Costal cartilage fractures: spectrum of findings at 64-slice multidetector CT

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Learning objectives

To review, illustrate and discuss the 64-slice multidetector CT appearance of costal cartilage fractures and related traumatic injuries.
Background

Anatomy and normal appearance:

The costal cartilage extend medially from the anterior rib ends and articulate with the sternum (cartilages of ribs 1-5) or costal arch (cartilages of ribs 6-10). These cartilages are bound to the external ends of the ribs by means of continuity of the periosteum of the bone and the perichondrium of the cartilage. The cartilages of the floating ribs (11\(^{th}\) and 12\(^{th}\)) terminate in the abdominal wall. [1]

Costal cartilages may not be radiographically recognizable unless they are calcified. In adulthood it is frequent to see ossification foci in costal cartilage, but these are irregular and gender-variable. These ossifications are generally seen in older than 30 years. Before that age may be associated with chronic renal failure, thyroid disease, autoimmune disorders and chondrosarcoma. The normal patterns of calcification differ between males and females, appearing as peripheral parallel lines extending from the anterior rib ends in males and as central, globular clumps, or a "waging tongue" pattern in females (begins as linear ossific tongues originating from the center of the rib at the costochondral junction and develops into relatively thick sheets of calcification) [2,1]

Variants:

We are able to see a diffuse enlargement of the costal cartilages in acromegaly and rickets. In acromegaly it is due to the hypersecretion of somatotropin that may activate endochondral bone formation at existing cartilage-bone junctions and induce periosteal bone formation. In rickets the zone of provisional calcification does not form. Maturing cartilage cells heap up, and there is a failure of osteoid mineralization, resulting in the classic rachitic rosary. [1]

There are also several variations in the anterior chest wall: tilted sternum, prominent convexity of the anterior rib or costal cartilage, well-defined small parachondral nodule, pectus excavatum or pectus carinatum.

Tilted sternum is present when the sternum is not oriented in the horizontal left-to-right axis of the body.

The anterior convexity of a rib or costal cartilage is considered when a solitary rib or costal cartilage demonstrates an apex anterior convexity with angulation greater than that of the adjacent superior, inferior or contralateral and costal cartilage. It is considered that
a costal cartilage is asymmetrically prominent when the anteroposterior diameter of one cartilage is more than 3 mm than the contralateral isolevel one.

Parachondral nodule is defined as the presence of a well-defined nodule less than 1 cm diameter noted in the subcutaneous fat immediately adjacent to the sternum or costal cartilage.

Pectus excavatum is present when the anterior chest wall is prominent concave with the midline located more posteriorly than the adjacent, more lateral chest wall.

Pectus carinatum is present when the anterior chest wall is prominent convex with the midline located more anteriorly than the adjacent, more lateral chest wall. [3]

Sonography allows visualize the costal osseous and cartilaginous component as a thin echogenic line with posterior shadow. Costal cartilage appears hypoechoic compared with osseous component [4,5,6].

On CT, cartilage density is uniform (70-120 HU) and higher than muscle and fat, but less than bone. MDCT allows visualize ribs and costal cartilage in multiplanar reformatted images, doing easy to view their anatomy.

On MRI, costal cartilage presents hyposignal in T1 and T2-weighted images, compared to the muscle and fat adjacent. Costal cartilage injuries are visible because of the high signal from the surrounding edema, seen even in cases of remote injury as a high T2 signal in the site of fracture. [7]

Rib fractures are common and usually involve the osseous component of a rib. However, fracture of the costal cartilage of the rib is rare and its diagnosis is difficult because it is usually not visualized in radiographies, apart from the one densely calcified.

Fractures of costal cartilages are rarely described in the literature, although they are probably more prevalent than previously thought. Ultrasound has been described as an useful diagnostic test in costal cartilage fractures, more sensitive than plain chest radiography.

Currently available MDCT offers the combined advantages of high speed, coverage of the entire thoracic wall, and outstanding spatial resolution, leading to superb multiplanar reformations and volume rendering. These technical advances provide an excellent opportunity for detecting costal cartilage fractures and related traumatic injuries.

To realize the diagnosis of fracture of costal cartilage in patient with pain, it is important to make the proper symptomatic treatment and to avoid doing more diagnostic tests. Many
of cases of costal cartilage fracture have been discovered in patients with unexplained considerable local acute posttraumatic pain, or because of a chronic painful lump without and obvious origin, with normal radiography studies [8].
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Costal cartilage fractures are identified on CT by focal interruption in the high cartilage density, displacement of the adjacent segments, soft-tissue swelling, calcifications surrounding the fracture, gas bubbles within the cartilage cleft [8,9].

When a chronic fracture of the cartilage is not recognized, the lesion may be misdiagnosed. Histologic analysis of the biopsy can reveal signs suggestive of a malignant tumor. Most of these fractures were diagnosed in young people, probably because the osseous component of ribs is strong in young people. [8].

Differential diagnosis includes other painful lesions of the costal cartilage, such as costochondritis and Tietze’s and Cyriax’s syndromes. When the main symptom is a focal mass, we must also consider tumoral or infectious lesions. Infectious costochondritis can be secondary to an extension of pulmonary infection or hematogenous dissemination or as a postoperative complication. CT findings include chondral enlargement or destruction, low-attenuation cartilage at CT, associated soft-tissue swelling and localized peripheral cartilage calcification. [1]. Chondrosarcoma usually arises at or near the costochondral junction and they usually contain a flocculent, stippled or ring- and arclike calcification. [1,2]. Chondral fracture with soft-lesion swelling can be differentiated from these other causes because of the visualization of the fracture line seen on multiplanar CT images, a step-off deformity and the presence of gas within the cartilage cleft.
Images for this section:

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Conclusion

64-slice multidetector CT is an excellent modality for diagnosing costal cartilage fractures.
References