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Chest wall – underappreciated structure in sonography. Part II: Non-cancerous lesions

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Abstract

The chest wall is a vast and complex structure, hence the wide range of pathological conditions that may affect it. The aim of this publication is to discuss the usefulness of ultrasound for the diagnosis of benign lesions involving the thoracic wall. The most commonly encountered conditions include sternal and costal injuries and thoracic lymphadenopathy. Ultrasound is very efficient in identifying the etiology of pain experienced in the anterior chest wall following CPR interventions. Both available literature and the authors' own experience prompt us to propose ultrasound evaluation as the first step in the diagnostic workup of chest trauma, as it permits far superior visualization of the examined structures compared with conventional radiography. Sonographic evaluation allows correct diagnosis in the case of various costal and chondral defects suspicious for cancer. It also facilitates diagnosis of such conditions as degenerative lesions, subluxation of sternoclavicular joints (SCJs) and inflammatory lesions of various etiology and location. US may be used as the diagnostic modality of choice in conditions following thoracoscopy or thoracotomy. It may also visualize the fairly common sternal wound infection, including bone inflammation. Slipping rib syndrome, relatively little known among clinicians, has also been discussed in the study. A whole gamut of benign lesions of thoracic soft tissues, such as enlarged lymph nodes, torn muscles, hematomas, abscesses, fissures, scars or foreign bodies, are all easily identified on ultrasound, just like in other superficially located organs.

The chest wall is a vast and complex structure where a whole range of pathological conditions may be encountered, with post-traumatic sternal and costal injuries and lymphadenopathy of thoracic lymph nodes being the largest group[1–10]. The objective of the present study is to discuss the usefulness of sonography in the diagnostics of noncancerous lesions of the chest wall.

1. Developmental anomalies are mostly found in children and young adults[9,11–16]. The most common defects are sternal and costal variations, present in approximately one third of patients in this age group[12]. The conditions encountered in the anterior chest wall include asymptomatic malformations manifesting as chondral, costal or sternal asymmetry, such as aplasia, hypoplasia, fused ribs or cartilages, increased angularity of the costal cartilage or rib, rib clefts, supernumerary costal cartilages and ribs (Fig. 1). Sometimes, spiked ends of the floating ribs may cause localized pain on rapid movements of the trunk (Fig. 2). Such anomalies are easily identified on ultrasound[9,17]. More serious thoracic deformations, however, such as pectus carinatum or pectus excavatum compressing blood vessels and the respiratory tract, frequently with concomitant kyphoscoliosis, require volume imaging modalities, such as CT or MRI[11–13]. In the sternum, the most common developmental variations include elongated or forked xiphoid process. Persistent developmental fissures or

foramina may also be present (Fig. 3). Less frequently, suprasternal bones (ossicles) are found over the suprasternal notch[16,17]. Congenital malformations of the scapula range from its complete absence to hypoplasia and partial duplication. Sometimes, the spine of the scapula may be improperly fused with the acromion, or the coracoid process improperly joined with the scapula. Congenital elevation of the scapula (Sprengel deformity) is commonly accompanied by anomalies in cervicothoracic vertebrae[18–20]. Muscular defects tend to be less frequent. They may manifest as aplasia, hypoplasia or hypertrophy of a given muscle or muscle set, or even the presence of additional muscles. Poland syndrome is a well-known anatomical deformity, involving unilateral underdevelopment or absence of the chest muscle, typically with coexisting ipsilateral cutaneous syndactyly[21–23].

2. Post-traumatic conditions of the chest wall are frequent, and they are easily identified on ultrasound. Blunt chest trauma typically results with rib fractures, which account for at least 50% of all chest injuries[3]. Only 10–60% of rib injuries are visible on plain film radiography[2,6,7–9,24]. Sonography is especially helpful in diagnosing occult fractures where no direct injury occurred, where bone dislocation is absent, or where it is costal cartilage that is fractured[2,4,7,25]. Breaks show on ultrasound as linear cortical discontinuity (Fig. 4), sometimes with a very slight, step-like, dislocation present. When the discontinuity is more prominent, there may be an acoustic shadow visible deep to its posterior border, customarily referred to as the lighthouse or chimney phenomenon (Fig. 5). An additional sign may be the presence of a hematoma at the anterior contour of the break (Fig. 6). Ultrasound is also used to check for the formation of a fibrocartilage callus (Fig. 7). It also helps to detect potential coexisting injuries, such as a pleural hematoma, pneumothorax or pulmonary contusion[5,6,8,9,24]. Ultrasound is more efficient than conventional radiography in the detection of sternal fractures following different types of trauma (Fig. 8)[9,26–29]. The identification of sternal and costal injuries caused by CPR intervention may be particularly interesting (Fig. 9)[26], as in such cases the pain in the anterior chest wall experienced by the patient tends to be misattributed to cardiac etiology, posing a diagnostic

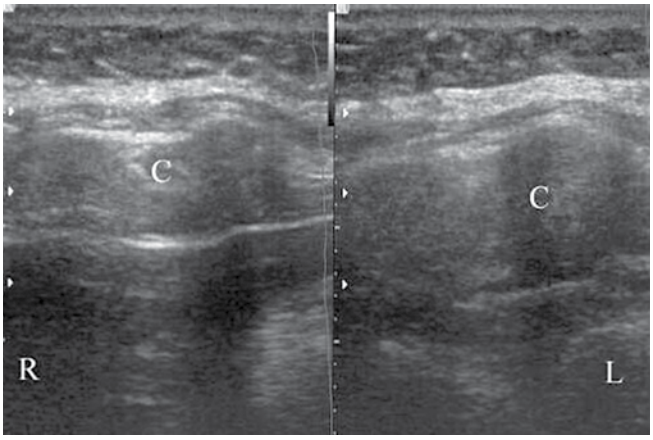

Fig. 1. *Comparative sonogram of costal arches. Costal cartilages (c), thicker on the left side (L)*

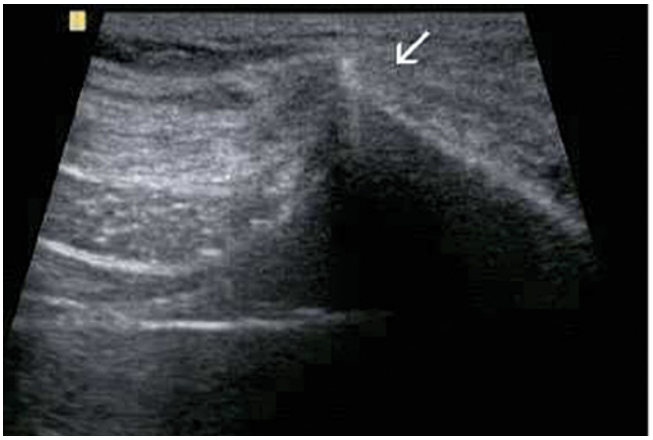

Fig. 2. *End of rib 11, pointed like a spike (arrow), compresses adjacent soft tissues, causing localized pain*

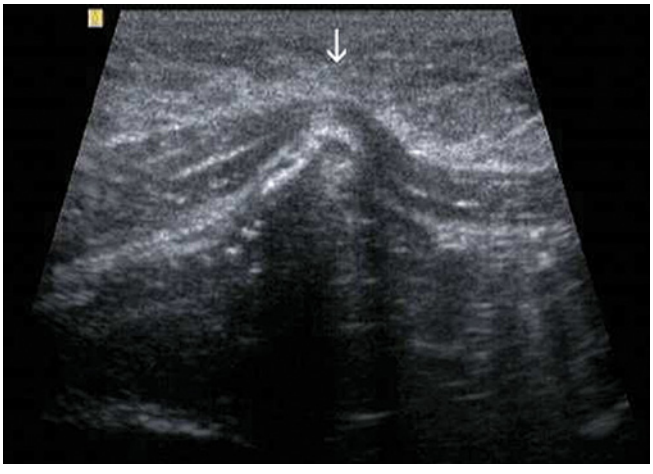

Fig. 3. *Ventrally deviated xiphoid process (arrow), which caused the patient's concern*

Fig. 4. *Fracture of right rib 4 without dislocation (arrow)*

Fig. 5. *Dislocated rib fracture, causing chimney phenomenon on ultrasound (arrows)*

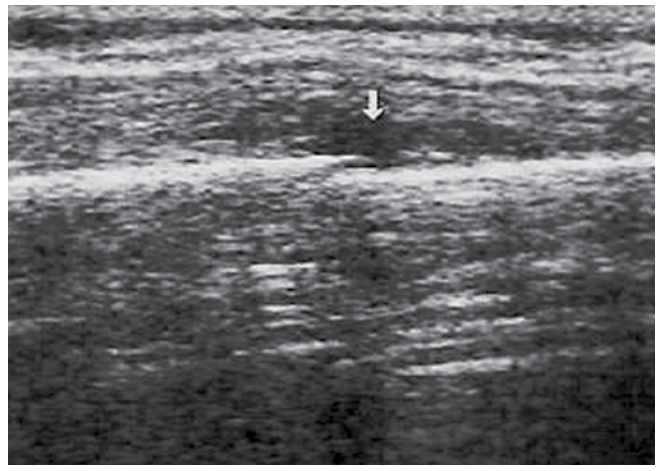

Fig. 6. *Hematoma (arrow) visible at the break*

challenge for the clinician. The large majority of sternal fractures occur in its body, with the sonographic features of sternal trauma being similar to those found in rib fractures. A prompt diagnosis of fracture may be misguided when the cartilage between the manubrium and the sternal body or between the body and the xiphoid process is intact (Fig. 10). Also, the rare longitudinal or horizontal fissures present in the sternum due to developmental anomalies should be kept in mind in such cases to avoid misinterpretation[16]. Ultrasound is very helpful in diagnosing abnormalities of the sternoclavicular joints. All anterior or posterior subluxations of the sternoclavicular ends, which are very challenging to diagnose with plain film radiography, are easily identified on ultrasound (Fig. 11)[30–33]. Intraoperative ultrasound is also extremely valuable as a tool able to confirm whether closed reduction has been successful or not[30]. Ultrasound findings of fracture-separation of the growth plate of the clavicular epiphysis in a 3 year-old boy have also been reported[34]. Additionally, there have been isolated case reports of identification of a scapular fracture on ultrasound[35,36] The modality is also useful for visualizing post-traumatic chest wall or pleural cavity hematomas. Similarly, the value of sonographic examination has been demonstrated for the diagnosis of pneumothorax[3,6,8,9].

3. US may be by the imaging modality of choice in complications of the chest wall following thoracoscopy and thoracotomy. The prevalence of sternotomy complications has been estimated at 0.5–5%[37–39]. The fairly common infected sternotomy wound with purulent drainage, including inflamed bone, is quite easy to diagnose on ultrasound (Fig. 12), even though the diagnosis of these complications involving anterior mediastinum is traditionally performed with CT[37]. Additionally, ultrasound permits an accurate diagnosis of sternal instability due to the absence of proper bone healing following sternotomy[40].

4. Degenerative lesions in the sternoclavicular or sternocostal joints are easy to find on ultrasound, as they present with narrowed joint space and marginal osteophytes, accompanied by distended joint capsule[9] (Fig. 13).

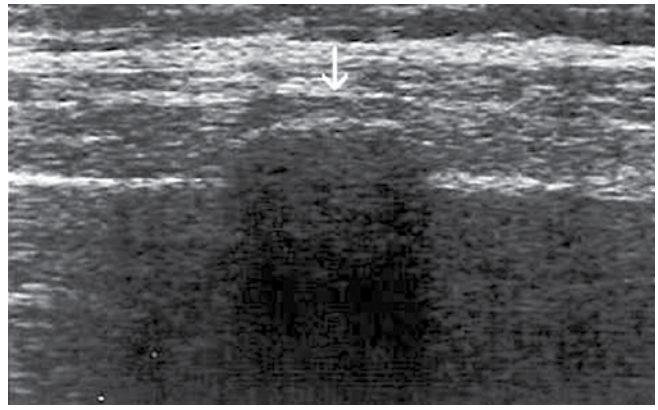

Fig. 7. *External fibrocartilage callus on healing rib (arrow,) 30 days after rib fracture*

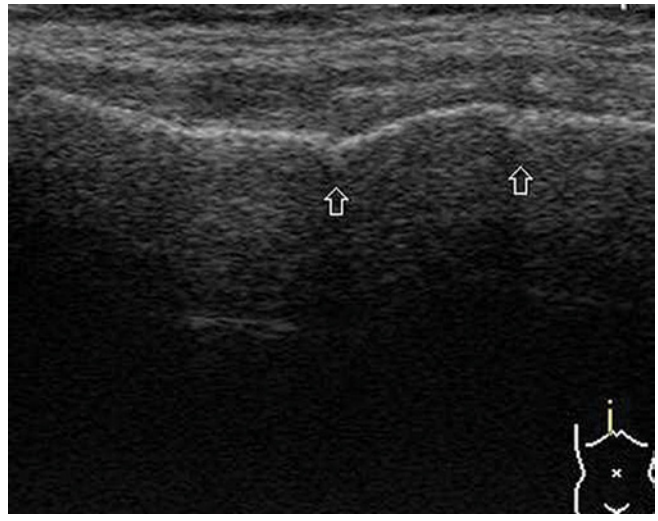

Fig. 8. *Double fracture of the sternal body (arrows) caused by seat belt compression*

5. Inflammatory responses in rheumatic diseases quite commonly involve chondral, osseous and articular ele-

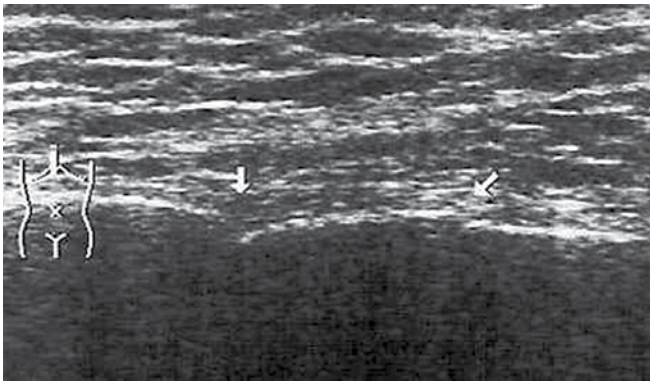

Fig. 9. *Double fracture of the sternal body caused by CPR*

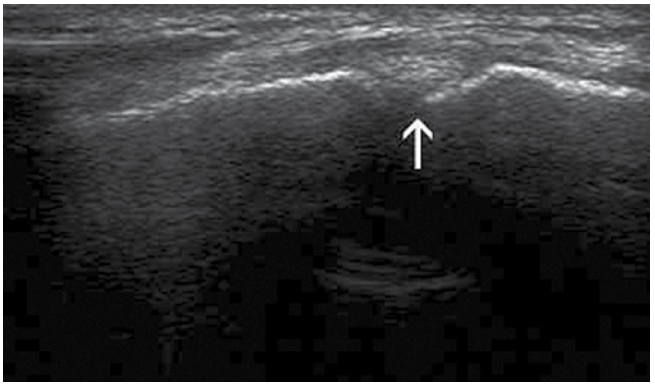

Fig. 10. *The site where the manubrium and the sternal body are joined (arrow) – occasionally misdiagnosed as fracture*

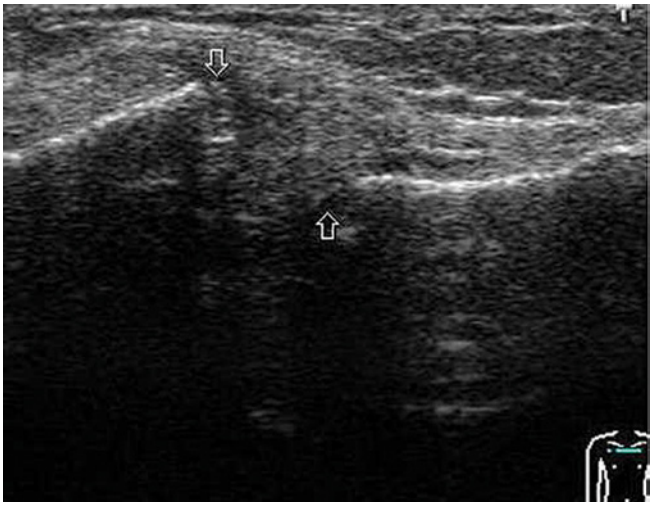

Fig. 11. *Anterior subluxation of the sternal end of the right clavicle. Arrows indicate dislocation distance*

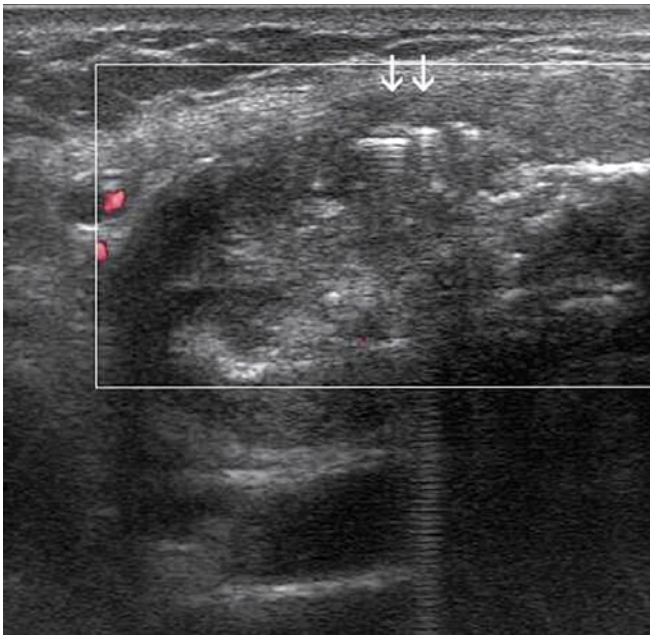

Fig. 12. *Sternal wound infection after sternotomy. Extensive sternal bone destruction where metal sutures were placed (arrows)*

ments of the chest, yet they are rarely the subject of sonographic investigation (Fig. 14)[41–44]. The listed studies are concerned with the so-called Tietze syndrome (osteochondritis), characterized by the inflammation of the cartilage of one or more of the upper ribs (costochondral junction). In this condition, sonographic features may be elusive, commonly limited to the heterogeneity of the cartilage, leading to the occurrence of an acoustic shadow. The most characteristic lesions show thickened cartilage with hazy-looking borders and accompanying edema of the adjacent soft tissue. Another rare condition of similar location is SAPHO (synovitis-acne-pustulosis-hyperostosis-osteotitis), yet as to date, ultrasound has not found its application in this disease entity[45,46].

Infectious lesions in the chest wall are uncommon, and when present tend to be situated in the sternoclavicular joints. They account for approximately 1% of all joint infections and typically affect drug users[9,44,47]. Chest wall tuberculosis is a rare, yet occasionally encountered entity, which involves the thoracic skeleton (Fig. 15).

According to Meuwly *et al.*[5,48], the slipping rib syndrome is not as much a rare, as relatively poorly recognized condition. It manifests by pain experienced in the vicinity of the costal arch, e.g. when coughing or lifting heavy objects. It results from costochondral hypermobility, whereby an inferiorly located cartilage slips onto a superiorly located one, causing nerve irritation in this area. The 7 upper sets of ribs are strongly connected directly to the sternum through sternocostal joints, whilst cartilages of rib 8, 9 and 10 are joined to each other by bands of loose fibrous tissue. This is where roof tile-like arrangement of cartilages may occur. The Valsalva maneuver performed by the patient during an ultrasound exam helps to induce such a setup, facilitating correct diagnosis. A linear transducer should then be placed in a position transverse to the course of the last cartilages[5,48] (Fig. 16).

6. Noncancerous soft tissue lesions of the chest wall, such as enlarged lymph nodes, injured muscles, hematomas, abscesses, fissures, scars or foreign bodies are easily identified on ultrasound, just like other superficially located structures and organs[5,6,8,9,24,44,49,50].

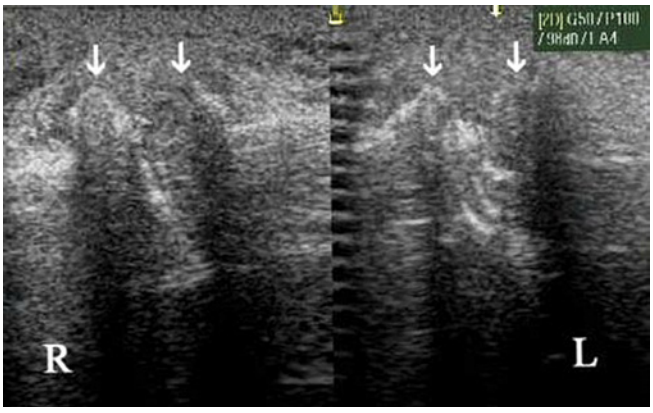

Fig. 13. *Marked degenerative lesions in sternoclavicular joints. Arrows indicate marginal osteophytosis*

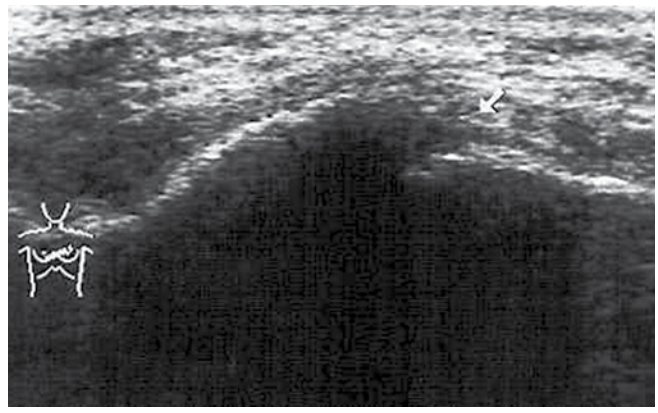

Fig. 14. *Destructive lesions accompanied by ossification found at the interface of the manubrium and the sternal body (arrow) in a patient suffering from ankylosing spondylitis*

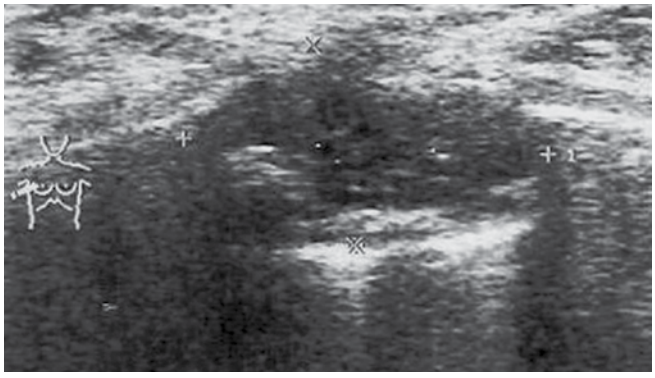

Fig. 15. *Extensive rib destruction caused by TB found in a 54-year old female farmer*

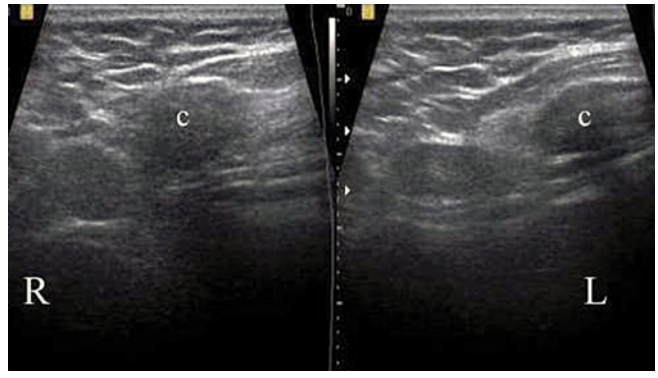

Fig. 16. *Slipping rib syndrome. Comparative sonogram showing dislocation of right rib 8 slipping towards rib 7 (R), revealed during Valsalva maneuver . No such effect was demonstrated on the left side while performing the same maneuver (L).*

Summary

Based on the literature of the subject and the authors' own experience, ultrasound may safely be assumed as the modality of choice for the diagnosis of a wide range of non-cancerous pathological conditions involving the chest wall.

Conflict of interest

Authors declare no financial or personal links t any persons or organizations that may adversely affect the content of this publication or claim rights thereto.

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