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Editorial

Incidental Radiographic Findings of the Cervical Spine in Trauma Patients

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Received: December 28, 2023; **Published:** January 04, 2024

The purpose of this editorial is to review the literature on incidental radiographic findings of the cervical spine, to report normal anatomic variants of the immature spine and congenital or idiopathic anomalies in trauma patients, to consider their potential or apparent clinical significance, and to present illustrative cases in children, adolescents, and adults.

Imaging techniques often reveal findings incidental to the ordered study [1]. The frequency of incidental findings in imaging research examinations varies significantly by imaging modality, body region, and age. However, little information exists concerning their clinical significance in the imaging research [2].

A wide range of incidental radiographic findings is evident in the common orthopaedic practice. Incidental findings in the vertebral column are common and typically benign [3]. However, some may require differentiation from potentially concerning pathology and complementary or repeat imaging. Comparatively, few incidental findings appear in the cervical and thoracic region, compared with the lumbar and sacral segments [4], and most of them are evident in the cervical and the proximal thoracic part due to the most intense local transformation during phylogeny [5].

Radiographic examination is critical to diagnose cervical spine trauma and anomalies [6]. In children, adolescents, and adults examined for neck pain, acquired torticollis, and traumatic injuries, various incidental findings may be detected. The definition incidental should not be interpreted as a less valuable finding [7]. Familiarity with variants or anomalies is necessary for correct image diagnosis, especially in children following trauma [8,9], and to distinguish malformed vertebrae from acute trauma on emergency imaging [10,11]. Therefore, accurate radiographic diagnosis is required since various findings have markedly different clinical courses, patient management strategies, and prognosis [12].

Evaluation of pediatric cervical spine images can be challenging even for the most experienced radiologist [13]. Familiarity with epiphyseal variants, incomplete ossification of synchondroses and apophyses, unique vertebral architecture, hypermobility/pseudosubluxation of the second cervical (C) vertebra on C3 and, to a lesser extent, of the C3-4 space, pseudospread of the anterior atlas on the odontoid in extension, anterior wedging of vertebral bodies, pseudowidening of prevertebral soft tissue, and varied atlantodens intervals is valuable for correct pediatric image interpretation (Figure 1). The absence of lordosis, although potentially pathologic in an adult, can be seen up to 16 years of age when the neck is in a neutral position [8,14-16].

Cervical spine imaging may also reveal abnormal vertebral morphology [17]. Cervical spine malformations are diagnosed in many inherited disorders but are rare in normal individuals [18,19]. Cervical spine congenital abnormalities are due to the unique embryology and are more likely in the craniovertebral junction than in the subaxial cervical spine. In addition, the biomechanics of the developing spine predispose children to craniocervical junction injuries [20,21].

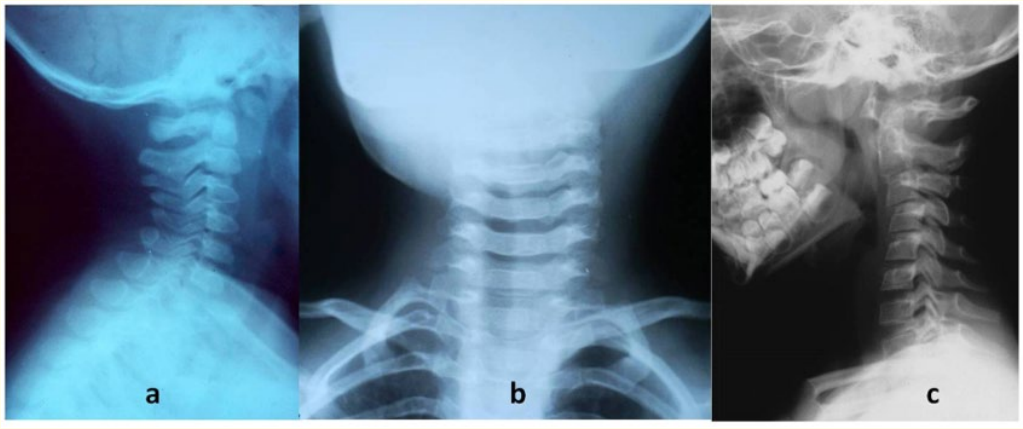

Figure 1: *Normal variations in children diagnosed after neck injuries. The lucent line at the base of the dens, representing the synchondrosis between the body of C2 and dens in this 7-month-old girl, should not be confused with a fracture. The ossification center of the cartilaginous anterior arch of the atlas (anterior nucleus) is not apparent on the radiograph (it usually appears at one year of age) (a). The open bilateral synchondroses, between the body and neural arches, of the subaxial cervical vertebrae in this 2-year-old boy should not be confused with fractures (b). The displacement (pseudosubluxation) on the C3-4 space of this 6.5-year-old boy should not be confused with a subluxation/dislocation (c).*

Vertebral malformations of the cervical spine are usually asymptomatic or have only minor/mild symptoms in most affected patients. Symptoms are due to C1-C2 instability, scoliosis, and bone torticollis or may develop due to degenerative arthritis in the hypermobile articulations adjacent to vertebral fusion [22,23]. Some vertebral anomalies may predispose the patient to trauma or myelopathy, while associated spinal cord abnormalities may occasionally exist [11].

Atlanto-occipital assimilation (occipitalization of the atlas) is one of the most common congenital anomalies of the craniovertebral junction [11]. Defects of the posterior atlas arch are much more common than anterior ones. Posterior midline cleft/rachischisis/spina bifida occulta of the atlas is typically an incidental, asymptomatic anomaly [24].

The most common congenital variations of the axis include the os odontoideum and a persistent ossiculum terminale. Various authors have reported hypoplasia/aplasia, posterior angulation or bifid odontoid, and fused odontoid tip with the inferior clivus, as well as abnormalities of formation or development of the neural arch, laminar variants, and spina bifida of the axis [25,26].

The subaxial cervical spine usually exhibits a similar ossification pattern from C3 to C7 [14]. Vertebral failures of formation or segmentation are less frequent in the subaxial cervical spine than in the rest of the spine and appear as incidental findings involving the body or the neural arch and the processes [27,28].

Cervical ribs, complete or incomplete, usually arise from the seventh cervical vertebra. However, they may also arise from the fourth, fifth, or sixth cervical vertebrae. They may represent a clinically nonsignificant anatomic variant, although 10% of the patients may gradually develop thoracic outlet syndrome [14,29]. The adult cervical spine is the second most common location of wrong-level surgery. Anatomical variations, especially cervical ribs, are one of the most significant incriminating risk factors [30].

A variety of congenital anomalies of potential or apparent clinical significance was diagnosed at our trauma service during radiography of the cervical spine in children (Figure 2), adolescents (Figure 3), and adults (Figure 4), as well as idiopathic ones (Figure 5). This paper indicates that cervical spine radiography may reveal various incidental findings, including normal anatomic variants of the immature skeleton and congenital or idiopathic anomalies. Although all the presented anomalies were of potential or apparent clinical value and involved multiple levels within the cervical spine in our patients, they presented as asymptomatic lesions or with mild clinical features, and their diagnosis was made only after a traumatic injury that necessitated a conventional radiographic examination of the cervical spine.

Figure 2: *Congenital anomalies in children. A 3-year-old girl presented with a mild muscular torticollis after a fall. Radiography indicated apparent aplasia of the dens (apparent because it could be cartilaginous and therefore not visible). There was also hypoplasia of the neural arch, the inferior articular facets, and the spinous process of the axis. The spinous process of C3 was thicker and projected further posteriorly than that of C1, C2, and C4. In addition, the laminae of C3 were larger. The superior articular facets of C3 also appeared to be dysplastic. The radiographic appearance of C3 was consistent with that of a typical axis. No anomalies were evident in the rest of the subaxial cervical spine. The malformation was considered potentially secondary to a malformative syndrome (a). A 13-year-old girl complained of mild neck pain and restricted cervical range of motion after a fall. A palpable hard prominence on the dorsum of the neck, more evident with flexion, was diagnosed as a "vertebra prominens" a few years ago. A digit-like bone appeared on the lateral radiograph posterior to the spinous process of C7 (white arrow). Computed tomography revealed pseudo-articulation between the segments of the cervical digit (black arrow). The lesion had a well-circumscribed cortex and medulla osseous structure (b).*

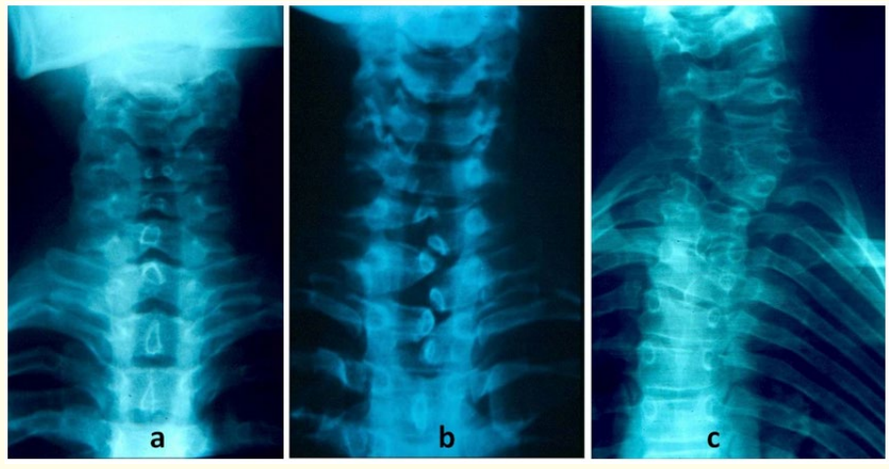

Figure 3: *Congenital anomalies in adolescents. A 17-year-old female suffered a trivial cervical spine trauma following a fall while running. On clinical examination, mild neck pain was evident. The radiographs showed posterior spinal element anomalies consistent with schisis of the posterior arch of C5 and C6. An asymptomatic incomplete posterior arch of C5 and C6 was the diagnosis (a). A 19-year-old female suffered a trivial cervical spine trauma following a fall from a bicycle. On clinical examination, mild neck pain was evident. The radiographs showed incomplete closure of the posterior neural arches of C6, C7, and the first thoracic (T) vertebrae. The left lamina of the involved vertebrae projected obliquely upward and the right obliquely downward, so although both reached the midline, they didn't meet. The diagnosis was an asymptomatic incomplete posterior arch of C6, C7, and T1 (b). An 18-year-old male suffered a trivial cervical spine trauma after a fall from stairs. On clinical examination, mild neck pain and torticollis were evident. He reported that he was born with a twisted neck. The radiographs showed scoliosis, multiple hemivertebrae, and vertebral synostosis of the lower cervical and upper thoracic spine. The radiographic diagnosis was a mixed failure of formation and segmentation of the cervicothoracic spine. The final diagnosis was congenital osseous torticollis (c).*

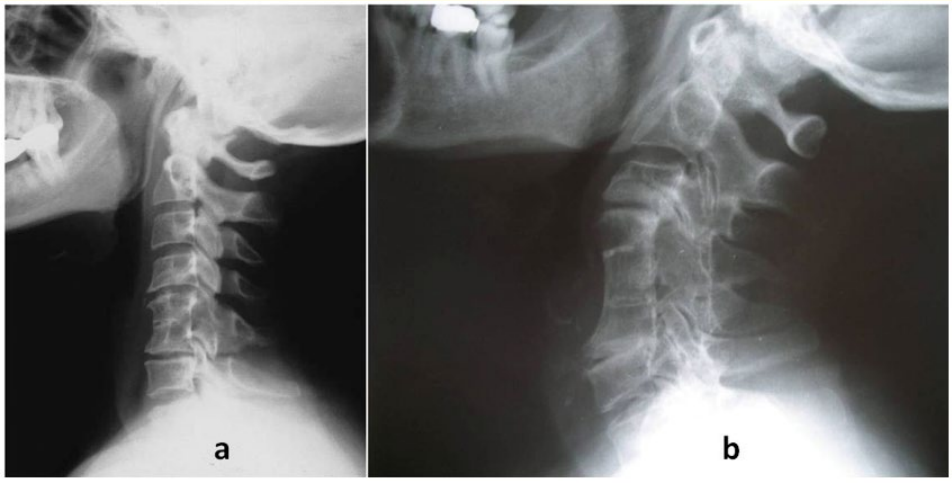

Figure 4: *Congenital anomalies in adults. A 51- and a 60-year-old female were examined for neck pain after a fall from a standing height a few days ago. On physical examination, minor discomfort in the neck was evident. The radiographs showed segmentation failure of C5 and C6 (a) and contiguous fusions between C4 and C6 vertebrae (b). There were no significant cervical spine degenerative changes or other skeletal abnormalities. Both patients were diagnosed with asymptomatic Klippel-Feil syndrome without any frank physical deformity.*

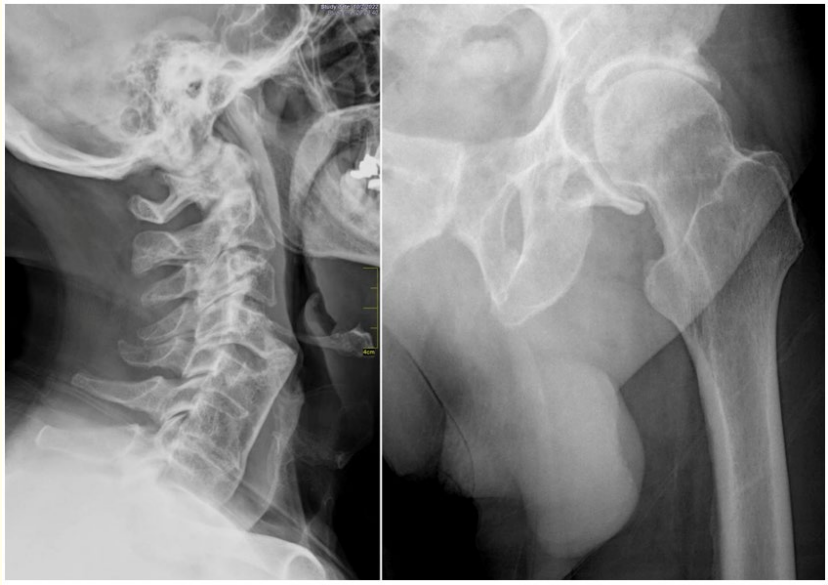

Figure 5: *Idiopathic anomalies in adults. A 61-year-old male was involved in a traffic road accident while riding a motorcycle a few days ago. He presented with neck, back, and hip pain. Plain radiographs showed two independent continuous linear calcifications along the anterior longitudinal ligament, leading to partial fusion of adjacent vertebrae of the lower cervical and the thoracic spine. Severe hyperostosis was also evident around the left hip joint. There was no involvement of disc spaces, facets, and sacroiliac joints. The patient was diagnosed with Forestier disease (Diffuse idiopathic skeletal hyperostosis).*

Finally, even if they can be considered rare entities and seldom require treatment, congenital or idiopathic anomalies may occasionally appear as incidental radiographic findings in the craniocervical and cervicothoracic junction and the subaxial cervical spine. To avoid a skipped diagnosis or misinterpretation of the broad spectrum of cervical spine malformations, particularly in children and adolescents or in the setting of acute trauma patients, the value of careful inspection from all sides, clinical examination, and plain radiographic assessment, at least in the anteroposterior and lateral planes, should never be underestimated.

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Volume 15 Issue 1 January 2024