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CASE REPORT

Unusual Costotransverse Joints Found in Laboratory Bones

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Abstract

The present study presents an anatomical variation in the costotransverse fovea of the thoracic vertebrae. This finding occurred at the Universidade do Vale dos Sinos, after cleaning a skeleton received from the regional cemetery, made by the technicians of the anatomy laboratory. The foveae in question were absent from the 8th thoracic vertebra. After this observation, a literature research was made, aiming to identify reports of this variation and its implications. It was then found that the absence of these elements can impact the biomechanics and physiology of the costovertebral joint complex, in view of the interdependence of the costotransverse and costovertebral joints. The costovertebral joints were preserved.

Key Words: *Costotransverse joint; Costovertebral joint; Thoracic vertebra; Anatomical variation*

Introduction

The thoracic vertebrae, articulating with the ribs, represent the structural part of the costal arches. The ribs have ventral and dorsal joint mechanisms. Ventrally, they give rise to the costochondral joints. Dorsally, they are involved in the costovertebral complex, which is formed by the costovertebral joints and costotransverse joints [1]. These joints, under typical conditions, are fundamental for the cohesion of the costal structures with the thoracic spine and the sternum, forming the rib cage [2].

Costovertebral Joints

The articulation of the rib with the vertebral bodies of the thoracic vertebrae is known as the costovertebral joint. The thoracic vertebrae have bilateral costal foveae in the vertebral bodies hemifoveal usually in pairs, one upper and one lower. These foveae articulate with the head of the rib and the intervertebral disc which articulates with the two adjacent vertebral bodies from the corresponding upper vertebral hemifovea and lower superjacent vertebra hemifovea [3].

This configuration of upper and lower hemifovea remains until the tenth thoracic vertebra. The two lower ribs form their joints with entire foveae of the last two thoracic vertebrae, thus not overlapping the intervertebral discs [4].

Costotransverse Joints

The joint between the rib and the transverse process of the thoracic vertebrae is known as the costotransverse joint.

Specifically, this joint is a junction between the costotransverse fovea of the transverse process of the

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vertebra and the articular facet of the rib tubercle, a structure that articulates with the fovea of the corresponding vertebra [3]. Although previously arranged, the costotransverse foveas have variations in their positioning in the transverse process, and they can be arranged in all possible variations between a limit given by the anterior face to the extreme of this structure4.

The twelve thoracic vertebrae have specific characteristics and are therefore classified as typical and atypical. The atypical vertebrae are considered the first thoracic vertebra (TI), the tenth (TX), the eleventh (TXI) and the twelfth (TXII) [5]. Some literature still considers the ninth thoracic vertebra (TIX) to be atypical too.

All the above, unlike typical vertebrae, they have entire bilateral costal foveae in their vertebral body or pedicles. Because the TX vertebra may have an entire costal fovea, the TIX eventually will not have a lower costal hemifovea, which may also be considered an atypical vertebra. It is also important to note that the TXI and TXII vertebrae do not have a costotransverse fovea and, therefore, do not have costotransverse joints [6].

Although their morphological structures are distinct, the costovertebral joints and the costotransverse joints are mechanically related by their naturally dependent movements, since they have a common horizontal axis of rotational movement passing through the center of these two joints [7]. Contributing to the high joint congruence of this costovertebral complex there are unique ligaments in both joints - linked directly to the costovertebral joint are the intra-articular ligament of head of rib and the radiate ligament of head of rib. On the costotransverse joint, there is the lateral costotransverse ligament, the costotransverse ligament, and the superior costotransverse ligament [3].

Case Report

The anatomical variation of this segment was located in a skeleton at the Universidade do Vale dos Sinos (UNISINOS).

Regional cemetery bones were donated to UNISINOS's Anatomy Laboratory for study in the anatomy courses at the university. Considering the characteristics of the skull and pelvis, it is possible to indicate that it belongs to an adult individual, probably male. No other demographic information could be obtained and/or verified. Upon being received by the anatomy laboratory technicians, such structures underwent a thorough cleaning. Subsequently, on the vertebral spine of one skeleton, the absence of costotransverse fovea from the eighth thoracic vertebra was observed, and the lack of the articular faces of the tubercles of the respective ribs (Figures 1 and 2).

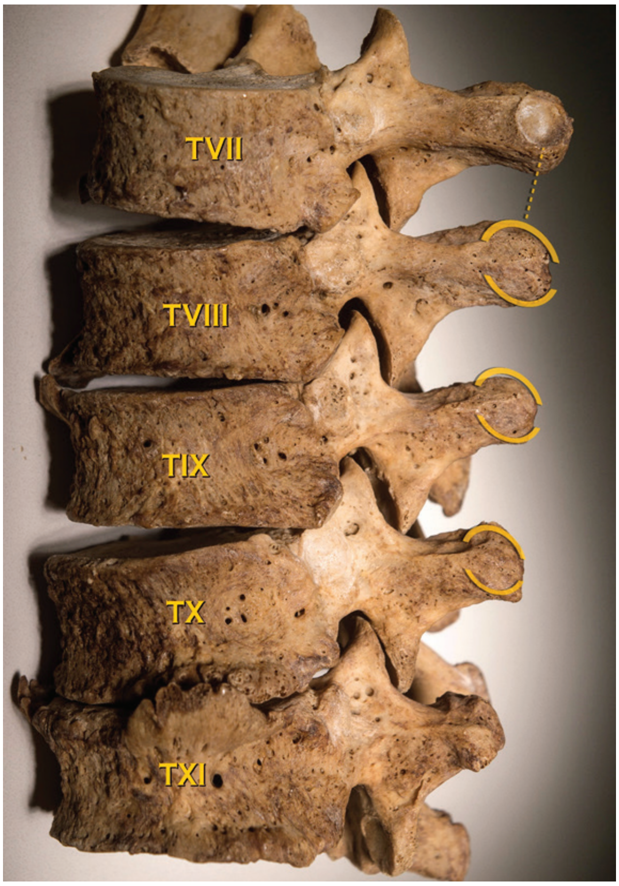

Figure 1) *The absence of costotransverse fovea from the eighth thoracic vertebra was observed.*

Figure 2) *The lack of the articular faces of the tubercles of the respective ribs.*

After identifying the variation, a literature research was initiated regarding joint components and case descriptions similar to this present report, to discover possible clinical and structural implications resulting from this morphological variation, which was not found.

Discussion

Even without bibliographic sources of variation of these joints, the lack of costotransverse joints and their ligaments can have a substantial impact on the joint biomechanics of the costovertebral complex. Specifically on the interaction mechanics of the structures that confer the costotransverse joint, Goldthwait [4] describes the existence of several possibilities for positioning the costotransverse fovea in the transverse process of the vertebra which, according to the findings of the present study, could not be observed in any of the processes from the eighth thoracic vertebra - as shown in Figure 1.

The costotransverse joint reciprocally has a natural dependence on the costovertebral joint movements, as they have a common anterior-posterior joint axis [7]. This costovertebral complex plays an important role in stabilizing, moving, supporting the load and protecting the rib cage, having a powerful influence on the physiological gestures of mobility, and ventilatory breathing movements [8].

In the ventilatory mechanics, the proper functioning of the costovertebral complex and thoracic muscles suffices to ensure the maintenance of ventilation, even if there is a paralysis of the diaphragm since the expansion of the rib cage is also linked to the movement of this joint complex [8]. The costovertebral complex contributes to pulmonary expansion from the mechanics of rib elevation, increasing the anterior posterior diameter and the transverse diameter of the thoracic cavity. This expansion may represent a volumetric increase of 20% of intrathoracic space. In the lower thoracic region, the lateral movements of the ribs when elevated are responsible for the increase of the transverse width of the rib cage, with the costotransverse joints, from the seventh to the tenth, the joints that enable this sliding up and down [2,8]. All of this mechanics can also be influenced by the difference in size of the transverse processes of the vertebrae in the costotransverse joints. This is because the lever exerted by the rib in relation to the contact surface in the transverse processes can confer a greater or lesser range of motion limitation, directly influencing the expandability in ventilatory mechanics4. Although it is not possible to establish clinical relationships with the analyzed bone, in Figure 1 it is possible to perceive the expected sizes of these processes, without major structural differences.

Although engaged in distinct movements and respiratory mechanics, the thoracic vertebrae are the most stable sector of the spine due to its structural conformation and involvement by various ligaments [9]. A considerable part of the weight of the upper limbs and the rib cage is suggested to be spread through the ribs to the spine by the costotransverse joints and ligaments [10].

The posterior elements of the thoracic spine influence the amplitude of its physiological movements. After removal of the costovertebral joints and costotransverse joints together with their ligament components, shifts in spinal rotation and lateral inclination were noted [11] - in line with the analysis by Jiang et. Al [12] in affirming the importance, for example, of the superior costotransverse ligament in the active lateral balance of the spine. In a study that aimed to analyze the load sharing between the structures and elements of the thoracic spine, based on its mimicry by computerized and validated models, it was found that the removal of the joints of the costovertebral complex may imply changes in the mechanics of the thoracic mobility of the segment, causing soft tissue overload and consequent ligament injuries [13]. Oda [11] also states that it is difficult to isolate the effects of costotransverse joints on spinal stabilization, contributing to Kapandji's [7] biomechanical concept.

Although there are other more prevalent factors, studies point to costotransverse joints as possible causes of back pain [14-16]. Contributing to the relevance of the relationship between costotransverse joints and back pain, a study of 20 individuals who received injections into the costotransverse joints for pain treatment showed a significant improvement in pain [17]. In addition, another study found pain markers in costotransverse joint capsules in their histological study, considering them the differential in the investigation of chest pain [18].

Little is noticed in the literature subjects related to the theme in question no reports were found of other studies that did not present costotransverse joints. It is also perceived a lack of clarity regarding the standardization of descriptors that involve the theme, making the isolation of costotransverse joints confusing for specific search and analysis.

Although it is possible to establish parallels between the findings and the impact on the health of human beings, this study is limited by the lack of information regarding the demographic data of the bone, making it impossible to determine and compare the consequences of the absence of this structure on the individual in question. More detailed studies are needed to determine more clearly the influence of this anatomical variation on the mechanics of the spine.

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