

MORPHOMETRIC ANALYSIS OF THE OCCIPITAL CONDYLES AND THEIR CORRELATION WITH HYPOGLOSSAL CANAL IN DRY SKULLS OF SOUTH INDIANS

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ABSTRACT

Background: Morphometric analysis of the occipital condyles is essential for craniocervical junction surgeries. There are no studies done yet on correlation of hypoglossal canal and occipital condyle, therefore the present study is carried out to find differences of parameters of OC in different races and to find out the correlation of various parameters of occipital condyle with orifices of hypoglossal canal.

Method: The size, shape and anterior, posterior inter condylar distances of occipital condyles and the locations of the extracranial and intracranial orifices of the 108 hypoglossal canal were studied in 55 dry skulls.

Result: The Mean length, height, width were 21.64 ± 2.97 , 11.06 ± 2.2 , 6.15 ± 1.44 respectively. Anterior, posterior inter condylar distances mean were ranged between 13.30-32.93 and 21.46–46.77 respectively and most common shape of occipital condyles was oval. Location of hypoglossal canal extra cranially was 3, whereas intra cranially it was 4 for both right and left sides. There was strong correlation between length of occipital condyle and width but the same was not with location of hypoglossal canal.

Conclusion: The measurements of occipital condyles were found to have some similarities and some dissimilarities among different races. These differences could be useful for anthropometric analysis and forensic sciences studies. Significant correlation was found between length and width, width and height, height and length. However no correlation could be found between various parameters of occipital condyle and orifices of hypoglossal canal.

KEY WORDS: Occipital Condyles, craniocervical, hypoglossal canal, occipital condyle.

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INTRODUCTION

Occipital condyles are large two protuberances at the base of skull and form important joint between skulls and vertebral column as Atlanto-occipital joint. This region mainly contains medulla oblongata, spinomedullary junction, upper cervical part of spinal cord, multiple cranial nerves, and many important blood and lymphatic vessels that supply the head and neck [1]. In addition to that, it contains the only articulation between skull and vertebrae i.e atlanto occipital joint. The occipital condyles are an oval bony outline that are arranged obliquely in such a way that the ventral end is more medial than its dorsal end, and presenting a convex anteroposterior surface [2,3]. Hypoglossal canal lie lateral to the base of the occipital condyles, immediately superior to condyles, transmits hypoglossal nerve. In some cases, the occipital condyles may project significantly towards the foramen magnum [4]. The canal of the hypoglossal nerve is located obliquely at the anterolateral margin of this foramen [5], transmits hypoglossal nerve, meningeal branch of ascending pharyngeal artery and emissary vein from basilar venous plexus.

It is important to understand the anatomical variations in craniovertebral junction, to carry out surgery in that region. The lateral approach during the surgery requires resection of the occipital condyles for the lesions anterior to the occipital condyles [6], for that trans-condylar approach is being increasingly used for their surgical treatment [7]. The Hypoglossal Canal is the area of skull involved in pathological conditions like fractures, congenital defects and neoplasms of occipital bone is commonly ignored [7]. For pre-planning of transcondylar approach an adequate knowledge of HC, its relation to condyles is essential to prevent damage of nerves and vascular structures related to it.

Studies have been done before on morphometry of occipital condyles but correlation of various measurements of occipital condyle with hypoglossal canal is rarely done.

Aim and objectives

The objective of this study is,

1. To find out bilateral and racial differences in morphometry of occipital condyles and to correlate with existing data.
2. To find out any existences of correlations between Hypoglossal canal location and various measurements of occipital condyles

METHODS

In the present study 55 dry human skulls were studied in the Department of Anatomy, East Point College of Medical Sciences & Research Centre, Bangalore with unknown age & sex. 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. The HC was observed for its Intra-cranial & Extra cranial locations. All the data was recorded on to MS excel and data was analysed using SPSS16 version, paired t-test was used to analyse the significance between the length, width and height of OC with that of its sides (right and left respectively). Correlation co-efficient was found out between measurements of OC with zone of location of hypoglossal canal.



Fig. 1: Measuring with Vernier Calliper.



Fig. 2: Oval shaped

Fig. 3: Kidney shaped



Fig. 4: S shaped (left side)



Fig. 5: 8 shaped



Fig. 6: Two portioned



Fig. 7: Triangular



Fig. 8: Deformed



RESULTS

Table 1: Means, standard deviation and the range of dimensions of the occipital condyles.

Parameter	N	Minimum	Maximum	Mean Std. Deviation
Occipital condyle Length (right)	55	15.1	34.33	21.79±0.09
Occipital condyle Length (left)	55	14.6	31.37	21.48±0.87
Occipital condyle Width (right)	55	6.58	19.85	11.03±2.22
Occipital condyle Width (left)	55	6.96	21.52	11.01±2.34
Occipital condyle Height (right)	55	2.63	10.88	6.18±1.31
Occipital condyle Height (left)	55	2.34	12	6.09±1.36
Anterior Intercondylar Distance	55	13.3	32.93	19.41±3.99
Posterior Intercondylar Distance	55	21.46	46.77	37.36±4.03
Total length (Right + Left)	110	14.6	34.33	2.97
Total Width (Right + Left)	110	6.58	21.52	11.06
Total Height (Right + Left)	110	2.34	12	6.15

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed)

The average anteroposterior length, width and height of occipital condyle and anterior and posterior intercondylar distances are summarised in table no 1. Mean of length, width and height found to be 21.64±2.97, 11.06±2.2, 6.15±1.44 respectively. Right and left sided values are summarised in table no 1. There were no significant differences found on right and left sides. Anterior and posterior inter condylar distances mean were ranged between 13.30-32.93 and 21.46– 46.77 respectively. Various measurements of occipital condyles are

tabulated in Table no 2, showing Pearson's correlation coefficient of asymmetry of condyles.

Table 2: Showing comparison between length, width and height on the right and left sides of the occipital condyles.

Left and right asymmetry	N	Correlations	Sig.
Occipital condyle Length	55	.802**	0
Occipital condyle Width	55	.857**	0
Occipital condyle Height	55	.823**	0

There was strongly positive correlation between length and width of occipital condyle (0.392), positive correlation between width and length (0.392) also. There were also positive correlations between occipital condyle length and height (0.232), width and height (0.214), height and length (0.232) and between height and width (0.214). There was no significant correlation between any of this measurement of occipital condyle with location of hypoglossal canal. Detail of this data were tabulated in Table no3.

Table 3: Correlations Between Length, Width, Height, Location of H canal EC and IC

	Length	Width	Height	EC	IC
Occipital condyle Length	1	.392**	.232*	0.175	0.098
Occipital condyle Width	.392**	1	.214*	-0.112	-0.152
Occipital condyle Height	.232*	.214*	1	0.017	0.098

** . Correlation is significant at the 0.01 level (2tailed).

* . Correlation is significant at the 0.05 level (2-tailed).

Table 4: Different shapes of occipital condyles.

Types	Total %
Oval	40.9
Kidney shaped	29.91
S like	15.45
8 like	7.27
Traingle	1.81
Ring	0.9
2 Portional	0.9
Deformed	3.63

The shape of occipital condyles was classified into eight, they are as follows—type 1: oval shape, type 2: kidney shape, type 3: S shape, type 4: eight shape, type 5: triangle shape, type 6: ring shape, type 7: two-portioned and type 8: deformed. The prevalence of shape of occipital condyle is given in table no 4. The dominant type of occipital condyle was oval shape 40.9%, 2 portioned and ring shaped being rarest.

Fig. 9: Location of orifices of hypoglossal canal extra and intra cranially.

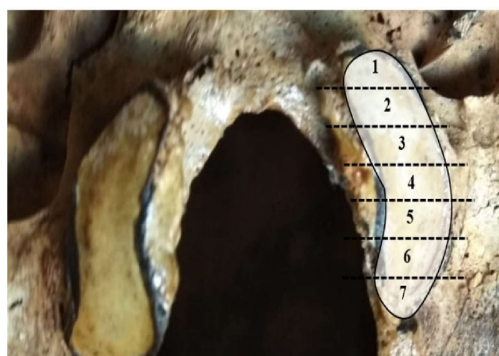


Table 5: Localisation of hypoglossal canal.

Location 1	Anterior one-fourth of occipital condyle
Location 2	The junction of first and second one-fourth of occipital condyle
Location 3	Second one-fourth of occipital condyle
Location 4	The junction of second and third one-fourth of occipital condyle
Location 5	Third one-fourth of occipital condyle
Location 6	The junction of third and fourth one-fourth of occipital condyle
Location 7	Fourth one-fourth of occipital condyle

In order to locate the hypoglossal canal orifice extracranially and intracranially, in objective and reproductive manner, the largest AP axis of the condyle was measured and divided into four equal portions. The location of the extracranial and intracranial orifice of hypoglossal canal was determined with regards to its position in any particular part as mentioned and shown in table no 5 and Fig no:9. Result is summarised in Table no 6. Most common location of hypoglossal canal opening extracranially was 3 on both side while as most common location was 4 for intracranially on both sides.

Table 6: The location of extracranial and intracranial orifices of hypoglossal canal.

Location	Extra Cranial Orifice		Intra Cranial Orifice	
	Right%	Left%	Right%	Left%
1	7.4	14.81	1.85	5.55
2	37	25.92	5.55	1.85
3	53.7	51.85	12.96	22.22
4	1.85	5.55	44.4	42.59
5	0	1.85	33.3	24.07
6	0	0	1.85	3.7
7	0	0	0	0

DISCUSSION

Cranio-vertebral lesions are surgically dealt with one of types of lateral approaches which include trans-condylar, trans-tubercular and trans-jugular approaches. Morphological assessment of occipital condyles would become extremely essential for these approaches as resection of occipital condyle is necessary in such procedures. Since extra cranial and intra cranial orifices of hypoglossal canal are located in lateral and medial limits of occipital condyle, such surgical approaches mandate the knowledge of hypoglossal canal orifices.

In the present study the mean length, width and height of occipital condyles were found to be 21.64, 11.06 and 6.15 respectively. Data found by various researchers have been shown in table no 7. Length and width of occipital condyle are

Table 7: Data of morphometry of occipital condyle in different studies.

	Naderi et al [6]	Bayat et al [8]	Shima & Islam [9]	Oliver [10]	Anil et al [11]	Present study
Population	Turkish	Iranian	Egypt	American	North Indian	South Indian
Length	23.6	19.35	22.9	23.7	24.4	21.64
Width	10.5	9.31	14.8	11.5	13.54	10.06
Height	9.2	7.27	-	8	8.98	6.15
AICD*	21.6	15.39	18.97	-	17.67	19.41
PICD**	41.6	35.6	38.39	-	42.02	37.36

*AICD – Anterior intercondylar distance **PICD – Posterior intercondylar distance

the major factors for partial/complete condylectomy procedures. Lengthier and wider occipital condyles may require more extensive resection and shorter condyles resection may cause more occipito-cervical instability. The mean anterior intercondylar distance and posterior intercondylar distance were found to be 19.41 and 37.36 which is lesser than Turkish and north Indian population studies but very similar to study done on Egyptian population. There was strong correlation between occipital condyle length and width which was similar to study done on Turkish population done by Naderi et al. There was significant correlation between width and height and between height and length of occipital condyle also and these findings were not observed in their study. Such correlation help surgeon to decide whether condylectomy will be free from constraint or not.

Table 8: Various data on occipital condyles shape.

Population	authors	Morphological types
Turkish	Naderi et al [6]	59.67% -Oval
Egypt	Fetou h [13]	22%-Kidney shaped
Indian	Kavitha et al [2]	30.7%-Oval shaped
Indian	Sinha et al [14]	25% S shaped
Iranian	Bayat et al [8]	34.4%-Kidney shaped
Greek	Nastis et al [15]	30.7%-S shape
Brazilian	Aragao et al [16]	19.8%- 8 shaped
South Indian	Present study	40.9%-Oval shaped

Table no 8 shows prevalence of morphological types of occipital condyles by various authors. Studies done by Naderi et al, Ozer et al, Kavitha et al and our study show highest prevalence of oval shaped occipital condyles while as rarest type was 2 portioned in our study and in Naderi et al. These data suggest that although some anthropometrical differences occur in the dimensions of occipital condyles and these differences would be overlapped in racial subgroups. Therefore, some similarities also occur in different racial subgroups.

This wide range reflects the asymmetry in the orientation, length and shape of occipital condyles and may affect the lateral approach. According to recent studies [2] condylectomy provides the wider angle of exposure. Wider inter condylar distances seem to provide more advantage for reaching foramen magnum without damaging the vital structures. The larger the distance, the free the corridor for posterolateral approaches.

The location of the extracranial and intracranial orifice of hypoglossal canal is also an important anatomical factor. Extracranial orifice is located lateral to occipital condyle and intracranial orifice is located medial to occipital condyle.

Identification of the location of the extracranial and intracranial orifices of the hypoglossal canal is an essential step of lateral approaches for occipital condylectomy. The extracranial orifice of hypoglossal canal was found at location 3 on both side in our study i.e. 2nd one fourth of occipital condyle. Our study is dissimilar to Naderi et al [6], who reported that in more than 90% of specimens EC orifice was located at 1 and 2 location, i.e., in the first one-fourth or at the junction of the first and second quarter of the hypoglossal canal. Naderi et al [6] reported that the intracranial orifice of the hypoglossal canal located in location 4, i.e. at the junction of second and. third quarter of the hypoglossal canal, in other words at middle half of occipital condyle, our study is similar to this study. Whereas Wen [12] reported in the middle one-third of occipital condyle,

We also found no correlation between occipital condyle length, height, width and location of hypoglossal canal which suggest location of HC is independent of any of the parameters of

condyle. The location of intracranial and extracranial orifices of the hypoglossal canal is mandatory in surgeries where condylectomy is required. Too dorsally located intracranial orifice of the hypoglossal canal may complicate and limit the condylectomy procedure. To avoid hypoglossal nerve injury the location of the hypoglossal canal should be determined in preoperative imaging stage. Furthermore, the direction and the location of the extracranial orifice of the hypoglossal canal should be also detected.

While observing the occipital condyles we also found duplication of hypoglossal canal in 12.27% of skulls, 10.99% unilaterally, only one skull (1.81%) showed bilateral duplication. This observation was also found by Fathima et al [17], they found similar incidence of 13.63%, unilateral 7.27% and bilateral being 6.36%. Duplication of hypoglossal canal may cause compression of hypoglossal nerve leading to paralysis of tongue muscles thereby affect the speech too.

Fig. 11: Duplication of Hypoglossal Canal (Intra Cranial).

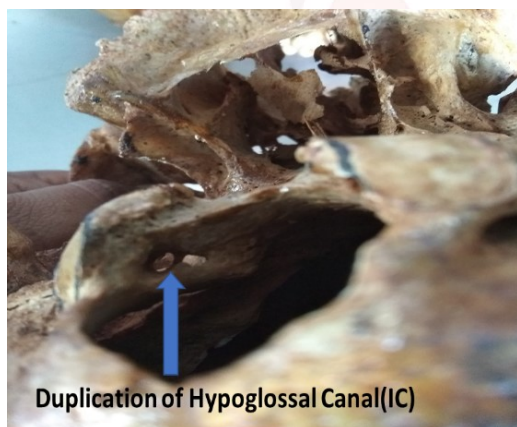
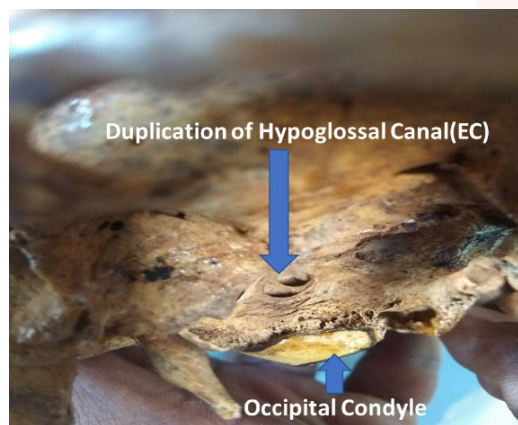


Fig. 12: Duplication of Hypoglossal Canal (Extra Cranial).



The results of this study are in line with the results of other studies focusing on cranio-

vertebral junction anatomy and particularly on occipital condyle anatomy. These results confirm the variability in almost all measured occipitalcondyle parameters, including length, width, height, anterior and posterior inter condylar distances, shape of occipital condyles and location of hypoglossal canal orifices. This variability seems to be due to the use of occipital condyles of each age and gender as material.

CONCLUSION

In the present study there is significant correlation between length and width, width and height and height and length. These correlation are important for prior planning of cranio vertebral surgeries involving complete/partial condylectomy procedures with lateral or posterior approach. Most common shape of occipital condyle we found was oval shape. Hypoglossal canal opening was in position 3 and position 4 extra cranially and intra cranially respectively. No correlation between location of hypoglossal canal and any of the parameters of occipital condyle. The results of the length, height, width, anterior, posterior inter condylar distances and shape of occipital condyles confirm that there are variations in all parameters which is due to usage of right sided and left sided occipital condyles as study material. The measurements of occipital condyles were found to have some similarities and some dissimilarities among different races. These differences could be useful for anthropometric analysis and forensic sciences studies. Limitation of this study is non inclusion of age and gender of the study samples.

Conflicts of Interests: None

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