

### **An osteological study of occipito-cervical and cervical synostosis in Telangana**

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#### **Abstract**

**Introduction:** Skeletal components of the back consist mainly of vertebrae, intervertebral discs [1]. During 4<sup>th</sup> week of development, cells from the sclerotomes shift their position to surround both spinal cord and notochord. Fusion of vertebral bodies is called vertebral synostosis. Occipito-cervical synostosis is a rare congenital condition in which the occipital bone is partially or completely fused with Atlas-1<sup>st</sup> cervical vertebra.

**Materials And Methods:** The study was conducted in Department of Anatomy in a Medical college in Telangana over a period of 6 years from 2014 to 2020 to determine the incidence of vertebral and occipito-cervical synostosis. A total of 396 adult skulls and 2772 cervical vertebrae were included in this study.

**Results:** In this study, among the 396 skulls, only one skull showed incomplete occipito-cervical synostosis. 2772 cervical vertebrae of both genders were studied

and only three specimens of fused cervical vertebrae were observed with an incidence of 0.1%.

**Conclusion:** Vertebral fusion is quiet a rare event which is detected at the cadaveric level. The pathogenetic pathway begins during embryological development of cervical vertebrae. Findings of multiple specimens of cranio-cervical synostosis and cervical synostosis is extremely rare which is evidently observed in our study, may present with symptoms of nerve root compression. This should be kept in mind when managing a case of occipito-cervical spine and neck pain associated with head and neck mobility. The possibility that Occipito-cervical synostosis may alter the course and location of nerves and vessels must be kept in mind during invasive head and neck procedures.

**Keywords:** Cervical Synostosis, occipito-cervical synostosis, fusion, vertebra

#### **Introduction**

Skeletal components of the back consist mainly of vertebrae, intervertebral discs [1]. During 4<sup>th</sup> week of

development, cells from the sclerotomes shift their position to surround both spinal cord and notochord. Mesenchymal cells between cephalic and caudal parts of original sclerotome segment do not proliferate but fill the space between 2 pre-cartilaginous vertebral bodies. In this way they concentrate to formation of intervertebral disc. Rearrangement of sclerotomes into definitive vertebrae causes myotomes to bridge the intervertebral discs and this alteration gives them the capacity to move the spine. Sometimes vertebrae may be partially or completely fused, such fusion of vertebral bodies is called vertebral synostosis. Occipito-cervical synostosis is a rare congenital condition of cranio-vertebral system in which the occipital bone is partially or completely fused with Atlas-1<sup>st</sup> cervical vertebra. This can be either unilateral or bilateral, complete or partial, symptomatic or asymptomatic and can be associated with hypoplasia of basi-occiput [ 10] The aetiology of fusion of cervical vertebra could be congenital, traumatic, surgical, pathological, can result in clinical manifestations like klippelfeil syndrome and may be associated with high riding scapula [Sprengels shoulder] [2]. The congenital fused cervical vertebrae which are usually two and rarely more than two in number, constitute a solitary unit that functions as one vertebra [4]. The incidence of congenital fused cervical vertebra varies between 0.5% [4] to 6.25% [5]. The frequency of fusion of 2<sup>nd</sup> and 3<sup>rd</sup> cervical vertebra varies between 0.10% [6] and 6.25% [7]. Congenital fused cervical vertebrae become symptomatic in adult life after degenerative changes, such as disc hernias and arthritis, occur above and below the fused cervical vertebral level leading to symptoms of nerve root compression [8].

## Aims and Objectives

In the current study, we aim to study the incidence of synostosis in cervical vertebra and including occipito-cervical synostosis in cadavers.

## Materials and Methods

The descriptive study was conducted over a period of 6 years from 2014 to 2020. A total of 396 adult skulls and 2772 cervical vertebrae were included in this study. The thoracic and lumbar, sacral and coccygeal vertebrae were excluded from this study. Paediatric skulls and vertebrae were also excluded from this study. Block vertebrae were excluded from this study. All the skulls and cervical vertebrae were inspected and examined for the presence of any partial or complete fusion between neighbouring vertebral bodies, laminae, transverse, or spinous processes. The skulls were inspected and probed for any fusion between occipital bone and first cervical vertebrae.

## Results

In this study, among the 396 skulls only one skull showed incomplete occipito-cervical synostosis with the following findings:

Figure 1 shows a skull with Incomplete occipito-cervical synostosis. The anterior tubercle of first cervical vertebra is not fused. Left anterior arch of first cervical vertebra is partially fused to the adjacent part of occipital bone. Right anterior arch of first cervical vertebra is not fused. Left facet for oval shaped occipital condyle along with lateral mass of first cervical vertebra is completely fused with adjacent part of occipital bone. Right facet for oval shaped occipital condyle of first cervical vertebra is completely fused with adjacent part of occipital bone. Left posterior arch is completely fused to the adjoining part of occipital bone. Right posterior arch does not show fusion. Transverse processes are partially fused on left side,

whereas, they are not fused on the right side. Both posterior arches are not fused and posterior tubercle is absent. The left Condylar fossa is reduced in size as compared to the right side which is normal in size. Transverse diameter [23mm] and sagittal diameter [ 22] of foramen magnum appears reduced on the anterior side.

Among the 2772 cervical vertebrae of both genders studied, apart from occipito-cervical synostosis, three different specimens of fused cervical vertebrae were observed.

Figure 2 depicts fusion of second and third cervical vertebrae. The articular processes were completely fused on both right and left side. Body is completely fused on right side, whereas partially fused on left side. Right transverse process shows fusion with right articular process leading to reduction in the size of right foramen transversarium. Right and left lamina shows partial fusion on inferior surface but the fusion is more prominent on right side as compared to left side. Intervertebral foramens are present in both fused vertebrae.

Figure 3 depicts fusion of fourth and fifth cervical vertebrae. The bodies of the vertebrae are completely fused. Inferior articular process is completely fused on left side, whereas inferior articular process is partially fused on right side. Posterior tubercle of left transverse process and right transverse process show partial fusion. Spine and laminae of both right and left side are not fused. Intervertebral foramens are present in both fused vertebrae.

Figure 4 shows fusion of sixth cervical and seventh cervical vertebrae. Bodies of both the vertebrae are completely fused. There is a very superficial slit demarcating the two vertebrae but no probe is able to pass through it. Both right and left lamina show almost

complete fusion separated by only a small thin slit. Left Inferior articular facet shows complete fusion whereas right inferior articular facet shows incomplete fusion.

### Discussion

Atlanto-occipital fusion was first described by Rokitansky in 1844 and demonstrated by Schuller in 1911 and both reported the incidence of atlantooccipital fusion varies from 0.5% to 1.0% in Caucasians [10]. AL-Motabagani MA et al. [2006] demonstrated total occipitalization of atlas and other studies showing incidence of atlanto-occipital fusion ranges from 0.14% to 0.75% of population, with both sexes equally affected [9]. D.K. Sharma et al [ 2017] demonstrated higher prevalence of 1.04 % in south Asian population predominantly in central India [11]. In the present study, done in Telangana, Incidence of Occipito-cervical synostosis is 0.25%. 396 skulls of both genders were thoroughly examined and revealed partial fusion of occipital bone with atlas, along with reduction of sagittal and transverse diameters of foramen magnum as was demonstrated by K. Prathiban et al [ 2019] in 3 skulls with an incidence of 0.85% with similar findings which might clinical implications of compression of spinal cord if sagittal diameter is reduced [12]. Normal diameters of foramen magnum: sagittal is 28 to 38 mm and transverse is 25 to 40mm [1].

Brown MW et al in 1964 demonstrated fusion of cervical vertebra could be congenital, traumatic, surgical, pathological, can result in clinical manifestations like Klippel-Feil syndrome and may be associated with high riding scapula [Sprengel's shoulder] [2]. Nazeer M et al in 2014 demonstrated congenital fused cervical vertebrae which are usually two and rarely more than two in number, constitute a solitary unit that functions as one vertebra [4]. Sharma M et al in 2013 and Nazeer M et al in 2014

demonstrated the incidence of congenital fused cervical vertebra varies between 0.5% [4] to 6.25% [5]. Roy PP et al [2018] and Kadadi SP et al [2016] demonstrated the frequency of fusion of 2<sup>nd</sup> and 3<sup>rd</sup> cervical vertebra varies between 0.10% [6] and 6.25% [7]. Singh A et al [2016] demonstrated congenital fused cervical vertebrae become symptomatic in adult life after degenerative changes, such as disc hernias and arthritis, occur above and below the fused cervical vertebral level leading to symptoms of nerve root compression [8]. Congenital fusion of cervical vertebrae. George k Paraskevas et al [2019] demonstrated congenital synostosis in one specimen of Block vertebrae involving Cervical 2<sup>nd</sup> and 3<sup>rd</sup> and 4<sup>th</sup> vertebrae. Vasudha Kulkarni et al demonstrated in 2012, vertebral synostosis in cervical 6<sup>th</sup> and 7<sup>th</sup> and thoracic 1<sup>st</sup> and 2<sup>nd</sup> vertebrae.

In the present study, 2772 cervical vertebrae of both genders were studied, apart from occipito-cervical synostosis, three different specimens of fused cervical vertebrae were observed with a frequency of 0.1%. There were fusions of second with third cervical vertebrae, fourth with fifth cervical vertebrae and fusion of sixth and seventh cervical vertebrae.

### Conclusion

Vertebral fusion is a rare event which is detected at the cadaveric level. The pathogenetic pathway begins during embryological development of cervical vertebrae. Radiological screening may provide etiological causes if any. Other investigations may be required to rule out other etiological factors such as tuberculosis and sarcoidosis which may also play a role in such fusions. Findings of multiple specimens of cranio-cervical and cervical synostosis is extremely rare which is evidently observed in our study. Individual may present during lifetime with symptoms of nerve

compression, which should be kept in mind when managing a case of occipito-cervical spine and neck pain, associated with head and neck mobility. Occipito-cervical synostosis may change the location of structures and has to be kept in mind during invasive head and neck procedures. The study stresses on the importance of keeping in mind the possibility of such synostosis in individuals during surgical procedures and in patients with neuro-orthopaedic symptoms. These individuals may be thoroughly screened for the presence of synostosis to prevent any complications.

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#### Legend Figures

Figure 1: depicts the base of skull showing incomplete occipito-cervical synostosis.

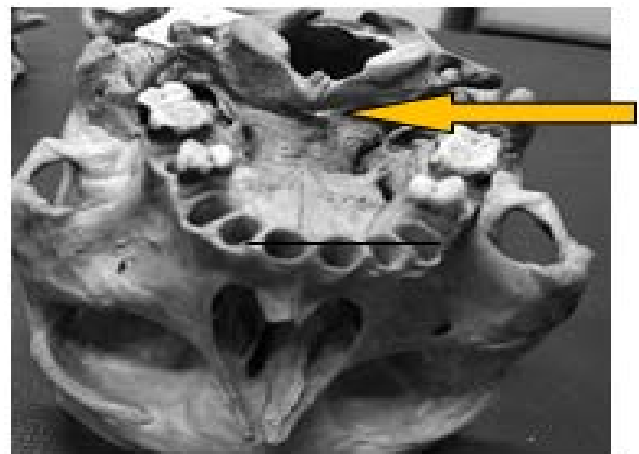


Figure 2: Fusion of second and third cervical vertebrae  
(anterior view)

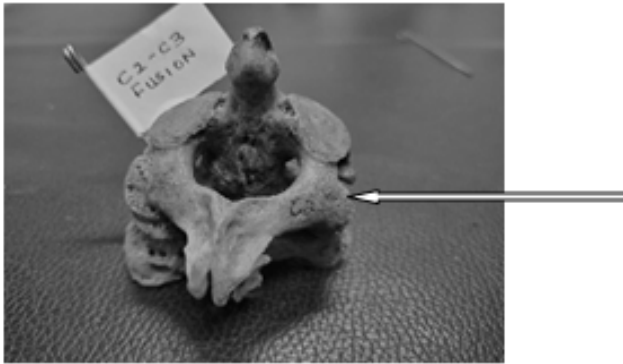


Figure 3a, b: Fusion of fourth and fifth cervical vertebrae.



Figure 4a,b: Fusion of sixth cervical and seventh cervical vertebrae

