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Case Report
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Bicipital Rib: a Fusion of the 1st and 2nd Thoracic Ribs

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ABSTRACT

Introduction: variations in ribs are rare incidental findings and include short, forked, and bicipital ribs. The bicipital rib results from the fusion of the cervical rib with the 1st rib or the fusion of 1st rib with the 2nd rib, with an incidence of 0.3% based on routine chest radiography.

Case Report: during a routine preparation and cleaning of a 19-year-old male skeleton donated to the osteology museum of the *Unidade de Ensino Superior de Feira de Santana*, we observed a rare case of fusion of the sternal diaphyses and extremities of the 1st and 2nd right ribs; however, their vertebral extremities were separated by a small intercostal space and had separately two heads, two necks, and two tubercles.

Conclusion: knowing the existence of the bicipital rib is of great importance for anatomists, radiologists, and thoracic surgeons who deal with this region. Further, it may indicate an underlying systemic disease, causing musculoskeletal pain or intercostal nerve compression, as well as being the cause of thoracic outlet syndrome.

Introduction

Congenital rib anomalies are very rare and are often discovered as incidental findings on routine radiographs. The 1st rib may be rudimentary or may fuse with the cervical rib or the 2nd rib to form the bicipital rib.[1,2] This synostosis is an unusual anatomical peculiarity that results from the fusion of axes of two distinct ribs in a typical body and is seen only regarding the 1st rib because of the fusion of a cervical rib with the 1st rib—or more commonly because of the fusion of the 1st rib with the 2nd rib.[3-5] Its incidence has been reported in 0.3% of cases in studies based on chest radiographs.[1,4-6] Thoracic rib fusion anomalies may be classified into three types: bicipital rib, which is characterized by fused sternal, diaphyseal ends, and separate vertebral ends; bridged rib, which is characterized by fused diaphyseal and separate sternal and vertebral ends; and forked rib, which is characterized by fused vertebral ends, separate diaphyseal, and separate sternal ends.[7,8]

Synostosis of the 1st and 2nd ribs is usually asymptomatic; however, it can also cause musculoskeletal pain, intercostal nerve compression, or any significant vascular pathology.[9]

Rib anomalies, whether pathological or normal variants (e.g., cervical rib, pelvic rib, bifid rib, and bicipital rib) usually indicate an underlying systemic disorder associated with progressive scoliosis, thereby reducing the thoracic volume.[10] The present study aims to report a fusion of the 1st rib with the 2nd rib: the bicipital rib

.Case Report

During routine preparation and cleaning of a 19-year-old male skeleton donated to the osteology museum, *Unidade de Ensino Superior de Feira de Santana* (UNEF), a rare case of a bicipital rib was found (Figure 1). It presented a fusion of the diaphyses and sternal extremities of the 1st and 2nd right ribs, which resulted in the obliteration of the 1st intercostal space. However, its vertebral extremities were separated, allowing a small intercostal space. Both ribs had two

Figure 1. Vertebral view of the bicipital rib
1. External crest of the 1st rib; 2. Tubercle of the 1st rib; 3. Tubercle of the 2nd rib; 4. Intercostal space; 5. Neck of the 1st rib; 6. Neck of the 2nd rib ; 7. Head of the 1st rib; 8. Head of the 2nd rib; H – Height; L - Length

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heads, two necks, and two tubercles. The head of the 1st rib had a round shape and an oval facet, while the head of the 2nd rib was flattened anteroposteriorly, and its facet was flat. The neck of the 1st rib was shorter and thicker, while that one of the 2nd rib was longer and thinner than the 1st. The intercostal space, whose maximum height was 5 mm and length 21 mm from the vertebral extremity to the costal tubercle, separated them. The tubercle of the 1st rib was prominent and irregular, oriented upward and backward, while that one of the 2nd rib was also irregular, directed backward and downward. The superior aspect of the bicipital rib (Figure 2) showed a crest extending from the posterior third of the rib to the tubercle of the 1st rib, and in front of it there was a rough triangular area for insertion of the middle scalene muscle. Still on this superior aspect, the tubercle for the anterior scalene muscle and two grooves (one shallow, anterior to the tubercle for the subclavian vein, and the other deep, behind the tubercle, for the subclavian artery and the lower trunk of the brachial plexus) were identified, as well as a rugosity for impression of the subclavian muscle. Already in the inferior view of the rib, there was a very prominent costal groove at its vertebral extremity (Figure 3).

Figure 2. Superior view of the bicipital rib
1. External crest of the 1st rib; 2. Impression of the middle scalene muscle; 3. Tubercle of the anterior scalene muscle; 4. Groove for subclavian vein; 5. Groove for subclavian artery.

Figure 3. Inferior view of the bicipital rib
1. Sternal extremity; 2. Vertebral extremities; 3. Rib groove.

Discussion

The ribs are developed from the mesenchymal processes of the primitive vertebral arches in the thoracic region. Any missegmentation of the axial skeleton during the 20th day of intrauterine life can lead to multiple anomalies of the vertebrae and ribs.[11] In humans and mammals, the ribs and vertebrae develop from a common primordial mass that passes through successive stages of membranous, chondrogenic, and osteogenic development.[12-14] During the first membranous stage, mesenchymal cells migrate toward the notochord to form the structure of the spinal column.[14] Chondrifications in parts of these blastemal masses are destined to become costal processes, neural arches, and ribs, but in all (except the thoracic vertebrae), these structures typically fuse with their respective vertebral centers by the 7th gestational week.[13-15]

Congenital rib defects are classified into numerical and structural defects. Numerical defects include supernumerary ribs (i.e., cervical, lumbar, pelvic, or sacral ribs), structural rib defects (e.g., short rib, bifid rib, or forked rib), fused or bridged ribs, and pseudoarthrosis of the 1st rib.[4,7,16-21] The bicipital rib results from the fusion of a cervical rib with the 1st rib, and can also occur due to the fusion of the 1st rib with the 2nd rib.[3,5,22] In our case, fusion of the sternal extremities and diaphysis of the 1st right rib with the 2nd right rib was observed, while its vertebral extremities were free. This was also reported by a number of authors. [4-7,22-26]

Congenital rib anomalies are rare and are usually discovered as an incidental finding on routine imaging examinations.[4,8,20,21,27] Structural deformities of the 1st rib are less common compared to other ribs. If present, they can lead to compression of the neurovascular bundle at the neck root, causing thoracic outlet syndrome.[7,28] In the reported case, there was synostosis of the 1st and 2nd thoracic ribs (i.e., the fusion of the sternal extremities and the diaphysis of the 1st and 2nd ribs on the right side), while the vertebral extremities of both ribs were free. These extremities had an intercostal space, which had a height and length of 5 mm and 21 mm, respectively. This agrees with the literature, in which the height ranged from 4.5 to 10 mm and the length from the vertebral extremity to the rib tubercle from 12 to 44 mm.[5,6,8,24,27] This anomalous 1st rib complex is an infrequent cause of thoracic outlet syndrome compared to the cervical rib. However, this anomaly should always be looked for whenever a patient complains of symptoms suggestive of this syndrome.[6,7] This anomaly may also be associated with several syndromes (e.g., Klippell-Feil syndrome, Poland syndrome, neurofibromatosis, and spondylocostal dysostosis).[3,21,26]

Thoracic outlet syndrome is a complex syndrome involving compression of neurovascular structures as

they pass from the base of the neck to the arm and presents in three forms: neurogenic (95%), venous (4%), and arterial (1%).[29] Extrinsic neurovascular compression because of the presence of a cervical rib, anterior scalene muscle hypertrophy, and other factors that obliterate the interscalenic space or the costoclavicular space can lead to thoracic outlet syndrome. This can cause arterial thrombosis or embolization, upper limb ischemia, and possible subsequent aneurysm formation.[3,6,27,28,30]

Conclusion

The bicipital rib is a rare anatomical variation that occurs due to the fusion of the 1st and 2nd ribs. Knowing it has great importance not only from an academic standpoint for anatomists, but also for clinicians, surgeons, and radiologists who deal with this thoracic region. Any rib abnormalities, whether normal (e.g., cervical rib, pelvic rib, bifid rib, bicipital rib) or pathological variants, may be misinterpreted as tumorous, traumatic, or inflammatory lesions of the chest wall, lungs, or pleura; therefore, they should not be overlooked.

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