Partial occipitalization of atlas

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Introduction
The atlas, the first cervical vertebra, supports the head. It is unique in that it fails to incorporate a centrum, whose expected position is occupied by the dens, a cranial protuberance from the axis. So it is ring shaped vertebra, without a body. The atlas consists of two lateral masses connected by a short anterior and a longer posterior arch. The transverse ligament retains the dens against the anterior arch forming a pivot type of synovial joint. The posterior arch is grooved by the third part of the vertebral artery and first cervical nerve [1].

The movements permitted in this joint are:
- Flexion and extension in the frontal plane/transverse axis, which give rise to the ordinary forward and backward nodding of the head.
- Slight lateral motion, lateral-flexion, to one or other side in the sagittal plane/anteroposterior axis.

Flexion is produced mainly by the action of the rectus capitis anterior, longus capitis; and extension by the splenius capitis, rectus capitis posterior major and minor, obliquus superior, semispinalis capitis, splenius capitis, sternocleidomastoid, and upper fibers of trapezius. The rectus capitis lateralis are concerned in the lateral movement, assisted by the trapezius, splenius capitis, semispinalis capitis, and the sternocleidomastoides of the same side, all acting together [2].

Case Report
During the routine osteology demonstration class for undergraduate medical students, a partial fusion of the atlas vertebra with the base of the occipital bone was seen. Sex and age of the skull assessed by craniofacial morphology expressed the evidently female character of the skull, which also had a prominent frontal bossing, with a very high arch palate.

The atlas vertebra was almost completely fused with the occipital bone at the base of the skull, except at the transverse processes on both sides. The lateral masses had fused completely with the occipital condyles.

Anterior arch of the atlas was fused with the anterior margin of the foramen magnum on right side, leaving a single anterior midline (1.1 cm) gap between the anterior tubercle and the basi-occiput, which continued up to the beginning of left inferior articular facet. A small circular facet of approximately 7-8 mm in diameter, located on the posterior surface of the anterior arch in the midline for articulation with the odontoid process of the axis vertebra was seen.

Almost the whole of the right segment of posterior arch which extended 2 cm from right inferior articular facet was synostosed with the posterior rim of the foramen magnum leaving a deficit of 0.4 mm between it and the left posterior arch. A separate foramen found on right side possibly for transmission of vertebral artery and first cervical nerve.

Abstract
Congenital bony fusion of the atlas vertebra to the base of the occipital bone of the skull is one of the common osseous anomalies of the craniovertebral junction commonly described as assimilation of the atlas. It is also known as occipitalization of atlas and atlanto-occipital fusion.

In our study there is partial fusion of the incomplete bony ring of the atlas to the base of occipital bone. Important findings include difference in circumference of foramen magnum and vertebral foramen producing narrowing of foramen magnum, total fusion of lateral masses, anterior and posterior arches partially fused on left side, completely fused on right side, a separate foramen found on right side possibly for transmission of vertebral artery and first cervical nerve, asymmetry in size of inferior articular facets.

The aim of this paper is to present an anatomical variant of fused atlas with the occipital bone discussing similar cases described in literature.


Key words [assimilation] [Atlas vertebra] [occipital bone] [foramen magnum] [fusion] [occipitalization]
The left segment posterior arch extended 2.6 cm from left inferior articular facet leaving a deficit of 0.4 mm between it and the right posterior arch. The left segment was not fused with the posterior margin of foramen magnum throughout the length.

The hypoglossal canals were present on both sides. There was a 1.2 cm slit between the anterior arch of atlas and the basilar part of the occipital bone on the left side possibly due to incomplete fusion.

**Inferior articular facets**

There was asymmetry in size of inferior articular facets as shown in Table 1.

<table>
<thead>
<tr>
<th>Side</th>
<th>Shape</th>
<th>Maximum transverse dimension</th>
<th>Maximum vertical dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right</td>
<td>Rectangular</td>
<td>1.7 cm</td>
<td>1.2 cm</td>
</tr>
<tr>
<td>Left</td>
<td>Nearly oval</td>
<td>1.5 cm</td>
<td>1.6 cm</td>
</tr>
</tbody>
</table>

The lateral masses were completely fused with the condylar parts of the occipital bone, as well as being symmetrical on the two sides.

On both sides, the transverse processes were directed downwards and laterally. On the right side, the costotransverse bar was missing (broken), causing an incomplete foramen transversarium. The transverse processes were not fused with the occipital bone or paracondylar processes. The left foramen transversarium was larger than right the one.

Foramen magnum had irregular margins and shape. Anteriorly, the margin of the foramen magnum was not overlapped by the inferior articular facets of the fused atlas. Posteriorly, the rim of the foramen magnum was encroached by the partially fused posterior arch due to the oblique union of the atlas. Because of this invasion by a portion of the occipitalized atlas, the functional size of the foramen magnum was reduced.

Difference in dimensions of vertebral canal of atlas vertebra and foramen magnum was also noteworthy (Table 2). The vertebral foramen of atlas was much smaller than the foramen magnum of skull, which might have compressed the spinal cord or brainstem. No part of the axis vertebra was fused with the atlas (Figures 1, 2, 3, 4).

**Table 2. Dimensions of vertebral foramen of atlas vertebra and foramen magnum.**

<table>
<thead>
<tr>
<th>Bone</th>
<th>Maximum transverse dimension</th>
<th>Maximum vertical dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atlas</td>
<td>2.5 cm</td>
<td>2.8 cm</td>
</tr>
<tr>
<td>Foramen magnum of skull</td>
<td>3.0 cm</td>
<td>3.1 cm</td>
</tr>
</tbody>
</table>
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Discussion

Occipitalization of the atlas may be incidentally detected at autopsies or during routine cadaveric dissections or in dry skulls in osteology classes. The fusion of the atlas with occipital bone may result in the compression of vertebral artery and first cervical nerve. Occipitalization of the atlas (atlanto-occipital fusion) is the congenital osseous variation found in the craniovertebral junction. This condition is caused by assimilation of the first cervical vertebra (the atlas) to the basicranium [3, 4]. The atlas is normally formed by three primary ossification centres: one for each neural arch and one for the body. Failure of segmentation of the basal occipital sclerotome and first spinal sclerotome lead to osseous fusion between the atlas and the occipital bone [5, 6]. Occipitalization of the atlas may be associated with developmental variations of the first and second branchial arch. This variation may be accompanied by: maldevelopment of the occipital bone, reduced length of the clivus, non-formation or inadequate formation of the occipitoaxial joint, dislocation of atlantoaxial joints, and platybasia [7, 8].

The ventral portion of the sclerotome surrounds the notochord and provides the form, which develops into the vertebral body. The dorsal portion surrounds the neural tube and provides the form, which develops into the posterior vertebral arch. The caudal half of each sclerotome combines with the rostral half of the sclerotome below it. The rostral half of the first cervical sclerotome combines with the caudal half of the last occipital sclerotome to form the base of the skull, while the caudal half of the first cervical sclerotome combines with the rostral half of the second cervical sclerotome to form the first cervical vertebra, the pattern continues in this fashion to form the other vertebrae [9]. In a small number of cases, the disruption of this merging process may result in atlanto-occipital assimilation. This condition may be partial or complete; the complete fusion of the atlas is more common than the incomplete [10].

Conclusion

The presented case is of incomplete fusion of atlanto-occipital joint which is less common. Atlanto-occipital fusion reduces the foramen magnum dimension which may lead to neurological complications due to compression of spinal cord and other nerves.
References


