Abstract

The costal cartilages, (CC’s,) which can be indicative of sex, bone age, and underlying systemic disease processes, 1, 2 often experience the large, sudden forces of acute body trauma including that of motor vehicle collisions. Despite descriptions of the imaging appearances on Radiographs, Ultrasound, and Magnetic Resonance Imaging, 3, 4 there is a paucity of literature describing CC injuries on Computed Tomography. Our primary intent is to review and characterize the spectrum of CC injuries based on a ten-year retrospective review of blunt trauma related body CT studies performed at our institution between 2003 and 2013 in which such injuries were prospectively identified. Secondly we propose a simple schema for characterization and classification of costal cartilage injuries based on our review. We then relate that classification system to the American Association for the Surgery of Trauma (AAST) Chest Wall Trauma Score. Finally we demonstrate some characteristic imaging appearances of costal cartilage injuries, and related injuries and complications.

Methods

After approval by our Institutional Review Board (IRB), a retrospective review of radiology reports and CT images from the radiology archive for the prospective diagnosis of costochondral injury in patients undergoing CT scan of the thorax for trauma was performed. We used a medical search engine (Sfoilik Illuminate, Prairie Village, KS, USA) to search a 10 year time frame, (January 2003–December 2013) in patients 18 years of age or greater. Data search utilized key phrases including “costal,” “chondral,” and “cartilage,” and “costochondral,” resulting in 44 cases. Each case was reviewed by a Radiologist with 15 years post fellowship experience in trauma imaging to confirm the presence of costal cartilage injury. Review of the electronic medical record was conducted to determine associated injuries and complications.

Characterization and Trauma Score

We advocate for a simple classification scheme based on type of CC disruption, (fracture, separation,) location, (costochondral, manubriosternal, costosternal,) percent displacement in terms of shaft width, and separation distance.

Rib fractures play a major role in assessment of the Chest Wall Trauma Score. A summary of this impact is in the table below.

<table>
<thead>
<tr>
<th>Rib Fracture Impact on Chest Wall Trauma Score</th>
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<tr>
<td>Grade</td>
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<td>Rib Fracture</td>
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We propose that costal cartilage injuries be considered similar to rib fractures in the chest wall trauma score as in our experience they appear to impart similar risks and the two often coexist.

Anatomy of Ribs and Costal Cartilages

• Costal Cartilages are the anterior-most portions of the 7 true and 3 false costal ribs.
• True ribs are individually attached to the sternum via CC’s.
• False ribs share a costochondral attachment to the sternum.
• Floating ribs do not contact the sternum.
• Ribs 1 and 2 are uniformly thick and quite dense, with short CC’s.
• Ribs increase in length from 1-7, then decrease from 7-12.
• CC’s originate from the same mesenchymal sclerotomes as their corresponding ribs.
• Each rib and CC form a ring, with most plasticity imparted by the CC’s.
• CC’s vascularize and calcify or ossify with age in various patterns which vary somewhat predictably by sex, age and race. 1, 2, 10, 11.
• Calcification is present in most 20-80 year old patients, begins in the third decade, and may decrease plasticity. 1, 12, 13, 14.

Pictorial Review of injuries

Figure 1, Figure 2, Figure 3, Figure 4

Associated Injuries / Complications

Most associated injuries observed in our case series were also associated with rib fractures. The frequency of such injuries included rib fractures, (seen in 50% of cases,) additional CC injuries, (48%), mediastinal hematoma, (32%), sternal/manubrial fractures, (22%), chest wall hematomas, (18%), pneumothoraces, (20%), hematomas, (9%), chest wall lacerations, (9%) and clavicular fractures, (7%).

In a few unique cases, there were late complications as well, as in one particular case in which multiple small chondral separations, (figure 5) when combined with contralateral rib fractures, functioned as a flail segment and resulted in a dramatic lung herniation which required surgical closure.

Learning Points

• CC injuries are uncommon injuries and, in our experience, may easily be overlooked.
• CC trauma commonly occurs in three locations:
  1. The CC attachment to the ossified rib end, or “costochondral junction,”
  2. In the mid-cartilage, or “manubriosternal” location, or
  3. At the costosternal/costosternal attachment
• Potential complications mimic those of rib fractures, and include:
  • Associated rib fractures and other costal cartilage injuries
  • Mediastinal hematoma
  • Sternum, manubrial, claviclar, and pelvic fractures
  • Pneumothoraces and hematomas
  • Chest wall lacerations and subcutaneous emphysema
• Greater awareness of spectrum of injuries and their appearances is intended to lead to greater recognition of this traumatic injury.

References