



# Atlanto-occipital fusion and other variations at the base of the skull: a case report

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## Abstract

Fusion of the atlas with the occipital bone is called assimilation or occipitalization of atlas. Either partial or complete assimilation can alter the course of vertebral artery, compression of vertebral artery and first cervical nerve, compression of spinal cord by reducing the diameter of foramen magnum. We found a skull with partial fusion of the atlas vertebra with occipital condyles and other variations in the norma basalis. Other variations include change in the size of the jugular foramen, hypoglossal canal, distance between the transverse process of atlas and styloid process, massive mastoid process on right side. The knowledge of such a fusion and variations at the base of skull is important for radiologists, anesthesiologists, orthopedic and neurosurgeons because skeletal abnormalities at the craniocervical junction may result in sudden unexpected death.

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**Key words** [atlas] [assimilation] [occipitalization] [occipital bone]

## Introduction

Atlas is one of the atypical cervical vertebrae, since it does not have a body or spine. It has two lateral masses connected by a short anterior arch and a long posterior arch. The superior articular facet articulates with occipital condyles to form the atlanto-occipital joint. Inferior articular facet articulates with the superior facet of axis to form the lateral atlanto-axial joint. Facet on the posterior surface of anterior arch articulates with dens of axis to form median atlanto-axial joint. The anterior and posterior arches of the atlas are connected to the anterior and posterior margins of foramen magnum by anterior atlanto-occipital membrane and posterior atlanto-occipital membrane, respectively.

Assimilation or occipitalization of atlas is one of the commonest variations at craniocervical junction. Partial fusion is rare compared to complete assimilation of atlas [1]. Usually it gets noticed only during radiological finding, surgery or autopsy, in cadavers during dissection or in dry skull. Patients with atlanto-occipital fusion may present with headache, pain in the neck, abnormal neck posture, reduced neck movements, dizziness, syncope, dysphagia and dysarthria [2]. The neurological symptoms and signs of atlanto-occipital fusion cannot be distinguished from that of the Arnold Chiari malformation [3].

## Case Report

During the routine osteology demonstration class for undergraduate students, we noticed a partial fusion of atlas vertebra with occipital bone of an adult male skull. The observations made were:

- Both lateral masses of atlas vertebra were fused with the occipital condyles completely (Figure 1).
- Anterior arch was free from anterior margin of foramen magnum (Figure 2).
- Posterior arch was fused with posterior margin of foramen magnum, except for a large osseous foramen on the right side, and small perforations on the left side. They were blind perforations since they were not opening inside into the cranial cavity (Figures 3, 4).
- Foramen transversarium were normal.
- The tip of the left transverse process was fused with jugular process of the occipital bone leaving a gap between the costo-transverse bar of atlas and jugular process of occipital bone.
- Size of the jugular foramen was reduced on left side compared to the right side.
- Left hypoglossal canal was slightly bigger than the right.
- The shape of the foramen magnum was altered (sagittal diameter: 3 cm; transverse diameter: 2.45 cm). Transverse

diameter was reduced because of tubercle protruding into foramen magnum from the medial side of the left lateral mass of the atlas.

- Distance between the styloid process and tip of the transverse process was reduced on left side (right side: 1.5 cm; left side: 1.0 cm) (Figure 5).
- Mastoid process was more bulky on right side compared to left side.
- Sockets for the third molar teeth were totally absent.

### Discussion

Assimilation of atlas is a congenital bony variation at the craniocervical junction. Atlas develops from first cervical sclerotome. During development the first cervical sclerotome divides into rostral half and caudal half. The rostral half combines with the most caudal occipital sclerotome to form the basilar part of occipital bone. The caudal half of first cervical sclerotome combines with rostral half of second cervical sclerotome to form the atlas [4]. Failure of segmentation of the first cervical sclerotome results in assimilation of atlas.

Spinal cord compression will not occur unless the diameter of foramen magnum is less than 18 mm [5]. But reduced diameter of foramen magnum might compress the vertebral vessels and first cervical nerve, which may result in dizziness, syncope



**Figure 1.** Norma basalis showing fusion of atlas vertebra with occipital condyles.



**Figure 2.** White arrow showing the gap between the anterior arch of atlas and anterior margin of foramen magnum.



**Figure 3.** White arrow showing blind perforations between the posterior arch and foramen magnum on the left side.

and neurological symptoms. But the signs and symptoms usually occur after second decade of life [6].

Fusion of atlanto-occipital joints can also result in restricted neck movement. Patients with cervical movement disorders can develop spondylotic changes with atlanto-axial instability due to greater shearing forces and bending movement of cervical vertebrae [7].



**Figure 4.** Needle showing the osseous foramen between the posterior arch and foramen magnum on the right side.

Transverse process of atlas is an important landmark for head and neck surgeons. The main neurovascular bundle of neck lies just anterior to it. Fusion of transverse process can result in misguiding in reaching the neurovascular bundle during surgeries [8].

The gap between the left costo-transverse bar of the transverse process of atlas and jugular process of occipital bone probably transmitted the left vertebral artery and first cervical nerve C1 [9]. Wang et al., classified four different pathways of the vertebral artery to enter the cranial cavity in case of atlanto-occipital fusion. In the present case, right vertebral artery probably entered the cranial cavity through the osseous foramen between the posterior arch of atlas and posterior margin of foramen magnum (Type III). Left vertebral artery probably entered cranial cavity either below the posterior arch of atlas running below the fused lateral mass (Type I) or below the posterior arch of atlas running posterior to the fused lateral mass (Type II) [10].

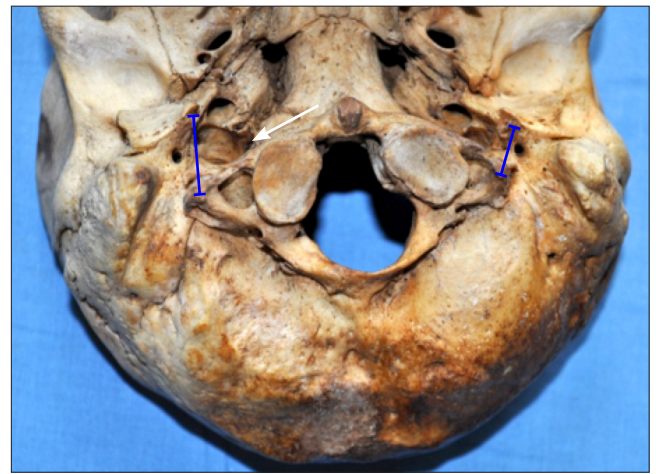
Knowledge of such a fusion is important for radiologists, anesthesiologists, orthopedic and neurosurgeons because skeletal abnormalities at the craniocervical junction may result in sudden unexpected death [11].

### Conclusion

The case report is of partial fusion of atlas with occipital condyles which is rare compared to total fusion of atlas with occipital bone. This may reduce the diameter of foramen magnum and lead to vascular and neurological complications due to compression of vertebral arteries and first cervical nerve.

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**Figure 5.** White arrow showing larger jugular foramen on right side and blue lines indicates the distance between the styloid process and transverse process of atlas and stylomastoid foramen next to the lines.

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