

## **A study of fusion of cervical vertebrae- C2 with C3**

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### **Abstract**

**Background:** Congenital anomalies are common in the vertebral column. In condition of fusion of the cervical vertebrae, two vertebrae appear not only structurally as one but also function as one. This fusion may be congenital or acquired. Vertebral fusion anomalies are likely to be associated with disturbance of Pax-1 gene expression in the developing vertebral column.

**Aims and Objectives:** The present study is to study the fused C2 with C3 vertebrae and its clinical importance.

**Materials and Methods:** The present study conducted on 75 dry adult human axis (C2) vertebrae of either sex in the Department of Anatomy, Vijayanagar Institute of Medical Sciences, Ballari, Karnataka, India. The fused C2 with C3 was found and carefully studied.

**Results:** In the present study the incidence of fused C2 with C3 is 1.33% (1 out of 75).

**Conclusion:** Fusion of C2 –C3 clinically important to rule out various syndromes; Klippel-feil syndrome, Crouzon's syndrome, which causes abnormalities of the neck movements with shortening of spine in the cervical region. Congenital Fused Congenital Vertebrae is one of the primary malformation of chorda dorsalis. Awareness of anomalies of cervical vertebrae is of great importance to anatomists, orthopaedicians, neurologists, neurosurgeons and even orthodontists. Also anaesthetists must be aware of these anomalies while doing endotracheal intubation, where extension of the neck is done.

**Keywords:** Anomaly, Axis, Cervical vertebra, Fusion

### **1. Introduction**

Cervical vertebrae are seven in number. The first (C1 -Atlas), Second (C2 -Axis) and Seventh (C7-Vertebrae Prominens) have special features considered as atypical cervical vertebrae whereas third, fourth, fifth and sixth (C3 to C6) are almost identical with general features and termed as typical cervical vertebrae. Axis vertebra is 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. The C3 vertebra is typical with the features similar to other cervical vertebrae [1]. Congenital anomalies are common in the vertebral column [2].

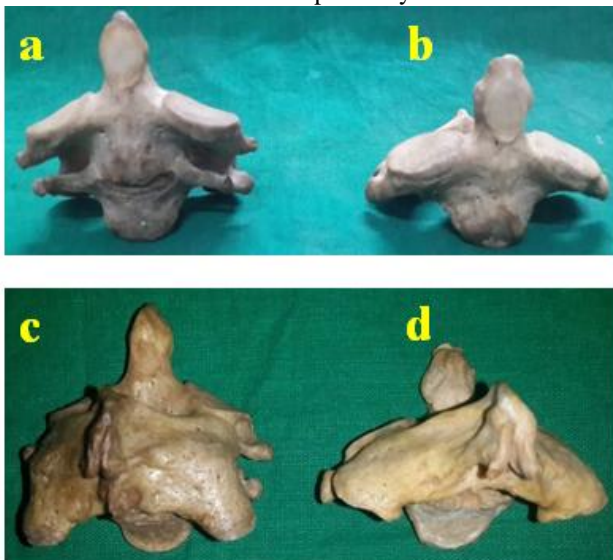
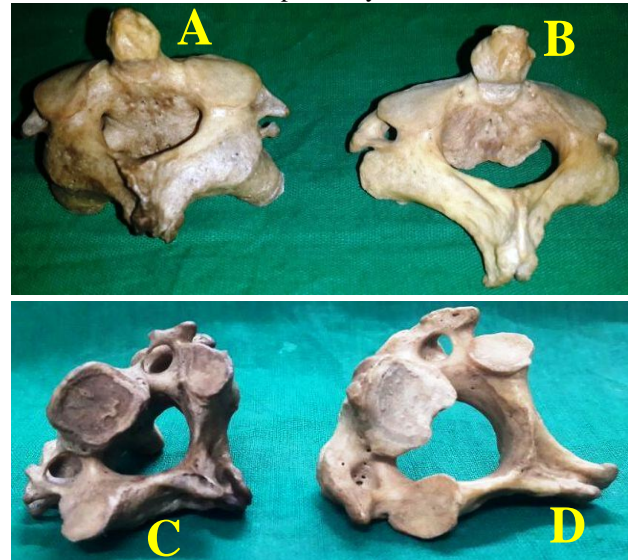
The fusion of cervical vertebrae, two vertebrae appear not only structurally as one but also function as one [3]. Fusion of cervical vertebrae may be congenital or acquired [4,5]. Congenital fusion of axis with the third cervical vertebrae limits the movements between these bones and because of this the third vertebrae was given the name as "vertebrae critica" by Cave [6]. This anomaly may be asymptomatic; however, it may also appear with manifestations of serious clinical features such as myelopathy

or may be associated with syndromes such as Klippel-feil[5,7,8] Crouzon's syndrome[9], limitation of the neck movement[10], or the muscular weakness, atrophy and neurological sensory loss[11]. Severe neck pain and sudden unexpected death may occur due to these abnormalities [12]. This anomaly has a clinical importance; thorough evaluation must be done by X-ray or Magnetic Resonance Imaging (MRI) for preventing any serious damage such as osteoarthritis by early diagnosis and treatment.

**1.1 Aims and objectives:** The aims and objectives of the present study is to study the Fused C2 with C3 vertebrae and its clinical importance.

### **2. Materials and Methods**

A total of 75 dried Human Adult axis (C2) vertebrae of either sex were carefully studied from the osteology lab in the Department of Anatomy, Vijayanagar Institute of Medical Sciences, Ballari, Karnataka, India. Among these 75 axis vertebrae we found only one axis (C2) vertebra fused with C3 (third cervical vertebra). The specimen was examined in detail.

**Figure 1: 75 Dried Human Adult (Axis) C2 vertebrae****Figure 2(I): Showing Normal Second cervical vertebra (C2), (II); Fused Cervical vertebrae (FCV) – (Fusion of C2 with C3)****Figure 3: (a) and (b) showing Anterior view of FCV and normal C2 respectively. (c) and (d) showing Posterior view of FCV and normal C2 respectively.****Figure 4: A and B showing Superior view of FCV and normal C2 respectively, C and D showing Inferior view of FCV and normal C2 respectively.**

### 3. Results and Observations

A total of 75 dried Human Adult Axis (C2) vertebrae of either sex were carefully studied and only one axis vertebra found to be fused with C3(third cervical vertebra) forming fused cervical vertebrae with an incidence 1.33%.

The present fused cervical vertebrae specimen showing complete fusion of the under surface of the body of the Axis (C2) with the upper surface of that of the C3 vertebra. The odontoid processis stunted and conical and clearly seen. The fusion of the bodies of the two vertebrae is complete except for the faint ridge which can be seen at the point of fusion of anterior surface of the body of the C2 and C3. The anterior surface of the body of the C3 vertebra is much prolonged inferiorly likethat of a normal Axis (C2).

The spinous process of the Axis is bifid and of c3 is not having bifid. The spinous processes partly fused, the laminae and the adjacent articular processes are completely fused and only faint grooves indicating the lines of fusion are seen. The transverse processes, however, have not fused and are quite separate on both sides and transverse foramina of axis and C3 on either side can be clearly made out.

The superior articular facets of the C2 have flat surfaces looking upwards. The right and left foramen transversarium is complete in both the C2 and C3 cervical vertebra. It is noteworthy that the fused segments are associated with other developmental anomalies such as stunted growth and deflection to one side of the odontoid process, nonunion of the two halves of the vertebral arch and marked projection inferiorly of the anterior surface of the body of the 3<sup>rd</sup> cervical vertebra.



## 4. Discussion

Fusion of cervical vertebrae (FCV) includes facet fusions, neural arc fusions, and block vertebrae. Block vertebrae was used to describe partial or complete fusion, either cartilaginous or bony, of two or more vertebrae [13]. The fusion may be either congenital or acquired. It is important to identify the case of FCV- whether it is congenital or acquired [14]. Congenital FCV is one of primary malformations of chorda dorsalis[15], believed to be due to defects which take place during the development of the occipital and cervical somites[3,16]. Cause of this anomaly is often a combination of environment and genetics which occurs during the 3rd week postconception[17]. Acquired FCV is generally associated with diseases like tuberculosis, other infections, juvenile rheumatoid arthritis and trauma [18].

All these abnormalities may lead to clinical signs and symptoms which are: Shortening of spine in the cervical region; The trapezei are unduly prominent laterally and give a webbed appearance; Limited neck motion; Osseous malformation (scoliosis, kyphosis, torticollis); Signs of peripheral nerve irritation such as pain, burning sensations and cramps; Signs of nerve compression such as hypoaesthesia/ anaesthesia, weakness/paralysis, fibrillations and reduced deep reflexes [12]. The signs and symptoms are similar with that of Klippel-feil syndrome (congenital fusion of cervical vertebrae, brevicollis). The presence of block vertebrae results in more biomechanical stress in the adjoining segments leading to more degenerative changes. The other changes are rupture of ligaments (mainly transverse ligaments), tear of intervertebral disc resulting in herniation of nucleus pulposus resulting in compression of spinal cord, fracture of odontoid process and spondylosis[19]. Patients with Craniosynostosis syndromes showed variety of skeletal anomalies in the cervical spine [9,20,21].

In the present study out of 75 axis vertebrae, only one axis (C2) vertebra fused with C3. Overall incidence of fused cervical vertebrae C2 with C3 in the present study is 1.33%. The incidence of fused cervical vertebrae C2 with C3 in the previous studies conducted by Shands AR on analysis of 700 patients spine in an orthopedic hospital was 0.5% [22], Sharma M, Baidwan S, Jindal AK, Gorea RK studies showed 6.25% of cervical vertebrae fusion in 48 dried adult vertebral columns<sup>23</sup> and Soni P studies encountered incidence of 0.4% to 0.7% [19]. Prevalence of cervical vertebral fusion in Lithuanian population was 2.6% [24].

### Embryological importance

The body, posterior arch and transverse process of C2 vertebra is derived from second cervical sclerotome, tip of dens derived from cranial half of 1<sup>st</sup> cervical sclerotome[25]. Block vertebra results from embryological failure of normal spinal segmentation due to decrease in local blood supply during the third to eighth week of fetal development. Vertebral fusion anomalies are likely to be associated with

disturbance of Pax-1 gene expression in the developing vertebral column [26].

The commonly encountered anomaly is block vertebrae [5], and the common site is C2–C3 with an incidence of 0.4% to 0.7% with no sex predilection [19]. The incidence of fusion was seen maximum in lumbosacral region, then in cervical, thoracic and lumbar regions in decreasing order [23].

## 5. Conclusion

The overall incidence of fused cervical vertebrae C2 with C3 in the present study is 1.33%. Fusion of Cervical Vertebrae is associated with Klippel-feil syndrome, Crouzon's syndrome and Chorda dorsalis, causing changes neck movement associated with severe neck pain and may cause sudden death. Fusion of Cervical Vertebrae evaluation must be done by X-ray or Magnetic Resonance Imaging (MRI) for preventing any serious damage such as osteoarthritis by early diagnosis and treatment. Knowledge of the fused cervical vertebrae is important academically for anatomists, clinically and surgically for orthopaedicians, neurologists, neurosurgeons and even orthodontists. Also anaesthetists must be aware of these anomalies while doing endotracheal intubation, where extension of the neck is done.

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