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Original Research Article

Morphology and morphometric study of occipital condyles

Asra Anjum *[1], Gayathri Pandurangam [2], Supriya Garapati [3], Naveen Bandarupalli [4], Hajera Rabbani [5], Divya P [6].

*[1] Tutor, Department of Anatomy, Mamata Academy of Medical Sciences, Hyderabad, Telangana State, India.

[2] Assistant Professor, Imam Abdulrahman bin Faisal Univeristy, College of Applied Medical Sciences in Jubail, Respiratory Care Department.

[3] Professor, Department of Anatomy, Mamata Academy of Medical Sciences, Hyderabad, Telangana State, India.

[4] Professor, Department of Anatomy, Mamata Academy of Medical Sciences, Hyderabad, Telangana State, India.

[5] Assistant Professor, Department of Community Medicine, Mamata Academy of Medical Sciences, Hyderabad, Telangana State, India

[6] Assistant Professor, Department of Anatomy, Mamata Academy of Medical Sciences, Hyderabad, Telangana State, India.

ABSTRACT

Introduction: The occipital condyles are undersurface protruberances of the occipital bone in vertebrates, which articulate with the superior facets of the atlas vertebra. The condyles are oval or reniform in shape, and their anterior extremities directed forward and medially and are closer together than the posterior end.

Aim: The aim of the study is to provide important anatomical parameters for lateral transcondylar approach.

Materials and Methods: 200 occipital condyles in 100 dry human skulls (73 males and 27 females) were studied. The measured parameters included length, width, height, shape, anterior and posterior intercondylar distance, distance between basion and opesthion, distance from anterior tip of the condyle to the basion and opestion and distance from posterior tip to the basion and opesthion. Measurements were made using Vernier Callipers.

Results: The mean length, width and height of the occipital condyles in males is greater than females. The anterior intercondylar distance is more in females whereas posterior intercondylar distance is more in males. The mean distance from basion to opesthion / anteroposteriordiamerer of foramen magnum is more in males than in females. The mean distance between the anterior tip of occipital condyles to basion is more in females than in males on both the sides.

Conclusion: The knowledge of condylar anatomy helps the surgeon in making important decisions regarding extent and direction of condylar drilling and minimizing injury and retraction of neural structures.

KEY WORDS: Occipital Condyles, Foramen Magnum, Intercondylar distance, Basion, Opesthion.

Corresponding Author: Mrs Asra Anjum, Tutor, Department of Anatomy, Mamata Academy of Medical Sciences, Hyderabad, Telangana State, India. **E-Mail:** asra.anjum1217@gmail.com

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INTRODUCTION

Occipital condyles are the two bony projections that are present in the inferior surface of occipital bone in the skull. The occipital condyle occupies the anterior half of the outer margin of foramen magnum. The articular surface is oval or reniform in outline, faces downward and laterally and articulates with the superior articular facet of the lateral mass of atlas forming the synovial atlanto – occipital joint [1]. The margins gives attachment to the capsule of the atlanto – occipital joints, and on the medial side of each is a rough impression or tubercle for the alar ligament. At the base of condyle, the bone is tunnelled by a short canal, the hypoglossal canal [2]. The stability of the craniovertebral junction depends largely on the morphometric parameters of the occipital condyles. Each occipital condyle is oriented obliquely, so that its anterior end lies closer to the midline. The hypoglossal canal directed laterally and slightly forwards, and jugular foramen is lateral to each condyle [3].

The CVJ refers to an area that includes the foramen magnum (FM), Occipital Condyles (OC's) and the first two cervical vertebrae, namely atlas and axis [4]. The CVJ is associated with many important structures such as the medulla oblongata, upper spinal and lower cranial nerves (glossopharyngeus, vagus, accessories and hypoglossus), vertebral arteries with its branches and vertebral veins, as well as the atlas, axis and occipital bone with important ligamentous and muscular attachments [5]. The study of the anatomy of these structures in clinical pathology and surgery justifies the implementation of new techniques for approaches at this region [6]. Due to its sensitive location, tumors located in the CVJ still have great challenges during their surgical resection. Although these tumors represent only about 1 percent of all intracranial tumors, their resection is extremely difficult [7]. A number of surgical access routes of this region are currently available including transcondylar, supracondylar, anf other lateral surgical approaches. Conventional anatomy and surgical textbooks donot describe the anatomical variations in the OCs. Many such anomalies can be encountered incidentally [8]. The wide difference between the AID and PIDs leads the OC to have different anterior and posterior angles. The anteroposterior orientation and narrow inercondylar space would require a more bony removal [9].

Aim: The aim of the study is to analyse the occipital condylar morphometry. The occipital condylar anatomy assists the surgeon in making important decisions regarding extent and direction of condylar drilling and minimizing injury and retraction of neural structures.

MATERIALS AND METHODS

The study was carried out in 100 dry adult human skulls (73 males and 27 females) from department of Anatomy from medical colleges in Telangana state. Damaged skulls were not included in the study. Sex of each skull was determined by meticulously scrutinizing the classic anatomic features. 200 occipital condyles in 100 dry human skulls (73 males and 27 females) were studied. The measured parameters included length, width, height, shapeanterior and posterior intercondylar distance, distance between basion and opesthion, distance from anterior tip of the condyle to the basion and opestion and distance from posterior tip to the basion and opesthion. Measurements were made using Vernier Callipers (fig 1 and fig 2). The following measurements were noted:

· Length of the occipital condyles (right and left).

· Width of the occipital condyles (right and left).

· Height of the occipital condyles (right and left).

· Shape of the occipital condyle (right and left)

· Anterior intercondylar distance.

· Posterior intercondylar distance.

· Distance from Anterior tip of occipital condyle to basion.

· Distance from Anterior tip of occipital condyle to opesthion.

· Distance from posterior tip of occipital condyle to basion.

· Distance from posterior tip of occipital condyle to opesthion.

· Distance from basion to opesthion.

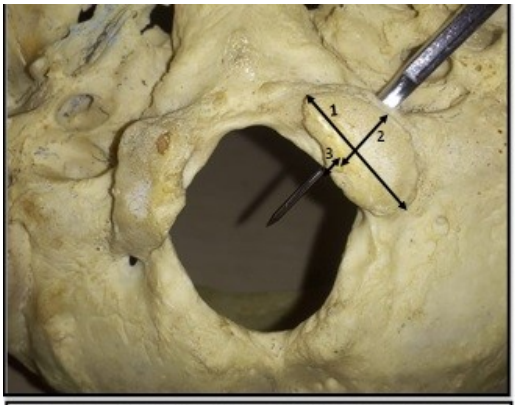


Fig: 1 – some metric parameters of occipital condyle(OC). (1) length of OC. (2) width of OC. (3) height of OC

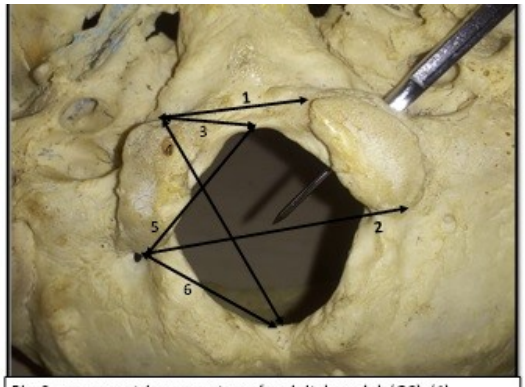
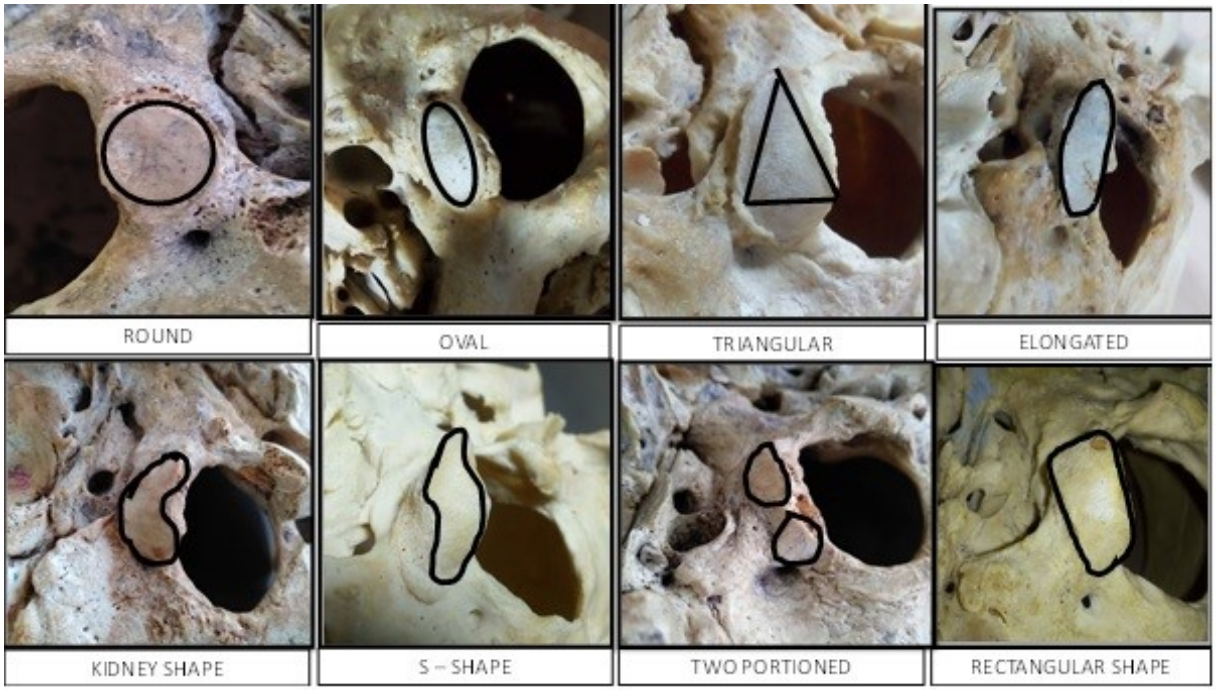
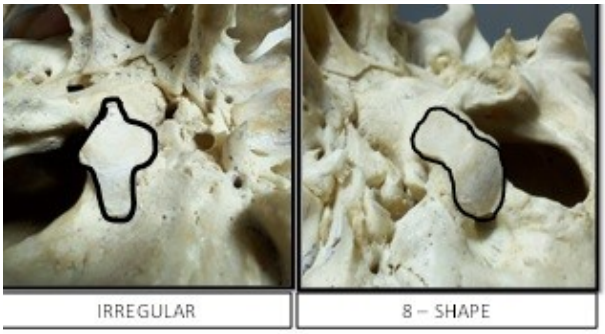


Fig: 2 – some metric parameters of occipital condyle(OC). (1) Anterior intercondylar distance. (2) Posterior intercondylar distance. (3) distance between anterior tip of OC and basion. (4) distance between anterior tip of OC and Opesthion. (5) distance between posterior tip of OC and basion. (6) distance between posterior tip of OC and Opesthion.





The length of the OC is measured from the anterior tip to the posterior tip. Width of the OC is measured from the midpoint of lateral margin to the midpoint of the medial margin. Height of the OC is measured along the thickness of the OC in the midpoint.

Statistical Analysis: All data was expressed as mean ± standard deviation (SD) and the level of statistical significance was performed using SPSS VERSION 20.

RESULTS

200 occipital condyles from 100 skulls were investigated among which 73 males and 27 females.

The mean length of the occipital condyles in males is 23.5 mm on the right side and 23.34 mm on the left side where as in females 22.44 mm on right side and 22.62 mm on left side. The mean width of the occipital condyles in males is 12.19 mm on right side and 12.29 mm on the left side, where as in females 11.46 mm on the right side and 11.87 mm on the left side. The mean height of the occipital condyles in males is 8.89 mm on the right side and 8.85 mm on the left side, where as in females 8.70 mm on the right side and 8.62 mm on the left side (Table 1).

The mean distance from anterior tip of OC to

basion in females is 10.85±1.34 and 10.98±1.28 on right and left sides respectively, where as in males the mean distance of anterior tip of OC from basion is 10.57±1.68 and 10.90±10.47 on right and left sides respectively. The mean distance from anterior tip of OC to opesthion in females is 38.09±2.74 and 37.64±2.96 on right and left sides respectively, where as in males the mean distance of anterior tip of OC from opesthion is 38.59±2.55 and 38.60±2.55on right and left sides respectively. The mean distance from posterior tip of OC to basion in females is 25.92±1.22 and 26.18±1.67 on right and left sides respectively, where as in males the mean distance of posterior tip of OC from basion is 26.54±1.98 and 26.73±2.24 on right and left sides respectively. The mean distance from posterior tip of OC to opesthion in females is 26.03±2.28 and 26.29±3.0 on right and left sides respectively, where as in males the mean distance of posterior tip of OC from opesthion is 27.15±2.14 and 27.57±2.68 on right and left sides respectively.

The anterior and posterior intercondylar distances in males were found to be 17.86mm and 41.27mm respectively, where as in females 18.44mm and 38.59mm respectively. The mean distance from basion to opesthion / antero-posterior diamerer of foramen magnum is 33.78mm in males and 33.57mm in females. (Table.2)

The incidence of shapes is given in table.3

Table 1: Parameters of Occipital Condyle.

Parameter	Female (Mean±SD)		Male (Mean±SD)	
	Right	Left	Right	left
Length(mm)	22.44±2.01	22.62±2.41	23.5±2.71	23.34±3.06
Width(mm)	11.46±1.56	11.87±1.45	12.19±1.53	12.29±1.47
Height(mm)	8.70±1.12	8.62±1.10	8.89±1.02	8.85±1.13

Table 2: Morphometric measurements of occipital condyles.

Parameters	Female [Mean(mm)±SD]		Male [Mean(mm)±SD]	
	Right	Left	Right	Left
Anterior tip to Basion	10.85±1.34	10.98±1.28	10.57±1.68	10.90±1.47
Anterior tip to Opesthion	38.09±2.74	37.64±2.96	38.59±2.55	38.60±2.55
Posterior tip to Basion	25.92±1.22	26.18±1.67	26.54±1.98	26.73±2.24
Posterior tip to Opesthion	26.03±2.28	26.29±3.0	27.15±2.14	27.57±2.68
Anterior ICD	18.44±2.96		17.86±2.45	
Posterior ICD	38.59±4.53		41.27±4.74	
Basion to Opestion	33.57±2.40		33.78±2.42	

Table 3: Incidence of shapes of oc in males and females.

Shape	Male	Female
8 - shaped	15.1(%)	11.1(%)
Elongated	16.4(%)	7.4(%)
Irregular	2.7(%)	3.7(%)
Kidney	2.8(%)	3.7(%)
Oval	40(%)	42.4(%)
Round	1.4(%)	7.4(%)
S - Shaped	2.7(%)	12.4(%)
Triangular	11(%)	7.4(%)
Rectangular	5.5(%)	-
Two portioned	2.5(%)	4.4(%)

DISCUSSION

The Occipital Condyle is the distinctive bony structure linking the skull and the vertebral column. The OC partly covers the fringe o the foramen magnum anteriorly and form an articulation with the superior articular facets on the lateral masses of the atlas imferiorly. Each OC is oval in outline and oriented obliquely and traversed by hypoglossal canal. A condylar fossa is situated just posterior to the OC and contains a posterior condylar canal for emissary vein from the sigmoid sinus. Laterally the occipital bone connects with the petorus part of the temporal bone anteriorly and mastoid process posteriorly [10].

The knowledge of approximate measurements of occipital condyles and variations in shape will serve as ready reference when surgical interventions are needed. The dimensions of the occipital condyles in this study are significant and comparable with other studies of similar parameters.

From the results obtained in our study it was observed that the mean length of the occipital condyles in males is 23.5 mm on the right side and 23.34 mm on the left side where as in females 22.44 mm on right side and 22.62 mm on left side. The measurements were greater in male skulls than in female skulls on both the sides. The present study is correlated with the study done by Swapnali Shamkuwar et al [11] who reported the mean length of OC in males is 2.33 cms on the right side and 2.31cms on the left side where as in females 2.23cms on the right side and 2.21cms on the left side. And also correlated with to what was found by previous authors as 2.3cm [9, 12, 13, 14, 15]. In the stydy by Bayat et al [16]

the mean length of left occipital condyle was 19.28mm and right occipital condyle was19.43 mm. these findings were observed lesser than our present study findings. In the study done by Oliviera et al [17] the mean OC length in males is 26.74mm on the right side and 26.85mm on the left side, where as in females 25.45 mm on the right side and 24.64 mm on the left side. These findings of Oliviera et al were higher than our present study findings. In our study, we also observed that women tend to have shorter OC than men.

The mean width of the occipital condyles in males is 12.19 mm on right side and 12.29 mm on the left side, where as in females 11.46 mm on the right side and 11.87 mm on the left side. The present study is similar with the findings of Swapnali Shamkuwar et al [11] who reported the mean width of the OC in males is 12.9mm on both the sides, where as in females 12.5mm on the right side and 12.7 on the left side. The mean measurements in male skulls were slightly higher than the female skulls. Other researchers reported slightly higher values, in which the mean width of the OCs is 12.97mm (by Sandeep Saluja et al) [18], 12.81mm (by salih AM et al) [19], 13.1mm (by Kizilkant ED et al) [20]. In the present study we found the mean width of OCs is narrow in females than in males which is in contrast with the study done by Sneha GK et al [9] who reported that males tend to have narrow OC than female.

The mean height of the occipital condyles in males is 8.89 mm on the right side and 8.85 mm on the left side, where as in females 8.70 mm on the right side and 8.62 mm on the left side. The thickness of OC also matters during condylectomy as one should know how deep OC has to be drilled. This measured height is approximate to the result obtained byOliver G et al [21] who reported the height as 8.8mm. The values are higher in the studies done by M. Mahamutha A et al [2] who reported the mean height of the OC on the right side is 9.6mm and 9.5mm on the left side.

The OCs were found to converge ventrally. The anterior and posterior intercondylar distances in males were found to be 17.86mm and 41.27mm respectively, where as in females 18.44mm and 38.59mm respectively. This study is in accordance with the findings of Vishal RJ et al [22] who reported the AICD as 18.23mm in males and 19.11mm in females.This study is also similar with the findings of Shimaa et al [23] who reported the anterior and PICDs as 18.97mm and 38.39mm respectively. These measured distances are lower than the results obtained by Kizilkant [24], Naderi. S [13], Fetouh F A [15] who reported AID as 22.6mm, 21mm,20mm and PID as 44.2mm, 41mm, 41mm respectively. The measured distances are higher than the results obtained by DeepaSomanath et al [25] who reported Anterior and PICDs as 15.2mm and 27.7mm respectively.

In the present study the mean distance from basion to opesthion / antero posterior diamerer of foramen magnum is 33.78mm in males and 33.57mm in females. This study coinsides with the study done by Vishal RJ et al [22] who reported the anteroposterior diameter 34.24mm in males and 33.97mm in females. The measured distance is higher than the results obtained by Gaurav Agnihotrri et al [26] who reported the anteroposterior diameter of foramen magnum as 32.83mm. And lower than the results obtained by Sayed [27] and Aziz[28] who reported the anteroposterior diameter of foramen magnum as 36.22mm and 35.94mm respectively.

The mean distance between the anterior tip of OC to basion on the right side was 10.57mm and 10.85mm in males and females respectively, and 10.90mm and10.98mm respectively on the left side. The mean distance between the posterior tip of OC to basion on the right side was 26.54mm and 25.92mm in males and females respectively, and 26.73mm and 26.18mm respectively on the left side. These measured distances are similar to the results obtained by Fetouh et al [15] as 16mm and 27mm respectively and by Naderi et al [13] who reported them as 10mm and 28mm respectively, and by Sneha GK et al [9] who reported them as 12mm and 27mm respectively.

The mean distance between the anterior tip of OC to opesthion on the right side was 38.59mm and 38.09mm in males and females

Table 4: Comparison of incidence of different shapes of occipital condyles with other studies.

Shape	Present study (%)		Sneha G K et al (%)		Varsha T S et al (%)		Swapnali S et al (%)		Ilhan p et al(%)
	Male	Female	Male	Female	Male	Female	Male	Female	Total
8 - shaped	15.1	11.1	29	22.5	24	12	5.4	-	-
Elongated	16.4	7.4	-	-	-	-	-	-	-
Irregular	2.7	3.7	11.8	11.3	4	2	3	1.7	22
Kidney	2.8	3.7	11.8	12	8	8	13	18.4	-
Oval	40	42.4	21.8	22.5	16	30	36.6	34.6	10
Round	1.4	7.4	-	1.4	2	2	-	-	6
S - Shaped	2.7	12.4	13.6	14.8	20	16	17.4	18	-
Triangular	11	7.4	9	10.6	24	12	12	24.2	-
Rectangular	5.5	-	-	-	2	14	3.6	1.8	24
Two portioned	2.5	4.4	2.7	4.9	-	4	4.2	2.5	-

respectively, and 38.60mm and 37.64mm respectively on the left side. The mean distance between the posterior tip of OC to opesthion on the right side was 27.15mm and 26.03mm in males and females respectively, and 27.57mm and 226.29mm respectively on the left side. This is in agreement with Naderi et al [13] who reported them as 39mm and 26mm respectively and Fetouh et al [15] who reported it as 50mm and 27mm.and by Sneha GK et al [9] who reported them as 39mm and 28mm respectively. The distance between the posterior tip of OC and the opisthion is important as it represents the width of surgical exposure in suboccipital craniotomy and larger the distance better is the access for the posterolateral approach [9].

The shape of OC was classified into different types. The most common type was oval in both males and females, whereas the most unusual type was two-portioned, round, s-shaped, kidney shaped and irregular in males, where as in females it was two-portioned, kidney, irregular, round and elongated. This study is compared with the studies done by Sneha G K et al [9], Varsha T S et al [29], Swapnali S et al [11] and Ilhan p et al [30].

CONCLUSION

The findings of this study provides a database for choosing the right surgical approach to minimize the mortality and morbidity in this region. The preoperative radiological evaluation through plain radiography, CT and MRI are important for achieving surgical success and this evaluation is required before surgery to prevent complications like hemorrhage, atlantooccipital instability and injury to major structures passing through Foramen Magnum. The data obtained from the present study will be useful not only to neurosurgeons and orthopeditians but also to the anthroplolgists, morphologists and clinical anatomists.

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Conflicts of Interests: None

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