figure 4: Anterior intercondylar distance

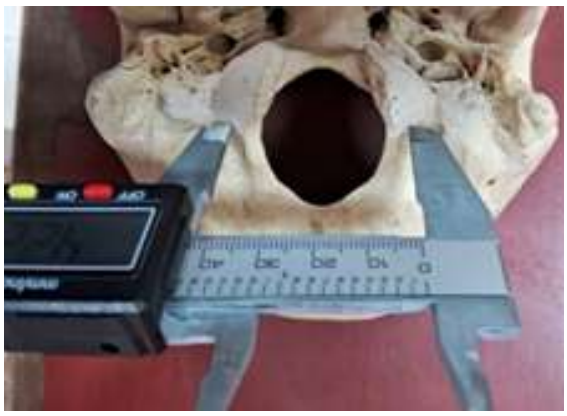

Figure 5: Posterior intercondylar distance

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Figure 6: Distance from anterior tip of Occipital Condyle to Basion

Figure 8: Distance from anterior tip of Occipital Condyle to Opisthion

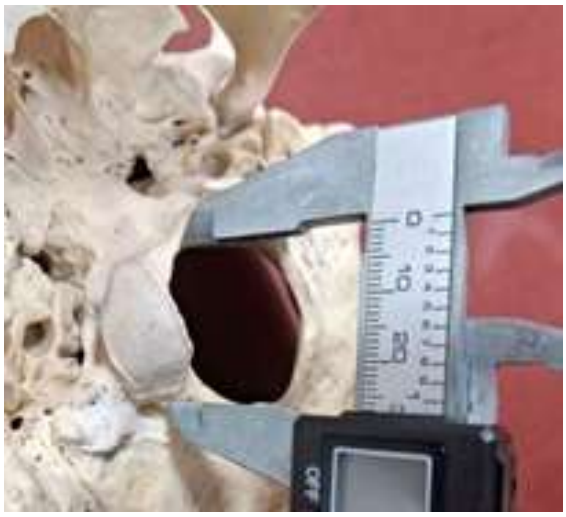

Figure 7: Distance from posterior tip of Occipital Condyle to Basion

Figure 9: Distance from posterior tip of Occipital Condyle to Opisthion

RESULTS

Table 1: Measurements of occipital condyle

PARAMETERS (mm)	SIDE	MEAN (mm) ± SD	RANGE (Min-Max) (mm)
Length of Occipital Condyle	Right	21.12 ± 2.03	16.57 - 25.25
	Left	21.12 ± 2.02	15.97 - 27.03
Width of Occipital Condyle	Right	11.27 ± 1.58	8.29 - 13.81
	Left	11.48 ± 1.72	7.66 - 15.72
Height of Occipital Condyle	Right	6.70 ± 1.56	4.69 - 10.32
	Left	6.84 ± 1.66	3.31 - 10.08
Anterior intercondylar distance (AICD)		19.33 ± 3.85	5.71 - 26.67
Posterior intercondylar distance (PICD)		37.87 ± 3.21	30.35 - 43.52
Distance from anterior tip of Occipital Condyle to Basion (DAB)	Right	9.13 ± 1.46	6.09 - 12.32
	Left	9.73 ± 1.72	6.84 - 13.27
Distance from anterior tip of Occipital Condyle to Opisthion (DAO)	Right	38.26 ± 3.35	30.93 - 44.30
	Left	38.86 ± 3.21	33.02 - 44.77
Distance from posterior tip of Occipital Condyle to Basion (DPB)	Right	26.44± 2.14	23.46 - 31.31
	Left	26.45 ± 2.03	23.59 - 31.63
Distance from posterior tip of Occipital Condyle to Opisthion (DPO)	Right	26.36 ±2.93	20.73 - 32.84
	Left	26.93 ±2.99	21.62 - 35.41

The study was done on 80 occipital condyles (40 Right and 40 Left) of 40 dry human skulls. The results obtained from present study are shown in Table No. 1. The Mean ± SD of length of OC were found to be 21.12mm ± 2.03 on right, 12mm ± 2.02 on left. The Mean ± SD of width of OC were found

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to be 11.27mm ± 1.58 on right, 11.48mm ± 1.72 on left. The Mean ± SD of height of OC were found to be 6.70mm ± 1.56 on right, 6.84mm ± 1.66 on left. The Mean ± SD of anterior and posterior intercondylar distance was measured as 19.33mm ± 3.85 and 37.87mm ± 3.21 respectively. The Mean ± SD of distance from anterior tip of condyle to basion were 9.13mm ± 1.46 on right, 9.73mm ± 1.72 on left. The Mean ± SD of distance from anterior tip of condyle to opisthion were 38.26mm ± 3.35 on right, 38.86mm ± 3.21 on left. The Mean ± SD of distance from posterior tip of condyle to basion were 26.44mm ± 2.14 on right, 26.45mm ± 2.03 on left. The Mean ± SD of distance from posterior tip of condyle to opisthion were 26.36mm ± 2.93 on right, 26.93mm ± 2.99 on left. There were no significant differences for the measured parameters between the right and left sides.

SHAPES OF OCCIPITAL CONDYLES

Table 2: Showing different shapes of occipital condyle and their percentage

SHAPE OF OCCIPITAL CONDYLE	NUMBERS	PERCENTAGE
OVAL	16	40
ROUND	3	7.5
KIDNEY	4	10
TRIANGULAR	1	2.5
8-LIKE	4	10
S-LIKE	5	12.5
TWO PORTIONED	2	5
RHOMBOID	5	12.5
TOTAL	40	100

The Table- 2 shows out of the 40 occipital condyles studied, the most common shape was oval (40%), followed by S-like (12.5%) and rhomboid (12.5%). Other shapes were also observed included kidney-shaped (10%), 8-like (10%), round (7.5%), two-portioned (5%) and triangular (2.5%). Oval shape of the occipital condyle is the most common (40%), representing nearly half of the cases. The triangular shape is the least common (2.5%).

DISCUSSION

Table 3: Comparison of occipital condyle parameters with previous studies

Parameters(mm)	Side	Priya A et al. (2019) [2]	Roopashree R et al. (2019) [3]	Archana K.et al. (2015) [4]	Sandeep S et al. (2016) [5]	Present Study
Length of Occipital Condyle	Right	19.9 ± 3.00	21.79 ± 0.09	21.83 ± 2.99	22.9-3.11	21.12 ± 2.03
	Left	22.3 ± 3.3	21.48 ± 0.87	22.19 ± 3.31	22.60-2.72	21.12 ± 2.02
Width of Occipital Condyle	Right	13.2 ± 2.4	11.03 ± 2.22	11.07 ± 2.41	12.98-1.62	11.27 ± 1.58
	Left	13.7 ± 2.7	11.01 ± 2.34	11.42 ± 2.31	12.97-1.46	11.48 ± 1.72
Height of Occipital Condyle	Right	6.2 ± 1.7	6.18 ± 1.31	8.25 ± 1.58	9.32-1.23	6.70 ± 1.56
	Left	6.2 ± 1.4	6.09 ± 1.36	8.19 ± 1.79	9.12-1.23	6.84 ± 1.66
Anterior intercondylar distance (AICD)		19.5 ± 3.4	19.41 ± 3.99	21.28 ± 3.03	17.81-2.93	19.33 ± 3.85
Posterior intercondylar distance (PICD)		36.6 ± 3.5	37.36 ± 4.03	40.61 ± 3.34	38.91-4.16	37.87 ± 3.21
Distance from anterior tip of Occipital Condyle to Basion (DAB)	Right	9.6 ± 1.7	—	—	9.74-1.78	9.13 ± 1.46
	Left	9.8 ± 1.5	—	—	9.56-1.33	9.73 ± 1.72
Distance from anterior tip of Occipital Condyle to Opisthion (DAO)	Right	37.8 ± 2.4	—	—	37.53-2.26	38.26 ± 3.35
	Left	38.2 ± 3.1	—	—	37.88-2.5	38.86 ± 3.21
Distance from posterior tip of Occipital Condyle to Basion (DPB)	Right	25.2 ± 2.6	—	—	28.16-3.26	26.44± 2.14
	Left	25.9 ± 2.5	—	—	26.93-2.16	26.45 ± 2.03
Distance from posterior tip of Occipital Condyle to Opisthion (DPO)	Right	26.9 ± 2.3	—	—	26.78-1.92	26.36 ±2.93
	Left	26.4 ± 1.8	—	—	26.17-2.51	26.93 ±2.99

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The present study compares the morphometric parameters of occipital condyles (OC) with earlier studies by Priya A et al. (2019),[2] Roopashree R et al. (2019),[3] Archana K. et al. (2015),[4] and Sandeep S et al. (2016),[5] as shown in the table-3.

The mean length of OC in present study was 21.12 ± 2.03 mm on right side and 21.12 ± 2.02 mm on left side. These values are comparable with finding of Roopashree R et al,[3] and Archana K et al,[4] while they are slightly lower than those reported by Sandeep S et al.[5] The mean width of OC in present study (right: 11.27 ± 1.58 mm; left: 11.48 ± 1.72 mm) also closely corresponds with those of Roopashree R et al,[3] and Archana K et al,[4] while slightly lower than those of Priya A et al,[2] and Sandeep S et al.[5] The mean height of OC in the present study was 6.70 mm ± 1.56 on right and 6.84 ± 1.66 mm on left, which are comparable to Priya A et al,[2] and Roopashree R et al,[3] significantly lower than those reported by Archana K et al,[4] and Sandeep S et al.[5] The anterior intercondylar distance (AICD) in present study (19.33 ± 3.85 mm) is closely aligned with the values of Priya A et al,[2] and Roopashree R et al,[3] but is lower than that of Archana K et al,[4] and higher than that of Sandeep S et al.[5] Similarly, the posterior intercondylar distance (PICD) was observed in present study (37.87 ± 3.21 mm) falls within the range of Priya A et al,[2] Roopashree R et al,[3] Sandeep S et al,[5] while being slightly lower than Archana K et al.[4] The mean distances from the anterior tip of the occipital condyle to basion (DAB) and opisthion (DAO) were 9.13 ± 1.46 mm and 38.26 ± 3.35 mm on the right, and 9.73 ± 1.72 mm and 38.86 ± 3.21 mm on the left, respectively. Similarly, distances from the posterior tip of the occipital condyle to basion (DPB) and opisthion (DPO) were 26.44 ± 2.14 mm and 26.36 ± 2.93 mm on the right, and 26.45 ± 2.03 mm and 26.93 ± 2.99 mm on the left, respectively. These values are comparable with data available from Priya A et al,[2] and Sandeep S et al,[5] and demonstrate bilateral symmetry of occipital condyles. The present morphometric data provide valuable baseline information that may aid neurosurgeons, orthopedicians and radiologists in preoperative procedures at the craniovertebral junction, particularly in planning approaches involving the occipital condyles.

CONCLUSION

The morphometric evaluation of occipital condyles plays an important role in safer transcondylar approach for craniovertebral surgery. It can be concluded that detailed knowledge will guide neurosurgeon and orthopedician in decision making regarding extent and direction of condylar drilling and minimize neurovascular injury. The most common shape of occipital condyle we found was oval shape, which facilitate better alignment and articulation with atlas vertebra.

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