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STUDYING THE MORPHOLOGY, DIMENSIONS AND CHARACTERIZATION OF THE OCCIPITAL CONDYLE IN HUMANS

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ABSTRACT

Background: During various surgical procedures in the craniovertebral region, it is vital to have a thorough understanding of the anatomical basis of anomalies seen in this region. Occipital condyle resection is needed during the lateral approach for performing the craniovertebral surgery.

Aim: The present study aimed to assess the morphology concerning dimensions and characterization of the occipital condyle in humans.

Methods: The present study assessed 400 occipital condyles in 200 adult dry skulls from humans that were of unknown gender and unknown age. The distances assessed were the distance between the anterior and posterior tip of the occipital condyle and opisthion and the distance between the anterior and posterior tip of the occipital condyle and basion. The data gathered were analyzed statistically.

Results: The distance between the anterior and posterior tip of the occipital condyle and opisthion were 27.83 and 38.99 mm on the right side and 26.6 mm and 39.07 mm on the left side respectively. The distance between the anterior and posterior tip of the occipital condyle and basion was 26.93 mm and 10.53 mm on the right side and 27.87mm and 11.45 mm on the left side respectively.

Conclusion: The present study concludes that the parameters of the occipital condyles and the associated variations are vital and must be taken into consideration during the surgical procedures involving the lateral and posterior approaches in the craniovertebral junction by Orthopedicians

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and Neurosurgeons. The large distance provides the free space to perform posterior and lateral approaches.

Keywords: Craniovertebral region, craniovertebral junction, craniovertebral surgery, Foramen magnum, occipital condyle

INTRODUCTION

The occipital condyles are vital anatomical landmarks that necessitate their identification and localization. These occipital condyles make a vital junction between the vertebral column and the cranium and are located with the superior articular facets of the atlas vertebra. The stability of the craniovertebral junction is largely governed by the integrity of the occipital condyles.[1]

Various bony anomalies in the craniovertebral region have been noted and identified for many years in the previous literature data on clinical-radiological and morphological studies. The anomalies of the craniovertebral junction are vital to various clinicians as well as anatomists as many of the associated deformities present different clinical symptoms with the main site of these variations has been attributed to the occipital bone. Anomalies seen in this region can be categorized as traumatic, acquired, developmental, and congenital that are either seen alone or in combination form.[2]

Over the past two decades, various biochemical and anatomical studies have largely focused on the craniovertebral junction as the main consideration. The majority of these studies considered the morphometric evaluation of the occipital condyles, whereas, few of these studies provide data on the different surgical approaches.[3] Cranial portion of the craniocervical junction is marked by the occipital condyles. A dorsal or ventral approach can be utilized to reach the lesions that occupy space present ventral to the spinal canal at the foramen magnum level. The high morbidity rates and the difficulties linked to the ventral surgical approach call for a dorsal approach in these conditions.[4]

It is vital to partially resect the occipital condyle during the transcondylar surgical procedure to the ventrolateral and ventral part of the foramen magnum. It is crucial to understand the three-dimensional anatomy in any of the surgical procedures in the craniovertebral region. Previous literature data have mentioned the incidence of injury to the vertebral artery during the lateral approach to the foramen magnum and while placing the occipital screw/trans articular screw.[5] These intraoperative injuries to the vertebral artery can compromise or limit the blood flow and can cause catastrophic bleeding intraoperatively. This can further lead to unpredictable neurological deficits that are based on the accuracy of adequate blood flow from the contralateral vertebral artery.[6]

Hence, the present study concerning the morphometric evaluation of occipital condyle was done. The study data was considered valuable for the Orthopedics, radiologists, and neurosurgeons in the preoperative treatment plan and decision-making.

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MATERIALS AND METHODS

The present study aimed to assess the morphology concerning dimensions and characterization of the occipital condyle in humans. The cadaveric study was done at the Department of Human Anatomy of the Institute.

The present study assessed 100 human skulls from adult human cadavers. The gender and age of the study cadavers was unknown. The skulls included were completely ossified, were free of any deformity, and were fully dried. All the skulls were from the Department of Anatomy of the Institute. All the measurements were performed by two examiners experts in the field. The equipment used for the present study were Vernier calipers to carry out the measurements and digital photography equipment which was measuring scale.

All the study parameters were assessed on both left sides as well as on the right side in all the skulls. The measurements done were distance between the posterior tip of the occipital condyle and the opisthion which was assessed using the Vernier Caliper maximum distance was noted from the left occipital condyle and posterior tip of the right occipital condyle to the posterior margin of the mid-point of the foramen magnum that marked the Opisthion. This was taken as the distance between the posterior tip of the occipital condyle and the Opisthion.

The distance between the anterior tip of the occipital condyle and the Opisthion was measured using the Vernier Caliper measured the maximum distance between the anterior tip of the left occipital condyle and the anterior tip of the right occipital condyle to the Opisthion marked by the posterior margin of mid-point of foramen magnum.

The distance between the posterior tip of the occipital condyle and the basion was assessed with the Vernier Caliper where the maximum distance between the posterior tip of the left and right occipital condyle and Basion marked by the anterior margin of the midpoint of foramen magnum was noted.

The distance between the anterior tip of the occipital condyle and the basion was calculated using the Vernier Caliper where the maximum distance between the anterior tip of the right and left occipital condyle and the basion marked by the anterior margin of midpoint of foramen magnum was calculated.

The data gathered were assessed statistically using the SPSS software version 25.0 (IBM Corp., Armonk, NY, USA) and the unpaired t-test. The significance level was taken at $p<0.05$.

RESULTS

The present cadaver study aimed to assess the morphology concerning dimensions and characterization of the occipital condyle in humans. The present study assessed 400 occipital condyles in 200 adult dry skulls from humans that were of unknown gender and unknown age.

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The distance between the Opisthion and posterior tip of the occipital condyle on the left side was 26.96±2.46 mm which was significantly lower compared to the right side where it was 27.83±2.46 mm with a p-value of 0.0008. The distance between the Opisthion and anterior tip of the occipital condyle was 39.07±3.2 mm on the left side and 38.99±3.46 mm on the right side. The difference was statistically non-significant with p=0.75 as summarized in Table 1.

The distance between the basion and posterior tip of the occipital condyle on the left side was 27.87±4.2 mm and on the right side was 26.93±3.19. The distance was statistically non-significant with p=0.011. A significant difference was seen for the distance between the basion and anterior tip of the occipital condyle with 11.45±1.76 distance on the left side and 10.53±2.2 mm distance on the right side and a p-value of 0.0001 as shown in Table 1.

DISCUSSION

Facets of the atlas vertebrae provide the articulation to the occipital condyles of the skull which forms a vital junction between the vertebral column and the cranium which further forms the lento-occipital joint as reported by Singh S[7] in 1965. A comprehensive understanding of the anatomical aspect of craniovertebral anomalies is vital when the surgery is performed in the concerned anatomical area. When the lateral approach is used in craniovertebral surgeries, it requires the occipital condyle resection. Hence, it is vital to comprehensively understand the morphology and anatomy of the occipital condyles and their facets as reported by Naderi S et al[8] in 2005.

A dorsal or ventral approach is usually used at the level of the foramen magnum to surgically manage any existing space-occupying lesion as suggested by Naderi S et al[8] in 2005. The majority of the surgical approaches used require the sectioning of the occipital condyles including the transcondylar approach, trans tubercular approach, and/or transjugular approach as reported by Wen TH et al[9] in 1997 and Al-Mefty O et al[10] in 1996. The surgical resection of the occipital condyle is a challenging approach requiring comprehensive knowledge and understanding of the anatomical aspects for preoperative treatment planning.

The study results showed a significant difference was seen for the distance between the basion and anterior tip of the occipital condyle with 11.45±1.76 distance on the left side and 10.53±2.2 mm distance on the right side and a p-value of 0.0001. These results were comparable to the study of Naderi S et al[8] in 2005 where authors reported the distance between the basion and anterior tip of the occipital condyle to be 11.1 mm and 10.5 mm respectively on the left and right side. Also, the study by Ahmad A et al[11] in 2006 reported this distance to be 11.3 mm and 11.1 mm on the left and right side respectively.

It was seen that the distance between the basion and posterior tip of the occipital condyle on the left side was 27.87±4.2 mm and on the right side was 26.93±3.19. The distance was statistically non-significant with p=0.011. These findings were in agreement with the results of Ahmad A et al[11] in 2006 where authors reported the distance to be 27.98 mm and 27.38 mm on the left and right sides respectively. However, the results were contradictory to the study of Naderi S et al[8] in

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2005 where the distance was reported to be 28.1 mm and 27.5 mm on the left and right sides respectively.

In the present study, the distance between the Opisthion and the anterior tip of the occipital condyle was 39.07±3.2 mm on the left side and 38.99±3.46 mm on the right side. The difference was statistically non-significant with p=0.75. These measurements were comparable to the study of Naderi S et al[8] in 2005 where the distance was reported to be 39.1 mm and 38.9 mm respectively on the left and right side by the authors.

The study results showed that the distance between the Opisthion and the posterior tip of the occipital condyle on the left side was 26.96±2.46 mm which was significantly lower compared to the right side where it was 27.83±2.46 mm with a p-value of 0.0008. These results were similar to the studies of Naderi S et al[8] in 2005 where authors reported the distance to be 26.2 mm and 26.7 mm respectively on the left and right sides. These results were in contrast with the study by Bozguba M et al[12] in 1999 where the distance was 24.7mm and 24.3 mm on the left and right sides respectively.

CONCLUSION

Considering its limitations, the present study concludes that assessing these parameters will help in the interpretation of neurologic surgical procedures and surgical planning for procedures involving the skull. Also, these parameters are vital during lateral and posterior approaches in the craniovertebral junction by Orthopedicians and neurosurgeons. The surgical resection of occipital condyles needs comprehensive knowledge of these anatomic landmarks for preoperative planning.

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TABLES

Variable	Left	Right	p-value
Distance between Opisthion and posterior tip of occipital condyle	26.96±2.46	27.83±2.46	0.0008
Distance between Opisthion and anterior tip of occipital condyle	39.07±3.2	38.99±3.46	0.75
Distance between the basion and posterior tip of occipital condyle	27.87±4.2	26.93±3.19	0.011
Distance between the basion and anterior tip of occipital condyle	11.45±1.76	10.53±2.2	0.0001

Table 1: Comparison of the left side and right side of the variables of occipital condyle

Variable	Side	Present study	Rathva A	Ozer MA	Avci	Ahmad F	Naderi S	Bozbugaetal M
Distance between Opisthion and posterior tip of occipital condyle	Left	26.96	26.1	30.0	27.1	27.94	26.2	24.7
	Right	27.83	26.5	29.0	26.6	27.87	26.7	24.3
Distance between Opisthion and anterior tip of occipital condyle	Left	39.07	34.1	39.7	-	40.1	39.1	-
	Right	38.99	35.9	41.4	-	39.9	38.9	-
Distance between the basion and posterior tip of occipital condyle	Left	27.87	27.1	29.5	-	29.97	28.1	-
	Right	26.93	28.5	29.4	-	27.38	27.5	-
Distance between the basion and anterior tip of occipital condyle	Left	11.45	11.0	10.0	10.0	11.3	11.1	13.7
	Right	10.53	10.1	12.6	9.9	11.1	10.5	14.4

Table 2: Comparison of the present study results to other previous studies