

Synostosis of first and second thoracic ribs: Anatomical and radiological assessment

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ABSTRACT

An unusual specimen showing synostosis of left sided first and second ribs was encountered during scanning of bones in anatomy department. The ribs were partially fused in the region of their neck and tubercles, and displayed an osseous tunnel. The tunnel measured 1.2 cm in length and was directed anterolaterally. The shaft of first rib imperceptibly blended with that of the second and resulted in obliteration of first intercostal space. The maximum width of this conjoint shaft was 3.6 cm. Superior surface of the rib specimen was marked by a large muscular impression for scalenus medius muscle. The groove for subclavian artery on the superior surface of first rib was prominent. The anterior end of the second rib and a portion of its shaft were separated from the anterior end of first rib by a V-shaped notch. The radiograph of the specimen confirmed the presence of a tunnel between the fused portions of neck and tubercle. Such skeletal abnormalities may be associated with segmentation defects of bony tissues and variations in the disposition of neurovascular structures, thus rendering them vulnerable to compression at the thoracic outlet. The fused ribs affect the chest wall expansion and may result in respiratory complications. Precise knowledge and awareness of such anomalies is important for clinicians, especially for thoracic surgeons and radiologists. © IJAV. 2009; 2: 131–133.

Key words [morphology] [fusion] [rib] [synostosis]

Introduction

The osseous tissue is constantly subjected to stresses which govern its architectural structure [1]. It is acknowledged that spinal nerves are the dominant factors in shaping the future ribs, their anomalies may be produced by downward pressure exerted by nerve trunk arching over them or abnormal disposition of vessels [2]. The rib anomalies whether pathological or normal variants such as cervical rib, pelvic rib, bifid rib, bicipital ribs etc., often indicate an underlying systemic disorder [3]. The costal anomalies occur quite frequently at the thoracic outlet, presence of cervical rib and hypertrophied scalenus anterior muscle have been regarded as important factors in the genesis of thoracic outlet syndrome (TOS). However, abnormal first & second ribs can also present with TOS [4,5]. A radiological study reported two cases of fused first & second ribs associated with thoracic outlet syndrome [5]. Fused ribs are also encountered in Gorlin's syndrome [3]. Incidence of fused first and second ribs has been reported as 0.3% in a study based on chest radiographs [6].

An isolated specimen of fused first and second ribs of left side was detected during routine scanning of bones in osteology section of anatomy department. Extensive review of literature revealed paucity of published data on the morphological description of such anomaly. The present study is unique since it describes the anatomical features of fused first two ribs as observed in the bone specimen. Such skeletal abnormalities have not received

the attention and clinical recognition they deserve, and the present paper is a humble attempt in this direction.

Case Report

During routine scanning of bones in the osteology section of department of Anatomy, Vardhman Mahavir Medical College & Safdarjung Hospital, we noticed a bone specimen displaying fusion of first two ribs of left side. The specimen was examined in detail and relevant anatomical features and various measurements were recorded. A skiagram was also obtained for its radiological evaluation.

The morphological examination revealed that ribs were partially fused posteriorly and the first rib overlapped the second. The two ribs completely blended with each other in the middle and resulted in obliteration of first intercostal space. However, the anterior ends of the two ribs were separated. A small intercostal space may have been present in the anterior and posterior parts. The head of the first rib presented an oval facet, whereas a single kidney shaped facet was observed on the head of second rib. The neck portions of the ribs were directed backwards and laterally. The maximum gap separating the neck regions of the two ribs was 5 mm (vertical); however, adjoining the tubercles, anteriorly the neck portions were fused with each other and could be traced in continuity with the inner border of the rib specimen. It was also observed that the ribs were partially fused in the region of tubercles and adjacent parts of shafts,

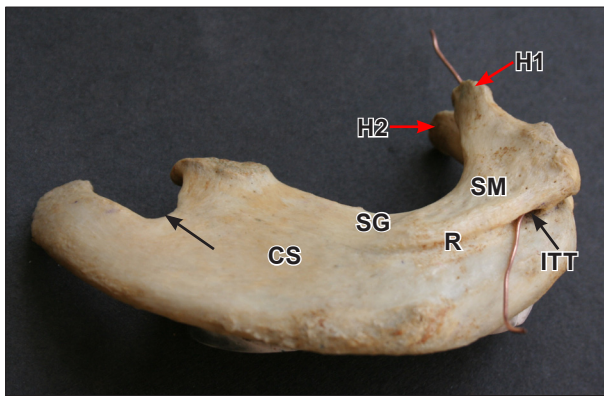


Figure 1. Specimen of fused first and second ribs of left side. (*H1: head of first rib; H2: head of second rib; SM: attachment of scalenus medius; CS: conjoined shaft; SG: groove for subclavian artery; R: ridge indicating the outer border of first rib; ITT: intertubercular tunnel; arrow: V-shaped notch*)

which resulted in the formation of an osseous tunnel, which could be designated as intertubercular tunnel. The tunnel measured 1.2 cm in length and presented medial and lateral openings (Figure 1).

Middle portion of the rib specimen was in the form of a conjoint shaft contributed by the first and second ribs. The sharp inner border extended from the fused portion of the neck of two ribs to the costal facet on the first rib, and presented scalene tubercle close to the anterior end. The outer border of the rib specimen presented a tuberosity near its middle part for the attachment of serratus anterior muscle.

The superior surface of the rib specimen displayed grooves and ridges. A ridge extending from tubercle of first rib to middle of conjoint shaft represented the fused outer border of first rib (Figure 1). A well-marked large and rough impression was observed on this surface for the attachment of scalenus medius muscle (Figure 1). Muscular impression for the subclavius muscle was also prominent. A deep groove for the subclavian artery and lower trunk of brachial plexus was observed on this surface (Figure 1). The inferior surface had a smooth contour and exhibited a costal groove in its posterolateral segment. The maximum width of the conjoint shaft was 3.6 cm as observed in its anterior part and was mainly contributed by the broadened shaft of the second rib. The anterior end of the rib specimen was marked by a V-shaped notch bounded by a short medial limb and a long lateral limb, each bearing a costal facet. The lateral limb was contributed by the terminal portion of the shaft of second rib and the short medial limb joined the anterior end of the first rib. The maximum width of the notch measured 1.5 cm (Figure 1).

Radiological Evaluation

The anomalous rib specimen was radiographed with the probe placed in the intertubercular tunnel. Examination of the skiagram revealed overlapping of the two ribs posteriorly. However, anteriorly the fused shafts occupied the same vertebral level. The outer border of the first rib could be delineated as a dense curved line extending

from the tubercle up to the middle of the shaft. The region of fused portion of neck and adjoining areas of the shafts and the fused part of tubercles were observed as two radio-opaque curved ridges (Figure 2). The osseous tunnel between the two ridges as indicated by probe was directed anterolaterally and was visualized as a zone of rarefaction (Figure 2).

Discussion

Rib abnormalities at the upper end of thoracic cage are due to errors in segmentation of bony tissue during development and may be associated with variations in the disposition of nerves and vessels [2]. The variation in arterial tree can affect development of upper ribs on the left side [2]. The first rib anomalies include the floating rib, central defects bridged by ligamentous bands, rudimentary structure terminating in a synostosis or pseudoarthrosis with second rib, bifurcated first rib etc. [4]. However, to the best of our knowledge the rib specimen similar to that found in the present study has not been reported in literature. The anatomical reports on the fusion of ribs described first rib as a rudimentary structure forming synostosis with the second rib [4,5,7,8]. Contrarily, in the present study, the fused first rib was of normal caliber. However, the second rib was much wider in the middle portion (Figure 1). The junction of ribs usually lies close to the insertion of scalenus anterior muscle and crossing of the trunk of brachial plexus and subclavian artery [4]. It may involve posterior or



Figure 2. Skiagram of the rib specimen showing synostosis of left sided first two ribs, with probe in the intertubercular tunnel (*black arrow*). (*R1: ridge formed by fused portions of neck; R2: ridge formed by fused portion of tubercles*)

anterior portions of the ribs or may be complete [6]. In the present study the ribs were partially fused in the anterior and posterior portions and completely blended with each other in the middle (Figure 1). This obliterated the first intercostal space. It may appear as crowding of spaces on the radiograph.

The first rib instead of forming a synostosis may remain floating in soft tissue similar to those found in birds [9], or may be connected by a ligamentous band with the sternum [2]. The rib specimen in this study presented costal facets and thus confirmed its articulation with the sternum. The presence of osseous tunnel in the rib specimen of the present study is a unique observation, which has not been reported earlier. Topography of the tunnel reasonably justifies its designation as inter-tubercular tunnel (Figure 1). This tunnel measuring 1.2 cm in length, might transmit the first intercostal nerve or posterior intercostal vessels, and could form a potential site for nerve entrapment or compression of vessels. The clinical experience and enormous reported data relates TOS to cervical rib or abnormalities of scalenus anterior muscle. However, similar clinical manifestations may be seen with congenitally abnormal first rib and associated second rib synostosis [4,5]. Few clinical studies reported that neurological symptoms and vasomotor changes of TOS could be attributed to broad attachment of scalenus medius muscle [5,10]. Compression of neurovascular structures may occur while passing from neck to axilla through a narrow interval between scalenus anterior, hypertrophied scalenus medius and first rib [10]. Interestingly, rib specimen of this study showed a large area for attachment of scalenus medius muscle (Figure 1).

Admittedly, the clinical history of the individual was not available for corroboration with the anatomical findings in the present study. First rib malformations such as rudimentary rib, fused ribs are commonly associated with postfixed brachial plexus with a large contribution from second thoracic nerve [4,8]. The contribution of second thoracic nerve may cause extra pressure on the groove [4]. It can only be a conjecture whether the deep groove on the rib specimen in the present study is associated with postfixed brachial plexus. The lower trunk of brachial plexus curves intimately round the sharp inner border of the rib in the region of groove [8]. Possibly the first and second thoracic nerves may get stretched over the broadened shaft of fused first and second rib, and may result in neurological symptoms of TOS. The radiological picture of the rib specimen with the probe in the inter-tubercular tunnel confirmed the morphological findings. In majority, the symptoms of TOS whether due to cervical rib or anomalous first rib are neurological [4,5,8]. However, significant vascular compromise has been reported with fused first and second ribs and warrants an early diagnosis and surgical intervention [5].

Rib fusion causes scoliosis and restriction of chest wall expansion [3], which may require surgical correction. We as anatomists opine that awareness and precise knowledge of skeletal abnormalities such as encountered in the present study, have important clinical significance besides the academic interest. The present paper is a sincere attempt to highlight the morphological and radiological evaluation of synostosis of first two ribs and also discusses the clinical implications.

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