STUDY OF VARIATIONS OF OCCIPITAL CONDYLES

Manoj Borkute¹, Kunhambu Shyamkishore²

¹Assistant Professor, Department of Anatomy, Seth G. S. Medical College and KEM Hospital, Parel, Mumbai.
²Additional Professor, Department of Anatomy, Seth G. S. Medical College and KEM Hospital, Parel, Mumbai.

ABSTRACT

BACKGROUND OF STUDY
Occipital bone is major contributor to the variations involving craniovertebral junction. Variations involving occipital condyle are important from clinical as well as surgical point of view.

METHODS
105 dry adult human skulls were studied for variation of occipital condyles.

RESULT
During this study, 3 skulls (2.86%) showing different grades of atlanto-occipital fusion, 2 skulls (1.90%) showing duplication of occipital condyles and 1 skull (0.95%) showing median occipital condyle are found.

CONCLUSION
Several medical disciplines are involved in treatment of craniovertebral junction anomalies such as orthopaedics, neurology, ENT, radiology, neurosurgery and skull base surgery. It is important that clinicians from each of these disciplines have a thorough understanding of the region; more so, the neurosurgeons performing far lateral transcondylar approach should be more familiar with the anatomy and variations of this region.

KEYWORDS
Occipital Condyle, Craniovertebral Junction Anomalies, Transcondylar Approach.


INTRODUCTION
Each occipital condyle is oval in outline and is oriented obliquely so that its anterior end lies nearer the midline. It is markedly convex anteroposteriorly, less so transversely.¹ Occipital condyles represent cranial portion of craniovertebral junction. Abnormalities of craniovertebral junction, are of interest not only to anatomist, but also to the clinicians because many of these deformities produce clinical symptoms.² There are several developmental variations in the region of the craniovertebral junction, many of which can resemble deformities. Some variations are minor anatomic abnormalities, but they can cause severe diagnostic problems. A reliable and exact radiologic diagnosis requires knowledge of the morphologic features of the variations and the appearance of their characteristic features in the common radiologic procedures.³ Far lateral transcondylar approaches require extensive dissection of the paravertebral muscles and vessels, in particular, the vertebral artery and removal of bony structures such as the Occipital Condyle (OC) and Jugular Tubercle (JT). These manoeuvres may result in injury to the vascular structures (vertebral artery, jugular vein and bulb) and to the lower cranial nerves and result in craniovertebral instability due to removal of the OC. Hence, neurosurgeons performing this surgery should be more familiar with the anatomy and variations of this region.⁴ Though occasional case reports of individual variations have been reported. There are very few studies regarding these variations. Embryological basis of these variations are usually not mentioned.

MATERIALS AND METHODS
Material for this study consisted of 105 dry human skulls. Material was obtained from two teaching institutes in the state of Maharashtra. Nothing is known about antecedents regarding community, caste, social status, etc., of the specimens. Owing to the difficulty in accurate sexing of skull, no such attempt was made. It is not unlikely that significant proportion of female skulls may have been included in this study. These skulls were studied for the presence of variations of occipital condyles. Where possible, variations found were measured in millimetres with the help of divider and scale calibrated in millimetres.

RESULTS
The Following Variations Were Found During Study
A. 3 skulls showing atlanto-occipital fusion.
B. 2 skulls showing duplication of occipital condyles.
C. 1 skull showing median (third) occipital condyle.

<table>
<thead>
<tr>
<th>Variation</th>
<th>Total Cases</th>
<th>Number of Cases</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atlanto-Occipital Fusion</td>
<td>105</td>
<td>3</td>
<td>2.86</td>
</tr>
<tr>
<td>Duplication of Condyles</td>
<td>105</td>
<td>2</td>
<td>1.90</td>
</tr>
<tr>
<td>Median (third) Occipital Condyle</td>
<td>105</td>
<td>1</td>
<td>0.95</td>
</tr>
</tbody>
</table>
A. Three Skulls Showing Atlanto-Occipital Fusion
i. Skull one is showing fusion of lateral mass of atlas on both sides. Anterior arch is separate from the occiput. Posterior arch is broken, so no comment can be made. (Fig. 1a).
ii. Skull two shows fusion of right half of anterior arch of atlas. Posterior arch is incomplete on the right side. Left half of posterior arch is completely present, which is not fused with the occiput. Lateral mass shows complete fusion on right side while on the left it shows incomplete fusion. So, it can be said that this skull is showing atlanto-occipital fusion predominantly on right side. (Fig. 1b).
iii. Skull three shows fusion of lateral mass on both sides. Anterior arch shows fusion in the midline. Posterior arch is showing fusion on right side. Presence of spina bifida could not be ascertained because the posterior arch was broken. (Fig. 1c).

B. Two Skulls Showing Duplication of Occipital Condyles
i. Skull one shows bilateral duplication of occipital condyles with following measurements. (Fig. 2a)
   - **Right Side**
     - Anterior condyle 13 mm x 11 mm
     - Posterior condyle 8 mm x 10 mm
   - **Left Side**
     - Anterior condyle 13 mm x 11 mm
     - Posterior condyle 8 mm x 10 mm

ii. Skull two shows unilateral duplication of occipital condyle on right side only with following measurements. (Fig. 2b)
   - **Right Side**
     - Anterior condyle 20 mm x 14 mm
     - Posterior condyle 6 mm x 6 mm
   - **Left Side Condyle**
     - 25 mm x 16 mm

C. One Skull Showing Median (Third) Occipital Condyle.
   (Fig. 3)
In this skull, median or third occipital condyle is seen along the anterior margin of foramen magnum. In addition, this skull shows incomplete duplication of occipital condyle on the left side with medial half of the left occipital condyle separated by groove.
   - Right side condyle - 23 mm x 12 mm
   - Left side condyle - 25 mm x 13 mm
   - Median (third) condyle - 05 mm x 06 mm
DISCUSSION
The numerous variants of the craniovertebral junction can be understood only if the regional embryonic development of the region is precisely known. The craniovertebral junction of vertebrates is an embryologically unstable region. The junction moves caudally with advancing evolution and reaches its lowest position in mammals. Since, this is an unstable region, developmental variations occur around this junction.

The evolutionary processes that result in the formation of both the base of the skull and the cervical spine are of particularly outstanding importance. First, segmented vertebral material is included in the base of the skull to form the “spondylocranium” or “spinal skull segment.” Second, material from the vertebral segments is reduced, displaced in a caudal direction and added to the upper cervical vertebrae. The latter process is especially important for the proatlas, whose corpus forms the tip of the dens axis called the Ossiculum terminale Bergmann. The corpus of the atlas forms the axis of the dens and the base of the dens. These two processes provide a basis for understanding the variants of the craniovertebral junction. If too much material is included in the base of the skull, occipitalization of the atlas will result. If the amount is too small, especially the material coming from the proatlas, manifestation of the occipital vertebra will result.

atlanto-occipital fusion
In some lower vertebrates (e.g., reptiles) the cranial half of the first cervical sclerotome remains as a separate bone, the proatlas, between the occiput and atlas vertebra. In man, it becomes assimilated into the occipital condyles and also forms the tip of the dens. The caudal half of first cervical sclerotome gives rise to the lateral masses and the anterior and posterior arches of atlas vertebra. The body of atlas vertebra disappears early giving rise to all, but the tip of the dens. The body, posterior arch and transverse process of axis vertebra is derived from second cervical sclerotome. If the normal segmentation fails to occur, atlanto-occipital fusion will result.

In the present study, three cases of atlanto-occipital fusion showing different grades of fusion were found.

duplication of occipital condyles
The occipital bone develops from the fusion of at least four primitive somites. The caudal portion of the fourth occipital somite fuses with the cranial portion of the first cervical somite to form the proatlas. The proatlas gives rise to the exoccipital bone and participates in the formation of the occipital condyle and the tip of the odontoid process. Malformation may produce defect in occipital condyles. Dissociated occipital condyles are called as a proatlas.

In present study, one case of unilateral and one case of bilateral duplication of occipital condyles were found.

median or third occipital condyle
The median or third occipital condyle (condylus tertius) was first described by JF Meckel in 1815. It is a bony process in the median line located at the front rim of the occipital foramen magnum. It is always present in reptiles. It may be either a tightly attached or an isolated bone element, or it may be articulated with the tip of the dens axis or with the anterior Atlantooccipital arch. It can be regarded as a rare variation in humans.

The condylus tertius is the medial residue of the hypochordal arch. In this variant, the lateral parts vanish, but the medial part persists.

The variations of the anatomic appearances of the median (third) condyle can be explained by the different degrees of persistence. An isolated, articulated condylus tertius, located in the median-sagittal plane and the anterior margin of the foramen occipitale magnum represents the highest degree of persistence.

The condylus tertius is of interest to the surgeon because it may result in a three-legged mechanism of head bearing, which can cause serious restrictions of head movement and even a bone derived torticollis.

CONCLUSION
The craniovertebral junction of vertebrates is an embryologically unstable region. Occipital bone is major contributor to the variations involving craniovertebral junction. In the present study, atlanto-occipital fusion was
found in 2.86% (3 skulls), duplication of occipital condyles in 1.90% (2 skulls), median (third) occipital condyle was found in 0.95% (1 skull). Many of these deformities produce clinical symptoms. Several medical disciplines must be included in treatment such as orthopaedics, neurology, ENT, radiology, neurosurgery and skull base surgery. It is important that clinicians from each of these disciplines have a thorough understanding of the region.

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REFERENCES