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## Case Report

# Accessory articulation of the transverse processes in the cervical spine <sup>☆</sup>

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## ABSTRACT

Accessory articulation between the transverse processes of the C6 and C7 vertebrae is an extremely rare anatomic variant that has only been previously described in two instances. In this report, we present the case of a 25-year-old male who sustained numerous injuries associated with a physical assault. A CT study of the cervical spine revealed a linear lucency mimicking a fracture but found on closer inspection to represent an accessory articulation between the anterior tubercles of the right transverse processes of the C6 and C7 vertebrae. In this report, we summarize this patient's clinical course, and provide an up-to-date review of the current literature, imaging characteristics, and potential mechanisms of the development of this anatomic variant. Our case also includes an incomplete version of the anomaly contralaterally as well as features of secondary osseous stress hypertrophy; these features have not been previously described and may aid in diagnosis. Finally, we provide the first-ever augmented reality model of this variant to fully convey its geometry and facilitate its unequivocal identification.

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## Introduction

The accessory articulation of the transverse processes of cervical vertebrae is an extremely rare anatomic occurrence. First described in 1960, this congenital variant is caused by the connection of protuberances extending between the anterior tubercles of the transverse processes of adjacent vertebrae [1]. Our literature search revealed six prior descriptions of such

accessory articulations occurring between the C5 and C6 levels [2–7]. However, there have been only two previously reported cases of accessory articulations between the C6 and C7 levels [7,8]. In this report, we provide an additional description of an accessory articulation of the transverse processes at C6–C7. Uniquely, our report includes the first observation of a partial or incomplete version of the anomaly contralaterally, as well as secondary features of transverse process hypertrophy. We also provide an augmented reality model of

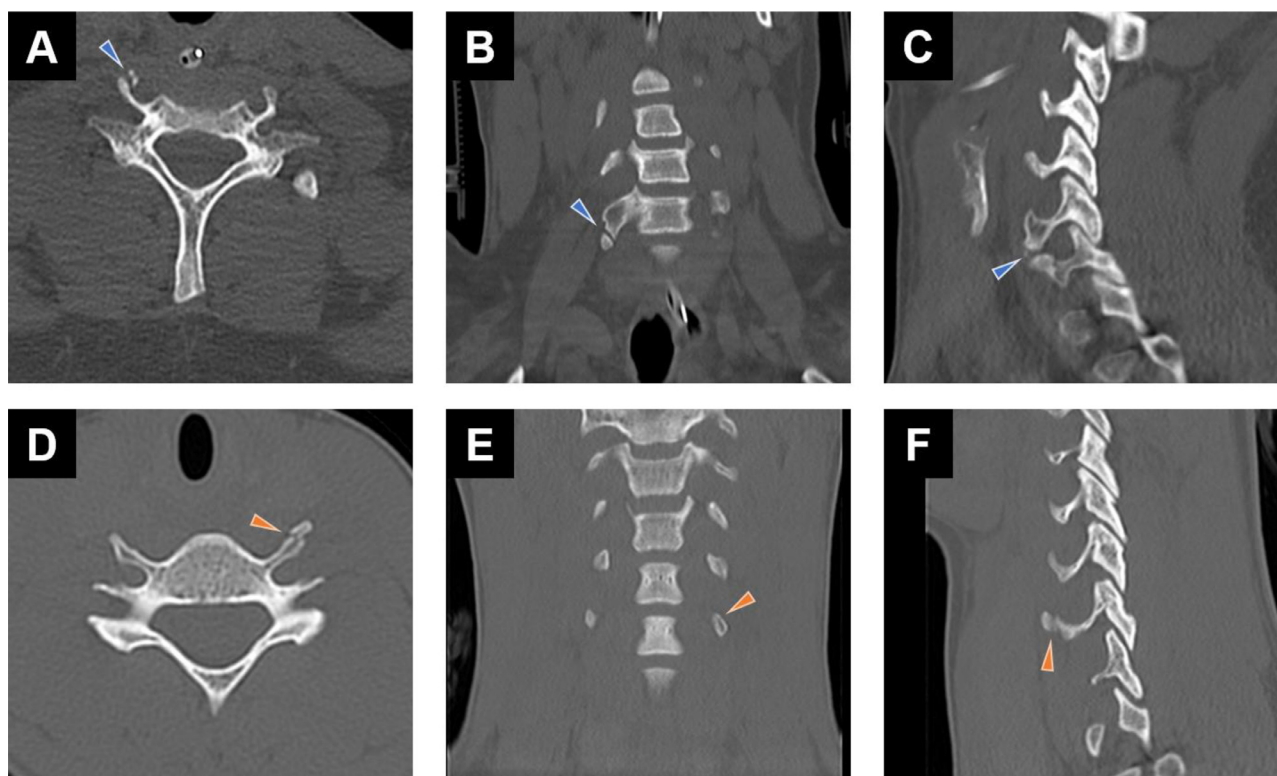
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**Fig. 1 – Accessory articulation of the transverse processes at C6-C7.** Axial view of the C7 vertebra in our case reveals an oblique lucency along the anterior tubercle of the right transverse process (A, blue arrowhead). The appearance mimics a common injury pattern: a similar lucency on the left at the C6 level in a different patient (D, orange arrowhead) represents a true fracture. Coronal and sagittal reformatted images more clearly show that the lucency in our case (B and C) reflects an accessory articulation of the transverse processes rather than a subtle fracture line (E and F).

this unique anatomy to illustrate its geometry and aid in diagnosis.

## Case report

A 25-year-old male was brought to our emergency department following an assault during which he sustained stab injuries to the left hand and wrist, left flank, right thorax, and right upper quadrant of the abdomen. Management of his injuries necessitated an extended hospital course.

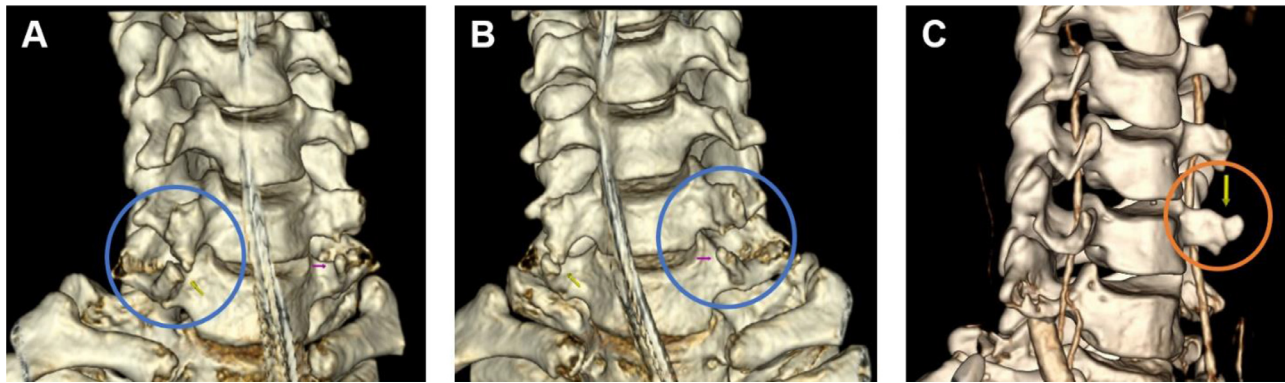
Given the mechanism of injury, he was placed in an immobilizing collar by paramedics prior to arrival, and a CT study of the cervical spine was performed shortly after his stabilization to evaluate for other injuries. Review of the axial images revealed an oblique linear lucency along the anterior tubercle of the right transverse process of the C7 vertebra, mimicking a fracture (Fig. 1). Careful examination of the sagittal and coronal reformatted images, however, revealed that the linear lucency actually represented an area of accessory articulation between a protuberance extending inferiorly from the anterior tubercle of the transverse processes of C6 and a protuberance extending superiorly from the anterior tubercle of the transverse process of C7. Interestingly, best seen on coronal oblique

3-D reconstructions, similar protuberances were also present on the contralateral side, but these were shorter and not fully articulating (Fig. 2).

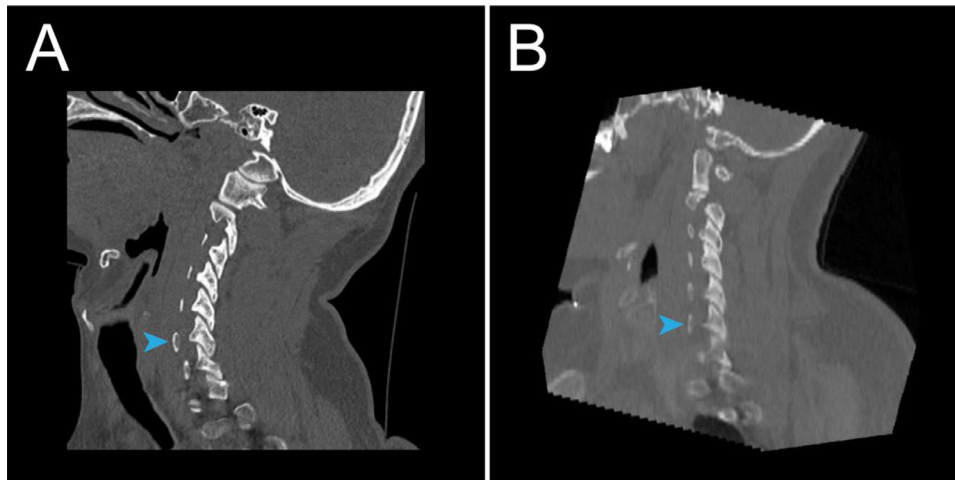
Further review of sagittal oblique reformatted images revealed hypertrophy of the portion of the right transverse process forming the anterior portion of the foramen transversarium at the C6 level, suggesting an element of chronic bony remodeling and further raising confidence in the absence of an acute traumatic injury in this location (Fig. 3). As a result, a diagnosis of accessory articulation of the transverse processes was made, no further imaging evaluation was recommended, and the immobilization collar was uneventfully discontinued.

## Discussion

Anatomically, the anterior tubercles of the C6 and C7 transverse processes have key biomechanical and clinical implications. The anterior tubercle of the C6 transverse process, also known as the carotid or Chassaignac tubercle, serves as a key landmark for anesthetic blocks and surgical procedures [9,10]. It also is a site of origination and insertion for the longus colli, anterior scalene, and longus capitis muscles [11,12]. The



**Fig. 2** – 3-D reconstructions of cervical transverse process accessory articulation versus true fracture. A coronal oblique view in our case shows accessory articulation of the right transverse processes at C6-C7 as bony extensions separated by a uniform, well-defined gap (A, blue circle). Contralaterally, there is a less developed version of the same variant with a prominent extension projecting superiorly from the C7 transverse process (B, blue circle). In comparison, a true fracture of the anterior tubercle of the left C6 transverse process (same patient shown in Figure 1 D-F) is seen as a subtle, vertically oriented groove separating a minimally displaced fragment (C, orange circle).

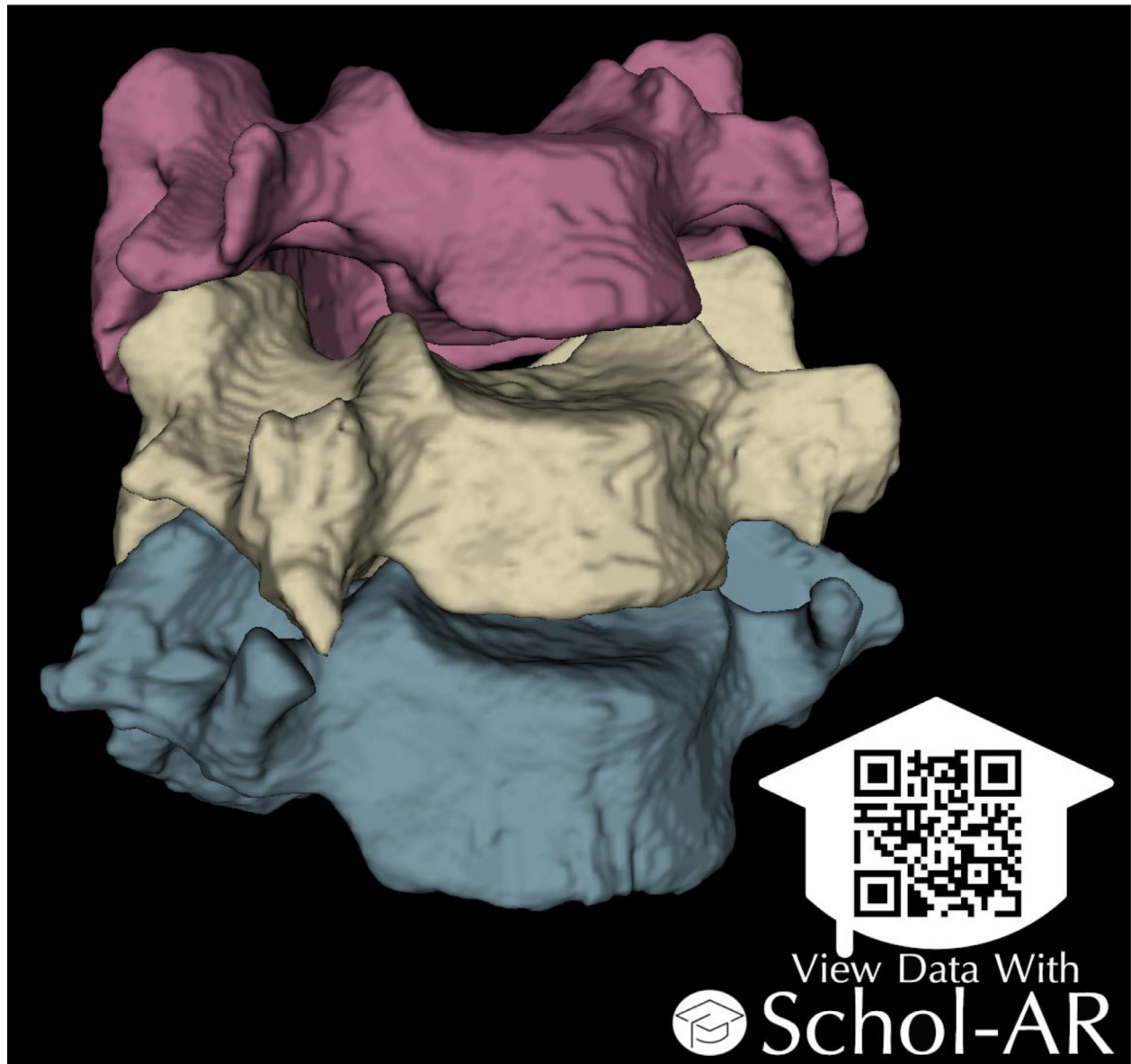


**Fig. 3** – Sagittal oblique reformatted images show that the portion of the right transverse process at C6 forming the anterior border of the foramen transversarium is significantly larger compared to those at more superior levels, likely reflecting chronic stress remodeling (A, blue arrowhead). For comparison, in a different patient without this variant, this portion of the transverse process is relatively uniform in size from C3-C6 (B, blue arrowhead).

C7 anterior tubercle provides a site of attachment for the suprapleural membrane of Sibson and also for the scalenus pleuraris muscle and cervical rib, both of which are anatomic variants [13,14].

The described accessory articulation of the cervical transverse processes derives from embryological development. The C3-C7 cervical vertebrae have three primary ossification centers that appear *in utero* around gestational weeks 8 and 9, with one ossification center in the centrum and two in the neural arches [15,16]. The centrum develops into most of the vertebral body while the neural arches form the pedicles and laminae while also providing sites of support and attachment for the transverse, inferior articular, superior articular, and spinous processes [16–18]. Specifically, the lateral extension of the neural arch centers form the transverse processes. Typ-

ically, the anterior tubercles of the cervical transverse processes are diminutive, but in some patients, they can be elongated. When isolated to C7, this elongation can produce cervical ribs; [19] however, in our case, elongations at C7 as well as C6 extended towards each other to form an accessory articulation. Previous studies have suggested that initiation of this ossification process might be attributable to specific movements and skeletal muscle activation of the fetus [20]. Another explanation for this accessory articulation could derive from the pivotal role of homeobox (*Hox*) genes in the regulation of vertebral development [21–23]. Previous studies have established the function of the *Hox* genes in the patterning of the axial skeleton through both gain-of-function and loss-of-function experiments [24–27]. Thus, aberrations in the *Hox* genes' regulation of segmental differentiation could explain the elon-



**Fig. 4 – Augmented reality model of the C5-C7 vertebrae showing accessory articulation of the right transverse processes at C6-C7. After installing the Schol-AR mobile application, first scan the QR code to download the 3D model, then scan the entire image to view and interactively manipulate the model.**

gation of the anterior tubercles of the cervical transverse processes. The presence of smaller extensions without full articulation on the contralateral side, uniquely seen in our case, may provide insight into the formation pattern of this variant.

Cases of accessory articulation between the anterior tubercles of the C6 and C7 transverse processes may be mistaken for a fracture, especially in the setting of trauma, or degenerative osteophytosis. However, the identification of osseous hypertrophy along the anterior aspect of the foramen transversarium as a secondary feature, as we describe in this case, may provide greater confidence in the identification of this variant anatomy. Given that prior reports have highlighted the importance of multiplanar reformatted images and 3D volumetric reconstruction for accurately identifying this anatomic

variant, we include here the first augmented reality model of this variant to aid in the understanding of this complex 3D anatomy (Fig. 4).

### Conclusion

Accessory articulation of the cervical transverse processes between the C6 and C7 vertebrae is an extremely rare congenital variant that may mimic a fracture. Careful inspection for the anatomical features described in this report, including the secondary finding of transverse process hypertrophy, should aid in the definitive diagnosis of future cases and prevent unnecessary additional workup and prolonged spinal immobilization.



## Patient consent

Informed consent for publication has been obtained.

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