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Original Research Article

Morphometrical analysis of occipital condyle in dry human skull and its clinical significance

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ABSTRACT: Background: *The human occipital condyle is a unique bony structure connecting the cranium and vertebral column. Craniovertebral surgeries require knowledge of anatomical aspect of craniovertebral junction.*
Aim: *The aim of this study is to analyze the occipital condyle morphometrically in dry human skull and its clinical importance.*
Material and methods: *In the present study 80 dry human skulls were studied in the Department of Anatomy, Patna Medical College Patna, Bihar, India, with unknown age & sex. The parameters like length, width, height, anterior and posterior inter condylar distances were recorded using digital Vernier callipers. The shape of the Occipital condyle was observed and recorded. Distance between anterior tip and basion(DAT-B), Distance between posterior tip and basion(DPT-B), Distance between anterior tip and opisthion(DAT-O), Distancebetweenposteriortipandopisthion (DPT-O) and Locationofhypoglossalcanalinrelationwith OC were observed and recorded.*
Results: *The mean length, breadth and height of occipital condyle were found to be 1.95±0.34, 1.29±0.26, 0.60±0.19on the right sideand 2.20±0.36 cm, 1.35±0.31 and 0.60±0.16cmon the left side respectively.Themeananteriorintercondylardistance and posterior intercondylar distance were measured as 1.93±0.31and 3.71±0.37 cm, respectively. Variations of occipital condyle shapes were kidney like (31.25%), S-like(23.75%),triangular(17.50%), rhomboid (7.5%),oval (11.25%), eight like (7.5%) and bipartite condyles(1.25%).The p value was >0.01.The hypoglossal canal was present related to anterior 1⁄3 of the occipital condyles in 72.50% case. In 1 of the skull occipital condyles of both the sides were having double articular facets and one bony tuberclesattheanteriormarginoftheforamen magnum. Articular facet number 2 was roughly oval in shape measuring 2.1 cmon the right side and 2.3 cm on the left side and articular facet number 2 was round in shape.*
Conclusion: *It can be concluded that careful radiological analysis of occipital condyles is required before craniovertebral junction surgery to prevent injury to structure passing through foramen magnum.*
KEYWORDS: *Occipital condyles, Morphometry, Transcondylar approach, condylectomy*

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I. INTRODUCTION

The occipital condyle is an important part of the craniovertebral junction and the articulation between the occiput and atlas. 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.[1]The stability of this craniovertebral junction depends largely on the morphometric data of the occipital condyles.[2]The OC partly cover the fringe of the foramen magnum anteriorly and form an articulation with the superior articular facets on the lateral masses of the atlas inferiorly. Each OC which is oval in outline and oriented obliquely is traversed by hypoglossal canal. A condylar fossa is situated just posterior to the OC and can contain a posterior condylar canal for an emissary vein from the sigmoid sinus. Laterally, the occipital bone connects with the petrous part of the temporal bone anteriorly and the mastoid process posteriorly.[3]Occipital plates are commonly used as the cephalad fixation point in these constructs but issues such as the need for multiple points of fixation within a limited area, limited surface area for grafting and potential for intracranial injuries have led to investigations for alternatives.[4] There are many kinds of pathological processes that involve the cranio vertebral junction. These lesions include intradural tumours such as meningiomas, neurinomas or vascular lesions such as aneurysms and arteriovenous malformations of the vertebral artery and vertebrobasilar junction, extradural tumours such as

chordomas, basilar invagination and other congenital anomalies, nontraumatic (rheumatoid) and traumatic entities with C1 — C2 subluxation.[5] The distance between anatomic landmarks and the sites where a number of vital structures have their entrance or exit are very important for clinical application, therefore the assessment of morhometry of occipital condyles and foramen magnum is helpful for lateral surgical approach for reaching lesion in the middle and posterior part of cranial base. Space occupying lesions like tumours anterior to the spinal cord at the level of foramen magnum can be surgically reached using a ventralordorsal approach.The ventral approach has a lot of difficulties and a high rate of morbidity thus dorsal and lateral trans-condylar approach becomes important which requires partial or complete resection of the occipital condyles.[6-8]Knowledge of dimensions of occipital condyles and it 's relation with neighbouring foramen is important for the neurosurgeons operating in thisregion. So the study of morphometric analysis of occipital condyles in dries human skull and its clinical importance in this region.

II. MATERIAL AND METHODS

In the present study 80 dry human skulls were studied in the Department of Anatomy, Patna Medical College Patna, Bihar, India, from 18 month , with unknown age & sex.

Methodology

The skulls with any pathological growth in the region of occipital condyles like osteophytes or fusion with vertebrae were excluded. The parameters like length, width, height, anterior and posterior inter condylar distances were recorded using digital Vernier callipers. The shape of the Occipital condyle was observed and recorded. Distance between anterior tip and basion (DAT-B),Distance between posterior tip and basion(DPT-B),Distance between anterior tip and opisthion(DAT-O),Distance between posteri or tipandopisthi on (DPT-O) and Location of hypoglossal canalinrelation with OC were observed and recorded.

III. STATISTICAL ANALYSIS

The recorded data was compiled entered in a spreadsheet computer program (Microsoft Excel 2010) and then exported to data editor page of SPSS version 20 (SPSS Inc., Chicago, Illinois, USA). Descriptive statistics included computation of percentages, means and standard deviations were calculated.

IV. RESULTS

The mean length, breadth and height of occipital condyle were found to be 1.95±0.34, 1.29±0.26,0.60±0.19on the right sideand2.20±0.36 cm, 1.35±0.31 and 0.60±0.16cmon the left side respectively (Table No.1).Themeananteriorintercondylardistance and posterior intercondylar distance were measured as 1.93±0.31and 3.71±0.37cm, respectively. Variations of occipital condyle shapes were kidney like (31.25%), S-like(23.75%),triangular(17.50%), rhomboid (7.5%),oval (11.25%), eight like (7.5%) and bipartite condyles(1.25%)(TableNo.2).The p value was >0.01.The hypoglossal canal was present related to anterior 1/3 of the occipital condyles in 72.50% case. In 1 of the skull occipital condyles of both the sides were having double articular facets and onebony tuberclesattheanteriormarginoftheforamen magnum. Articular facet number 2 was roughly oval in shape measuring 2.1 cmon the right side and 2.3 cm on the left side and articular facet number 2 was round in shape. This was an unusual finding we observed duringthestudy.Themovementattheatlanto- occipital joint may be effected due topresence of double articularfacet.

Table 1: Dimensions of the Occipital Condyles (OC).

Parameters		Range (Min-Max) (cm)	Mean (cm)	SD
Length	Right	1.3-2.5	1.95	0.34
	Left	1.7-3.0	2.20	0.36
	Mean	1.3-3.0		
Breadth	Right	0.7-1.6	1.29	0.26
	Left	0.9-1.7	1.35	0.31
	Mean	0.7-1.7		
Height	Right	0.5-1.1	0.60	0.19
	Left	0.3-0.9	0.60	0.16
	Mean	0.5-1.1		
Anterior intercondylar distance		1.3-3.1	1.91	0.33

Posterior intercondylar distance		3.1-4.6	3.68	0.32
Distance between anterior end &basion	Right	0.4-1.1	0.97	0.20
	Left	0.5-1.1	0.98	0.18
	Mean	0.4-1.1		
Distance between anterior end &opisthion	Right	3.5-4.3	3.78	0.26
	Left	3.4-4.6	3.86	0.37
	Mean	3.5-4.6		
Distance between posteriorend andbasion	Right	2.1-2.8	2.52	0.31
	Left	2.1-Mar	2.63	0.25
	Mean	2.1-Mar		
Distance between posterior end and opisthion	Right	2.3-3.5	2.77	0.29
	Left	2.4-3.1	2.72	0.20
	Mean	2.4-3.5		

Table 2: Shapes of Occipital Condyles (OC)

Shape of OC	Number	Percentage
Oval	9	11.25%
Kidney shaped	25	31.25%
S Shaped	19	23.75%
Triangle	14	17.5%
Rhomboid	6	7.5%
8 like	6	7.5%
Bipartite(withdoublefacets)	1	1.25%

Table 3: location of hypoglossal canal with relation to Occipital Condyles (OC)

Location of hypoglossal canal	Number=80	Percentage
Anterior 1/3 of OC	58	72.50%
Middle 1/3 of OC	22	27.5%
Posterior 1/3 of OC	-	-

V. DISCUSSION

Craniovertebral regions are predisposed to an arrayofpathologieslikefractures,dislocations, benign diseases and malignancy. This area is difficult to approach as there are many important structures present around the occipital condyles.Inadequateknowledgeofanatomyof this area can result in potential complications. Treatment of fractures, dislocations, tumours and malignancy involves surgery. Different approaches have been described such astransfacetalapproach,transcondylarapproach, extreme-lateral transjugular approach and the transtubercular approach.[9-12]some of these surgeries require partial or complete resection of the occipital condyles. The morphometry of the occipital condyles are different in different populations. The variations in the morphometry of the occipital condyles can be attributed to the genetic constitution of the various populations.Thiswill also help in comparison of dimensions of the occipitalcondyleswithotherpopulations.[9]The recent treatment modalities of trauma and tumourssuchasmeningiomas,neurofibromaof this region involves a transcondylar approach. This approach provides a wide surgical exposure and is better than the conventional techniques which are associated with high morbidity. It involves removal of occipital condylespartlyorcompletelyalongwithlateral mass of C1.During the condylar drilling care should be taken of hypoglossal nerve, jugular bulb and internal jugular vein.[10] Naderi et al.[10] classified the occipital condyles into three types. Type 1(Short) condyles with length less than 2cm; Type 2 (Moderate) condyles with length between 2cm to 2.6cm; Type 3(Long) condyles with length more than 2.6cm.The length of the occipital condyle (OC) in the present study is 2.2 cm which is comparable to the length measured by Le TV et al.[12]

intheAmericanpopulation.ThelengthofOCin the present study is less than the study conducted by SalihMA et al in Sudanese population.[13] Ozer MA et al[11] and Naderi etal[10]reportedlengthoftheOCtobemorein the Turkish population than the Indian population. Breadth of the OC in the presentstudy(1.31cm)wascomparabletothe Sudanesepopulation(1.3cm).[13]Itwaslessinthe American[12]andthe Turkishpopulation[10]Heightof the OC in the present study was less (0.61cm) whencomparedto the American (0.99cm)and the Turkish population (0.92). Accurate dimen- sionofoccipitalcondy lesisrequiredduringthe operative interventions in this area.Operative procedures such as transcondylar approach, lateral transjugularapproachrequires resection of the condyles. Resection of the condyles depend upon the length, breadthand height of the condyles. If the condyles are long widespread resection can be done but if the condyles are short widespread resection can resultininstabilityofatlanto-occipitaljoint.[9,10]If the condyles are wider resection becomes more difficult. During occipitocervicalscrew placement is more successful if the height of the occipital condyles are more.[9,14]Also knowledgeregardingtheanteriorandposteriorintercondylar distance is required for the successfulscrewplacementduringoccipitocervicalfixation.Thedistancebetweenanteriorend and basion (AOCB) and opisthion (AOCO) were lessbutthedistancebetweenposteriorendand basion(POCB) andopisthion (POCO)werecomparable to the study done by Naderi etal.A study on south Indian skulls by Kalthur et al[15]observedthelength,breadthandheightof the occipital condyles as 2.2 cm, 1.1cm and 0.9 cm. Breadth of the occipital condyles in the present study was more whereas the height of the condyles was less. The AICD and PICDwere noted to be 1.91 cm and 3.68 cm. The AOCB and AOCOwaslessinthepresentstudy. Figureof8shapewasmostcommonlynoted in Kalthuretal[15]study.Inthepresentstudythemost commonobservedshape of theoccipitalcondyle waskidneyshaped (31.25%) ,S-like(23.75%),triangular(17.50%), rhomboid (7.5%),oval (11.25%), eight like (7.5%) and bipartite condyles(1.25%).The p value was >0.01.The hypoglossal canal was present related to anterior 1/3 of the occipital condyles in 72.50% case.In the present study 1 occipital condylewith double articular facet and 1small bony tuberclesweremotedtobepresentonboththe side. Articular facet 2 was oval in shape with length2.1cmonrightsideand2.3cmonleftside whereas articular facet 2 was round .Thesurfacewasnotedtobesmoothwith no linear bony elevations. Similar case was reported by Srijit Das et al.[16] but the surface of the condyles were rough and an incomplete groove was also noted. The antero-posterior diameter and transverse diameter were differentonrightandleftside.Suchfindingscan result in occipitocervicalinstability. These finding may be due to developmental anomalies. The occipital bone ossifies from 8 centres: one for the basilar part, one for each condylar part,fourforthesquamouspartandoneforthe posteriormarginoftheforamenmagnum.Each condylar part starts ossification in cartilage in the8thweekofintra-uterinelife.Thefusionbetweenthecondylarpartandthesquamousparts takes place at the end of two years. Within six years condylar part fuses with basilar part.[17] [Presence of extra ossification centres and any deviation in the fusion of these parts may attribute to above observed presence of two articularfacets in theoccipitalcondyleswithtwobony tubercles at the anterior margin of the foramen magnum.In humans the neural arch of the proatlasdivides into anterior and posterior segments. The anterior segment forms the occipital condyles while the posterior segment forms a part of the rostral facets on the atlasvertebrae.[18]

VI. CONCLUSION

It can be concluded that careful radiological analysis of occipital condyles is required before craniovertebral junction surgery to prevent injury to structure passing through foramen magnum.

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