STUDY OF ATLANTO-AXIAL FUSION- [C1 AND C2 VERTEBRAL SYNOSTOSIS] AMONG 200 ATLAS VERTEBRAE

Rekha B. S¹, Tanveer Ahamed Khan H. S²

¹Associate Professor, Department of Anatomy, Shivamogga Institute of Medical Sciences.

²Assistant Professor, Department of Anatomy, Shivamogga Institute of Medical Sciences.

ABSTRACT: Skeletal abnormalities of cervical region or in craniocervical region are of interest to the anatomists, orthopaedicians, neurologists, neurosurgeons and even orthodontists. These abnormalities may result in severe neck pain, decreased neck mobility, muscular weakness of both upper limbs, sensory deficits of arms and hands etc. It was observed that the atlas vertebra is fused with the second cervical vertebrae. It was observed that the dens or odontoid process is separated from centrum of axis and fused to anterior arch of atlas, laminae of the axis were free and pedicles of C2 were completely fused on both sides. The features of these fused cervical vertebrae were analyzed and the specimen was photographed from different aspects.

KEYWORDS: Atlas, Axis, Odontoid Proces, Fusion, Vertebralsynostosis, Cervical Vertebrae.

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INTRODUCTION: Cervical vertebrae are seven in number. C3-6 are typical whereas C1 (Atlas), C2 (Axis) and C7 (Cervical prominens) are atypical. Atlas vertebra is a ring of bone consists of two lateral masses connected by a short anterior and posterior arch. It is unique in that it fails to incorporate a centrum. C2 vertebrae are different from other by the presence of Dens (Odontoid process), which projects cranially from the superior surface of the body. The axis acts as an axle for rotation of atlas and head around the dens.¹

Vertebrae and intervertebral disc are one of the main manifestations of body segmentation or metamerism. The bodies of vertebrae, thus formed by metamerism can be fused partially or completely, such a fusion of vertebral bodies is called vertebralsynostosis or spinal fusion or block vertebra. The aetiology of this variation can be congenital or surgical or traumatic.² Congenital anomalies at craniovertebral or cervical region are common. (Roma 1981).³ Congenital fusion of cervical vertebrae, Klippel-Feil Syndrome is a relatively common malformation. However fusion between atlas and axis is not so frequent.

Dwight in 1901 figured and briefly mentioned an undoubted specimen of complete atlanto-axial fusion, it was not until Elliot Smith in 1907-9 described what must be regarded as the classical case that the correct nature and interpretation of this most interesting vertebral variation was finally established. In this paper attention is drawn to one such a variation.

Cave 1930.^[4] has described 3 types of atlanto-axial congenital fusion:

1. Fusion of separated odontoid process with anterior atlantal arch.

2. Complete or bilateral fusion of atlas and axis with or without the attempted assimilation of the first vertebra by second.
3. Incomplete or unilateral fusion, one -half of the atlas retaining its independence with or without some degree of assimilation Thus here we are reporting a case of atlanto-axial fusion type 3.

MATERIALS AND METHODS: In 200 hundred atlas vertebrae collected mainly of South Indian origin one among these showed this type of variation.

RESULTS AND DISCUSSION: Atlas vertebra was fused to axis in such a way that odontoid process is deflected markedly backwards and to left uniting with facet at the anterior arch and its summit looks upwards and lying altogether above anterior arch of atlas and displaced from centrum of axis. Articular capsule and transverse ligaments were completely ossified. Lateral mass of atlas bearing superior articular surface with transverse foramen on either side were normal.

Anterior arch was fused to displaced odontoid process. Posterior arch with vertebral artery groove on either side were normal, but inferior aspect of the posterior arch of the atlas near the median plane was united with the superior surface of the spine of the axis and on either side is completely free for emergence of second cervical spinal nerve above the axis. Inferior articular surface of the atlas on the left side fused with left superior articular surface of the axis on its right side, but right inferior articular surface was fused with centrum and right pedicle of the axis on its anterior aspect, left pedicle united with odontoid process cephalic to it.

Axis -centrum fused to atlas on its superior aspect and inferior was normal. Transverse foramen in the transverse process was facing superolaterally on right but on left side due to fusion it is directed laterally and looking downwards. Right superior articular surface of the axis is fused with the inferior articular surface only on its posterior aspect, laminae inferior articular surface were normal.

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Corresponding Author:

Dr. Rekha B. S,

Department of Anatomy,

Shivamogga Institute of Medical Sciences.

E-mail: rekhasrangappa@gmail.com

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Embryological Significance: The development of the atlas and axis from the embryological stage to adult life differs from that of other vertebrae because the first two cervical bones are especially adapted to support the head and provide a wide range of head motion.⁵

Somites are formed from paraxial mesoderm that lies on each side of the neural tube. The somites are divided into three parts: Ventromedial sclerotome; Intermediate myotome; and Lateral dermatome.

The vertebral column is formed from the sclerotome of the somites. Normal segmentation of the sclerotomes is important for the development of a normal vertebral column. But in certain cases due to decreased local blood supply during the third to eighth week results in abnormal segmentation and formation of congenitally fused vertebrae or block vertebrae.^[6]

In a study of occipito cervical segmentation in human embryos (Muller and O. Rally) designated the 3 complete rostral centra which develop in the atlanto axial region. These three centra have been named as X Y and Z components. The apical X component at first projects into the early foramen magnum and forms an occipitoaxial joint. It has come to be known as the proatlas and constitutes the main portion of the odontoid process. Although it is commonly written that odontoid process develops from centrum of C1. Y component becomes the centrum of atlas, Z component becomes centrum of the axis.^[7] Failure of fusion of XY complex with Z at the dens synchondrosis or maintenance of transitory intervertebral disc at this point, produces an os odontoides thought to be induced by excessive movement at the time of ossification of dens.^[1]

Molecular Basis: Vertebral fusion anomalies are likely to be associated with the disturbance of Pax-1 and Pax-9 gene expression in developing vertebral column.

Morphology: There is a restoration of centrum of atlas.²

Clinical Significance: The aetiology is not only congenital other acquired fusion vertebrae is due to disease such as Tuberculosis, Juvenile rheumatoid arthritis and trauma.²

Patient may present with no symptoms, present with neck complaints, or transitory or permanent neurologic deficits or may die suddenly. Symptoms of cranial nerve irritation seldom occur, but symptoms of cerebral and brain stem ischemia is occasionally noted owing to compression of the vertebral arteries in the area of atlas.

C1, C2 arthodesis is the treatment for many congenital or acquired diseases leading to instability or subluxation of atlanto-axial joint, The occipito-atlanto –axial region is transition zone between the more standard vertebral design and the radically different skull. More free space present for

spinal cord is present here than elsewhere in the spine there by decreasing the risk of injury to vital medullary structures.

The occipital-atlantoaxial complex contains the most complex structures, which are unique and highly specialized the three units maintain structural stability and at the same time combine to allow sizable quantities of motion in flexion –extension, lateral rotation and especially axial rotation.

The major axial rotation in the region is between C1 and C2, which contributes to 40% to 50% of the axial rotation of the entire cervical spine and occiput.

It is generally accepted that there is a coupling pattern at the atlantoaxial joint. The axial rotation of c1 is associated with vertical translation. In 1858 Henke described it as a double –threaded screw joint. This coupling is probably due to the biconvex design of the C1 –C2 articulation negligible at C1 and C2, The instantaneous axes of rotation (IAR) for C1 C2 articulation are somewhere in the region of the middle third of the dens for flexion –extension and in the center of the dens for axial rotation. Lateral bending is negligible at C1 –C2 thus making IAR determination moot.⁷

CONCLUSION: Thus fusion atatlantoaxial joint limits all the movements by changing instantanius axes of rotation and results in more biomechanical stress in the adjoining segments leading to more degenerative changes. If these anomalies are diagnosed early, they will help us in finding the change due to an injury, ageing or progression of a degenerative process and also motivate the patient to change their lifestyles to lead a normal life.

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***Fig. 1: Showing the Inferior View
of Fused C1- C2 Vertebrae***

***Fig. 2: Showing the superior view
of the Fused C1-C2 vertebrae***