

## Occipital condyles and its relation with hypoglossal canal: Anatomical study in central Indian population

Naresh Thanduri<sup>1</sup>, Neha Rai<sup>2,\*</sup>, Sheema Nair<sup>3</sup>, Vishal Bankwar<sup>4</sup>

<sup>1</sup>Assistant Professor, <sup>2</sup>Associate Professor, <sup>3,4</sup>Professor, <sup>1,2,3</sup>Dept. of Anatomy, <sup>4</sup>Dept. of Community Medicine, LN Medical College and Hospital, Bhopal, Madhya Pradesh, India

**\*Corresponding Author:**

Email: drneharai@gmail.com

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### Abstract

**Introduction:** For transcondylar approach, most relevant step during surgical process is the resection of OC. Also it is important to have knowledge about its relevant anatomy and its relation with hypoglossal canal. This helps to avoid any iatrogenic injury during craniovertebral surgeries.

**Aims:** The present study helps us to understand the morphological and morphometric data of occipital condyles and its relation with hypoglossal canal and its importance in transcondylar approach.

**Materials and Methods:** The study was performed on 85 adult human dry skulls of unknown age and sex, obtained from Dept. of Anatomy, LNMC & JK hospital, Bhopal, India. Manual vernier calliper was used for the measurement. The length of the OC was measured. Also its shape was noted. In addition to all this, the different location of hypoglossal canal in relation to OC were assessed.

**Statistical Analysis:** Mean and standard deviation of the parameters were analysed. Comparison was made of left and right side using unpaired t test and p value was calculated.

Percentage of location of hypoglossal canal was calculated in relation with occipital condyles.

**Results:** The mean of the length of occipital condyle on right side were found to be 21.24 mm and on left side 20.71 mm. The most common shape was quadrilateral type. The most common location of intracranial orifice of hypoglossal canal was located at location 4 and extracranial orifice was detected at location 3.

**Conclusion:** All these parameters will be useful for performing various transcondylar surgical approaches and for reaching lesions in middle and posterior part of cranial base.

**Keywords:** Occipital condyles, Hypoglossal canal, Transcondylar approach, Morphometry.

### Introduction

The posterior part of human skull is formed mainly by occipital bone. Adjoining the foramen magnum the occipital condyles are present. The occipital condyles are the distinctive bony structure linking the skull and vertebral column.<sup>1</sup> The superior articular facets of the atlas articulates with the occipital condyles to form atlanto occipital joint. The occipital condyles are oval in shape and placed in an oblique manner so that its anterior end lies closer to the midline than its posterior end.<sup>2</sup> Occipital condyles represent the cranial aspect of craniovertebral joint. The hypoglossal canal is directed anterolaterally and present above the occipital condyles at its junction of anterior 1/3 and posterior 2/3. It transmits the hypoglossal nerve, meningeal branch of ascending pharyngeal artery and emissary vein connecting basilar plexus to internal jugular vein. This venous plexus is highly important as it serves as major sources of venous drainage through posterior cranial fossa.

Extradural and intradural tumours are frequently seen in cranial base near foramen magnum and it poses a challenge to surgeons due to its deeper location. As the ventral approach is dangerous and has a high rate of

morbidity the dorsal approach is mostly preferred at the CVJ.<sup>5,6</sup>

In modern era with advanced technology, transcondylar approach (TCA) has gained popularity which enables shorter and more direct route to anterior part of pontomedullary junction with minimal brainstem retraction. The key point of this surgery includes drilling of posterior part of OC which threatens opening of HC.<sup>7</sup> The extent of bony removal for optional exposure is unclear ranging from suboccipital craniotomy to total OC removal.<sup>8-10</sup>

The position of HC in relation to OC is very significantly for neurosurgeons. Very scanty information was available the shape of OC, its length and its relation with the HC in central Indian population. Hence, aim of present study was to analyse the shape of OC, its length and portion of HC in respect to the OC in central Indian population.

### Materials and Methods

In the present study, 85 adult human dry skulls of unknown age and sex were obtained from the Dept of Anatomy, LN Medical College and Research centre. Dry skulls those were in good condition were included

in the study. Deformed, damaged and pathological skull were excluded from the study. Manual vernier calliper was used for the measurement.

#### Morphometric study:

A single following parameter was measured of 170 occipital condyles (i.e right and left side):

**Length of the condyles:** Largest antero-posterior distance between anterior and posterior tips of occipital condyles.

The parameters were measured by using manual vernier calliper. The measurements were repeatedly taken to ensure the accuracy. All the measurements were taken in mm.

The data were statistically analysed and tested for significance between the right and left sides.

**Table 1: Locations of the hypoglossal canal orifice relative to the occipital condyle**

Location	Position of the orifice relative to occipital condyle
Location 1	1st one-fourth of occipital condyle
Location 2	Junction of the 1st and 2nd one-fourth of occipital condyle.
Location 3	2 <sup>nd</sup> one – fourth of occipital condyle
Location 4	Junction of 2 <sup>nd</sup> and 3 <sup>rd</sup> one fourth of occipital condyle
Location 5	3 <sup>rd</sup> one – fourth of occipital condyle
Location 6	Junction of 3 <sup>rd</sup> and 4 <sup>th</sup> one fourth of occipital condyle
Location 7	4 <sup>th</sup> one – fourth of occipital condyle

#### Statistical Analysis

Unpaired t test results: The two tailed P value equal 0.6006. By conventional criteria, this difference is considered to be not statistically significant. Confidence Interval – Mean of left and right side is 0.53. 95% Confidence interval of this difference from 1.51 to 2.57.

#### Results

170 occipital condyles of 85 adult human dry skull were used for this study.

**Morphometric study:** The results obtained from the present morphological study is tabulated in TABLE 2. Mean length of the occipital condyle were found to be 21.24 mm on right and 20.71 mm on left side. The range of length was 16 – 26 mm on right side while it was 15 – 27 mm on left side P value is 0.6006, this difference is considered to be not statistically significant.

**Table 2: Comparison of Right and Left side of occipital condylar parameters**

S. No	Parameter	Right			Left			P value	Significance
		Mean	SD	Range (mm)	Mean	SD	Range		
1	Length of occipital condyles	21.24	2.82	16- 26	20.71	3.02	15-27	0.60	Not significant

**Morphological Study:** In the present study occipital condyles were classified according to their shapes in 8 different types as shown TABLE 3. The percentage of each was calculated and comparison was made between right and left. The most common type was found to be quadrilateral type which is 23.52% in central Indian population. The most unusual type was kidney type i.e 8.8 % and Ring like was absent. When the right and the left occipital condyles of the same skull were compared, then the most common type on right side (23.5%) was quadrilateral and on left side it (29.4%) was triangular.

**Table 3: The rate of different shapes of the occipital condyles**

Type	Right	Left	Total
1 Kidney shaped	11.7%	5.8%	8.8%
2. S- like	17%	11.2%	14.5%
3.Oval	17%	5.8%	11.7%
4.Two portioned	17%	11.7%	14.7%
5. 8 –Shaped	11.7%	11.7%	11.76%
6. Ring like	0.0%	0.0%	0.0%
7. Triangular	0.0%	29.4%	14.7%
8. Quadrilateral	23.5%	23.5%	23.52%

In this study, the location of the intracranial and extracranial orifices of the hypoglossal canal in relation to the occipital condyles are tabulated in a Table 4 & 5 respectively.

It was found that the intracranial orifice of hypoglossal canal was found to present from location 2 to location 4. Out of which, most common location was found to be location 4 having 52.94 % followed by location 3 having 47.05% in central Indian population. Location 2 has an extremely low percentage i.e 2.9%.The intracranial orifice was not obtained in location 1, 5, 6 and 7.

**Table 4: The location of intracranial orifices of hypoglossal canal relative to the occipital condyle**

Location	Intracranial orifice				
	Right		Left		Total
	Number	%	Number	%	%
Location 1	0.0	0.0	0.0	0.0	0.0
Location 2	1	5.8	0.0	0.0	2.9
Location 3	11	64.7	5	29.4	47.05
Location 4	6	35.29	12	70.58	52.94
Location 5	0.0	0.0	0.0	0.0	0.0
Location 6	0.0	0.0	0.0	0.0	0.0
Location 7	0.0	0.0	0.0	0.0	0.0

While, extracranial orifice of hypoglossal canal was found to present from location 1 to location 4. Out of which, most common location was location 3 having 35.29% followed by location 2 having 32.35% in central Indian population. Location 1 has 26.4% and least percentage is of location 4. The extracranial orifice was not found at location 5, 6 and 7.

**Table 5: The location of extracranial orifices of hypoglossal canal relative to the occipital condyle**

Location	Extracranial orifice				
	Right		Left		Total
	Number	%	Number	%	%
Location1	2	11.76	7	41.17	26.4
Location2	4	23.52	7	41.17	32.35
Location3	11	67.7	1	5.8	35.29
Location4	0.0	0.0	2	11.76	5.8
Location5	0.0	0.0	0.0	0.0	0.0
Location6	0.0	0.0	0.0	0.0	0.0
Location7	0.0	0.0	0.0	0.0	0.0



Fig. 1: "Triangle type" occipital condyles

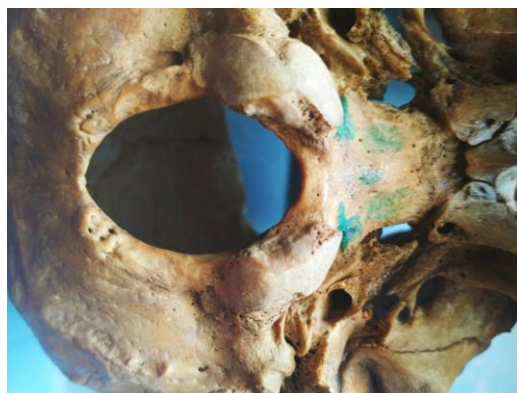


Fig 2: 8 type of Occipital condyles

## Discussion

Variations of craniovertebral junctions are of interest not only to the anatomist but also to the clinicians because of various surgical approaches, like transcondylar, partial transcondylar approach, occipital condyle resection (partial / complete ) used for posterior cranial fossa lesions.<sup>11,12</sup>

The length of occipital condyles is an important surgical issue. The results of partial condylectomy in short type are different from results obtained in long type occipital condyles. In case of shorter occipital condyles removal of > 2/3 part can lead to craniocervical instability.<sup>13</sup> Various studies were done on length of occipital condyles. Length of occipital condyles was found to be larger in left side in studies of S. Kavita et. al, Aric et al, Archana K. Tale but length of occipital condyles was larger in right side at Diva mahajan et al, Mustafa bozuga et al, Naderi et al.<sup>1</sup> In the present study also length of right occipital condyle was found to be larger than left i.e 21.24 > 20.34 mm. The range of occipital condyle length on right side was (16 –26 mm) and on the left side (15 – 27 mm) which was in accordance with the studies of Saliya et al.<sup>14</sup>

Table: 6 Comparison between other studies

Parameter		S.Kavitha et al (19) (2013)	Divya Mahajan et al (20) (2011)	Mustafa Bozbuga et al (21) (1999)	Avic et al(22) (2011)	Naderi et al(1) (2005)	Anil Kumar et al (23) (2014)	Bayat P et al (24) (2014)	Present study
Length of OC	R	21.97	22.61	23.1	23.7	23.6	-	21.83	21.24
	L	22.34	22.36	22.9	24	23.2	-	22.19	20.71

Oc = occipital condyle, R = right, L = left

The shape of occipital condyles decides the amount of condylectomy. Triangular, deformed and kidney type of occipital condyle requires a more extensive condylar resection. The nail resection becomes more easy in oval type of occipital condyle as compared to triangular, ring

like and two positioned type of occipital condyle.<sup>15</sup> In our study on central Indian population overall most common type of occipital condyle was quadrilateral type (23.52%), and on right side also quadrilateral type dominated by (23.5%) as compared to other types. But on the left side triangular shape was predominated

found (29.4%). In contrast to our study Naderi et al (2005) found the most common shape of occipital condyle to be oval in greek population. Natsis et al (2013) in his study on greek population found oval type of occipital condyle right side (8.6%) and on left side (6.5%). Kalthur et al also noted oval type was the most common shape but with a frequency less than North Indian population.<sup>12</sup> These finding suggests that North Indian and Greeks are at less risk of condylectomy as compared to Central Indian population due to triangular and quadrangular shape of occipital condyles are more prone to risks of condylectomy.<sup>16</sup>

The location of extracranial and intracranial openings of hypoglossal canal affects the lateral approaches to the cranialvertebral junction. This measurement gives an indication about the maximum amount of resectable condyle without entering the hypoglossal canal.<sup>17</sup> In the present study the intracranial opening was found to be located on location 3 >> 4 in right side while on left side location 4>>3 was more commonly found. The overall location was 4>> 3>> 2. The location 1, 5, 6, 7 were not encountered where as Naderi et al reported intracranial opening in location 4 in more than 55 %.<sup>1</sup> Fetout FA et al in his study on Arab population found intracranial opening in 4 and 5 location with a total percentage of 65 %.<sup>9</sup>

In present study extracranial opening of hypoglossal canal was found maximum on 3<sup>rd</sup> location on right side whereas it was found to be on 1 and 2<sup>rd</sup> location on left. Overall the predominant location of extracranial opening of hypoglossal canal was 3>>2>>1>>4. In accordance to our study on left side portion of extracranial opening of hypoglossal canal Naderie et al also found more than 90% location as 1 and 2.<sup>1</sup> Fetout FA et al found extracranial opening of hypoglossal canal mainly in 2 and 3 locations with total % of 69 % which was in accordance with our right side condylar study.<sup>18</sup>

## Conclusion

The present study on central Indian population showed that:

1. The length of occipital condyle on right side was (16 – 26 mm) while on the left side (15 – 27 mm) with mean on right side (21 .24) and left side (20.71).
2. The overall shape of occipital condyle showed following trend as quadrilateral > triangular = S shaped = 2 positioned > oval = 8 shaped > kidney shaped.
3. The overall position of hypoglossal canal intracranially was location 4>>3>>2 while extracranially 3>>2>>1>>4.

The above parameters will be useful for performing various transcondylar surgical neurosurgeon approaches and for reaching lesions in middle and posterior part of cranial base.

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