MRI Evaluation of Costal Cartilage Injuries

OBJECTIVE. The usefulness of MRI in costal cartilage injuries has not been shown. We report the MRI findings in a series of patients with costal cartilage injuries.

CONCLUSION. MRI can be a useful technique in the diagnosis of costal cartilage injuries.

Keywords: costal cartilage, costochondral injuries, MRI, rib fracture, trauma

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Materials and Methods

After obtaining a waiver of informed consent from our institutional review board, a retrospective search was conducted for the time period of January 1, 2000, to December 31, 2006, using the radiology reporting database. All MRI examinations with the words “costal cartilage” or “costochondral” appearing in the dictated report were identified. Costal cartilage injury was defined as costal cartilage fracture or junctional injuries involving separation with or without associated chondral fracture involving the sternochondral or costochondral junctions. Fifty-three examinations were identified. Eight of these examinations (seven chest wall MRI examinations and one abdomen MRI) reported costal cartilage injury and were included in the study. The other examinations were excluded because costochondral injury or fracture was not reported. One of the included examinations involved injuries at two contiguous levels. Five additional MRI examinations of costal cartilage injury from two other institutions were also included, for a total of 13 patients with 14 injuries.

The injuries occurred in 10 male and three female patients ranging in age from 17 to 50 years old (mean age, 32.9 years) who had costal cartilage injuries diagnosed on MRI examinations. All 13 patients had a history of antecedent trauma and clinical symptoms directly referable to the area of abnormality on the imaging studies. Injuries were related to sports activities in nine patients. Four of these nine patients with sports-related injuries were professional athletes: three professional hockey players and one professional football player. In the other five patients with sports-related injuries, two patients had wrestling-related injuries and three patients had injuries related to rugby, karate, and weightlifting. The four non-sports-related injuries were the result of a motor vehicle accident, a fall from a height, lifting a heavy object, and a heavy object falling on the chest. All but one patient had pain in the involved area of the chest wall. Two patients complained of mass in the chest wall.

MRI was ordered to ascertain the cause of the pain or mass and to distinguish between bone, soft-tissue, and cartilage injury. In 11 of the 13 patients, the trauma was fairly close to the time of presentation (< 3 months), whereas, in the other
two cases, the trauma was further removed (> 6 months) from the time of presentation. The injuries were right-sided in six patients and left-sided in seven patients.

The patients were imaged on various MRI scanners: four cases on a 1-T magnet, eight on a 1.5-T magnet, and one on an open 0.3-T magnet. Spin-echo T1-weighted (TR range/TE range, 419–783/10–20), fast spin-echo T2-weighted sequences with or without fat suppression (2,000–6,440/83–96), or STIR images (1,800–6,970/13–60; inversion time, 130–160 milliseconds) were obtained in all but one of the patients. One patient, whose examination was a dedicated abdominal examination, underwent only T2-weighted fast spin-echo imaging of the costal cartilages. Gradient-echo sequences were performed in four of the cases. Coronal and axial images were acquired in all cases, and sagittal images were acquired in seven. Oblique planes were not routinely obtained. The fields of view ranged from 14 to 40 cm.

The MRI examinations were reviewed retrospectively by two trained musculoskeletal radiologists in consensus to identify the imaging features associated with these injuries. These features included location of injury, presence of edemalike signal at and around the site of injury, presence of a fracture line, amount of fracture displacement, and associated injuries such as muscle tears or osseous rib fractures.

Additional cross-sectional imaging at the time of injury was performed in five patients (CT in four patients and nuclear medicine bone scanning in one). Electronic or hard-copy charts were available for review in seven patients. Imaging or clinical follow-up was available in six patients.

Results

MRI showed involvement of the first or second ribs in nine of the 14 injuries, with the most common site being the first rib (n = 8 injuries) (Fig. 1). Twelve of the 14 injuries were junctional injuries—that is, involving either the sternochondral (n = 5 injuries) or costochondral (n = 7 injuries) junction. In one case, injury occurred at two adjacent levels. Increased edemalike T2 signal was seen at the site of injury. The injuries were best visualized on the fluid-sensitive sequences (fat-saturated fast spin-echo T2-weighted or STIR sequences) and in the coronal plane (Fig. 2A) with a field of view focused to the region of clinical symptoms. Gradient-echo images, when obtained, also showed the fracture lines well (Fig. 2B).

All five sternochondral junction injuries were at the first rib and manubrium articulation and showed a similar imaging pattern: a small triangular fragment of cartilage remaining firmly attached to the sternum. All but one of the costochondral injuries were at contiguous levels involving ribs 5 and 6, occurred in a wrestler. The other three injuries were all seen in professional hockey players as a result of a direct blow to the chest.

Three patients had additional injuries. In two patients, fractures of the adjacent osseous rib or ribs were seen; and in one patient with a sternochondral injury to the first rib, injury to the adjacent sternoclavicular joint was seen. No remote muscle injuries or tears were present aside from injury to the adjacent intercostal musculature. As previously stated, one patient had injuries at two adjacent levels involving the costochondral junctions.

CT performed in four patients correlated with and confirmed the MRI findings, as did bone scanning performed in one of these patients. In one patient, CT was initially interpreted as normal because of a subtle nondisplaced fracture line (Fig. 4A). However, the injury was readily visible on MRI, which showed marked increased T2 signal at the site of injury (Fig. 4B). Six patients had documented radiographs obtained before MRI that were reported as normal in all but one case, in which irregular calcification at the site of the injury was thought to be suspicious for a costal cartilage fracture. All patients in whom clinical notes were available for review were treated conservatively with rest and restriction from painful activity, nonsteroidal antiinflammatory medications, local anesthetic injections for temporary pain relief for two professional hockey players, or physical therapy.

All five patients who had clinical follow-up showed improvement or resolution, although in some cases this occurred gradually over several months. The only patient with radiographic abnormalities underwent repeated

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Fig. 3—21-year-old man with chest wall pain after rugby injury. Coronal STIR image shows high signal at first costal cartilage near sternochondral junction (white arrow), compatible with fracture. Note small triangular fragment (arrowheads) of first costal cartilage that still remains attached to sternum. High signal is also seen at left sternoclavicular junction (black arrow), compatible with associated sternoclavicular injury.

Fig. 4—17-year-old boy with persistent chest wall pain after wrestling injury. A, Axial CT image shows subtle nondisplaced fracture (arrows) that was initially missed. B, Injury is more apparent on fat-suppressed T2-weighted coronal MR image because of high signal (arrow) at site of injury. C = clavicle, S = sternum.

rib radiography 4 months after MRI, and the films were normal. Two patients had follow-up MRI 4 months and 1 year after the initial examination, both of which showed near-complete resolution of the increased T2 signal at the site of injury.

Discussion

Identifying the cause of anterior chest wall pain is often difficult. Clinically, the differential diagnosis is broad and includes rib fractures, costal cartilage injuries, and muscle or soft-tissue injury [2, 3, 11]. Radiographs, although useful for detecting osseous abnormalities, are insensitive in detecting cartilage and soft-tissue abnormalities [3]. Because costal cartilage injuries are often located in the junctional regions, sternochondral or costochondral, the overlapping osseous structures in these areas limit the usefulness of radiographs. Cross-sectional techniques such as CT, sonography, and MRI are more sensitive for detecting these injuries.

Several studies have been published describing the usefulness of CT and sonography in the detection of costal cartilage injuries [3, 8–11]. In the largest published series, Malghem et al. [8] described a series of eight patients with 15 costal cartilage injuries diagnosed on CT in all patients and on sonography in three. Their patient population was young (mean age, 27.5 years), and all patients had a prior traumatic injury, related to contact sports [8–10]. In particular, wrestling and football frequently cause costochondral separation [11]. The injuries often involve the first and second ribs and the sternochondral or costochondral junctions [8, 10]. These injuries may be a twisting and rotational type injury to a relatively immobile upper rib cage, particularly in the case of wrestling, as opposed to injuries to the lower ribs, which, in our series, all were in professional hockey players as a result of significant trauma that is often associated with contact sports [8–10]. In particular, wrestling and football frequently cause costochondral separation [11]. The injuries often involve the first and second ribs and the sternochondral or costochondral junctions [8, 10]. These injuries may be a twisting and rotational type injury to a relatively immobile upper rib cage, particularly in the case of wrestling, as opposed to injuries to the lower ribs, which, in our series, all were in professional hockey players as a result of a direct blow to the chest wall in this location.

To our knowledge, however, there has been no published report of the MRI findings of costal cartilage injuries. Our results show that costal cartilage injuries are readily visible on MRI because of the high signal from the surrounding edema; they are often more conspicuous than on CT. Even in cases of remote injury, high T2 signal was visualized at the site of fracture that was presumably due to nonunion given the persistent clinical symptoms. This hypothesis is further supported by the fact that in two cases in which follow-up MRI was performed after the resolution or significant improvement of the clinical symptoms, the T2 signal was nearly normal. The findings were usually best seen on a fat-saturated fluid-sensitive sequence in the coronal plane with a focused field of view.

Therefore, in all patients with trauma and suspected costal cartilage injury, we recommend performing at least one fat-saturated T2-weighted or STIR sequence in the coronal view with a field of view focused to the area of symptomaticity.

Our findings support the previously published articles on costal cartilage injuries with regard to patient demographics, location of injuries, and athletic activities. These injuries typically occur in young patients as a result of significant trauma that is often associated with contact sports [8–10]. In particular, wrestling and football frequently cause costochondral separation [11]. The injuries often involve the first and second ribs and the sternochondral or costochondral junctions [8, 10]. These injuries may be a twisting and rotational type injury to a relatively immobile upper rib cage, particularly in the case of wrestling, as opposed to injuries to the lower ribs, which, in our series, all were in professional hockey players as a result of a direct blow to the chest wall in this location.

The literature regarding the treatment of costochondral injuries is sparse. At our institution, these injuries are treated in a similar manner to osseous rib fractures—that is, typically nonsurgical treatment involving ice, nonsteroidal antiinflammatory medications, and taping of the ipsilateral chest wall or use of a rib belt; in addition, athletes are restricted from sport for 3 weeks or longer.
and encouraged to use protective padding on their return to sport [11]. All patients in our series were treated nonsurgically. Improvement of symptoms was seen in all patients at clinical follow-up, although in some this occurred gradually over several months. In two of our cases involving professional hockey players, symptoms were reduced by the injection of local anesthetic at the site of injury.

The limitations of our study include its retrospective nature, small number of cases, and the selection bias of including only those patients who had an abnormal finding on MRI.

Costal cartilage injury is a rare imaging diagnosis but likely occurs more frequently in clinical practice and is managed without imaging confirmation. In patients in whom the clinical diagnosis is uncertain or requires confirmation and exclusion of related injuries, particularly in professional athletes, MRI can be a useful technique. MRI may be preferred to CT and sonography not only for the diagnosis of costal cartilage injuries but also as a follow-up tool to monitor healing because of the lack of ionizing radiation in this young patient population, the excellent contrast resolution for identification of associated soft-tissue injuries, and its availability in a setting in which an experienced sonographer may not be available to perform sonography. Further studies, however, are needed for validation.

References