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CLINICAL IMAGING

Diffusion-weighted whole-body imaging with background body signal suppression facilitates detection and evaluation of an anterior rib contusion

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Abstract

We report the magnetic resonance imaging (MRI) findings in a 29-year-old woman with anterior chest wall pain following blunt trauma, with special emphasis on the value of diffusion-weighted whole-body imaging with background body signal suppression (DWIBS). Although a rib contusion could be depicted at (fat-suppressed) T2-weighted MRI, anatomical localization and assessment of lesion extent were superior and more straightforward at DWIBS. Thus, this report shows the utility of adding DWIBS to an MRI protocol for anterior chest wall evaluation.

Keywords: Diffusion-weighted whole-body imaging with background body signal suppression (DWIBS); Musculoskeletal; Costochondral region; Contusion; Trauma

1. Introduction

Plain radiography, ultrasound, and computed tomography (CT) are commonly used imaging modalities in the diagnostic work-up of blunt trauma to the anterior chest wall, but magnetic resonance imaging (MRI) may also be of use, especially in case of injuries in the costochondral region [1]. Recently, diffusion-weighted whole-body imaging with background body signal suppression (DWIBS) was introduced [2], which has various applications in oncological imaging [3]. However, DWIBS may also be useful in nononcological applications, such as in the case of traumatic musculoskeletal injuries. To our knowledge, this is the first report to demonstrate the utility of DWIBS in detecting, localizing, and assessing the extent of a lesion in the costochondral region following blunt trauma.

2. Case report

A 29-year-old woman with no previous medical history presented with complaints of pain in the right lower anterior chest wall/right upper abdomen. Five days before presentation she was involved in a traffic accident, in which she fell from her bicycle on the street, scraping her right forehead, elbow, and knee. In addition, the steering wheel of her bicycle twisted and impacted her lower anterior chest wall. Despite conservative treatment (i.e., rest, restriction from physical exercise, and nonsteroidal anti-inflammatory medication), the pain in the right lower anterior chest wall intensified after 5 days. The pain was related to movements, including walking and breathing. On physical examination, there were no visible abnormalities of the chest wall. However, breathing was superficial and the patient was unable to perform deep breathing due to pain. Palpation and percussion revealed a painful area in the right lower anterior chest wall. On auscultation, normal vesicular breathing was heard. Because of the suspicion of a lesion in the costochondral region, the limited sensitivity of radiographs in detecting this type of injuries [1,4,5], the absence of an

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experienced musculoskeletal ultrasonographer, and to avoid radiation exposure by CT in this relatively young patient, an MRI scan was performed.

MRI was performed using a 1.5-T system (Achieva, Philips Healthcare, Best, The Netherlands), using a 16-element phased array surface coil (SENSE XL Torso coil, Philips Healthcare). Axial and coronal T1-weighted [repetition time (TR) of 10 ms, echo time (TE) of 4.6 ms, slice thickness/gap of 7.0/1.0 mm, number of slices of 25, number of signal averages (NSA) of 1, matrix of 256×126 (axial) or 256×146 (coronal), field of view (FOV) of 405×285 mm^2 (axial) or 405×329 mm^2, breath-hold image acquisition, effective scan times of 33.4 s (axial) or 38.4 s (coronal)] images showed no apparent abnormalities (Fig. 1A). Axial, coronal, and oblique coronal (focused to the painful area) T2-weighted and fat-saturated T2-weighted [TR of 556 ms, TE of 80 ms, slice thickness/gap of 7.0/1.0 mm, number of slices of 25, NSA of 1, matrix of 400×215 (axial) or 400×249 (coronal), FOV of 405×285 mm^2 (axial) or 405×329 mm^2 (coronal), breath-hold image acquisition, effective scan time of 13.9 s (axial) or 16.1 s (coronal and oblique coronal)] images showed slight bilateral pleural effusions. More importantly, after careful review, an abnormal hyperintense/hypointense signal in one of the lower right ribs was seen at axial T2-weighted/T1-weighted images, respectively, without any clear fracture line (Fig. 1A–C). Although no radiograph was available to exclude a fracture, based on MRI findings the most likely diagnosis was a rib contusion/bone bruise. However, the lesion could not be clearly depicted at coronal and oblique coronal images, making exact lesion localization and assessment of lesion extent difficult (Fig. 2A, C, and D). Axial DWIBS (TR 8737 ms, TE 74 ms, inversion time 180 ms, slice thickness/gap of 4.0/0.0 mm, number of slices of 60, motion probing gradients in three orthogonal directions, *b* values of 0 and 1000 s/mm^2, NSA of 10, matrix of 160×88, FOV of 400×320 mm^2, image acquisition under free breathing, effective scan time of 6 min and 7 s) clearly showed an area of high signal intensity in one of the lower right ribs (Fig. 1D). Postprocessed three-dimensional (3D) maximum intensity projections (MIPs) using the axial source DWIBS dataset confirmed the lesion, showed its extent, and easily localized it to the medial side of the right anterior eight rib in the costochondral region (Fig. 2B and E). In addition, an apparent diffusion coefficient (ADC) map was created using *b* values of 0 and 1000 s/mm^2, and ADC of the rib lesion and ADC in a normal ipsilateral rib were calculated by means of region-of-interest analysis. Mean ADC (in 10^{-3} mm^2/s) of the rib lesion was 1.25±0.15 mm, whereas ADC in the normal ipsilateral rib was 0.85±0.13.

3. Discussion

The differential diagnosis of anterior chest wall pain includes rib fractures, bone contusions/bruises, costal cartilage injuries, and muscle or soft tissue injuries. Radiographs are useful for detecting osseous abnormalities, but are insensitive in detecting bone marrow, cartilage, and

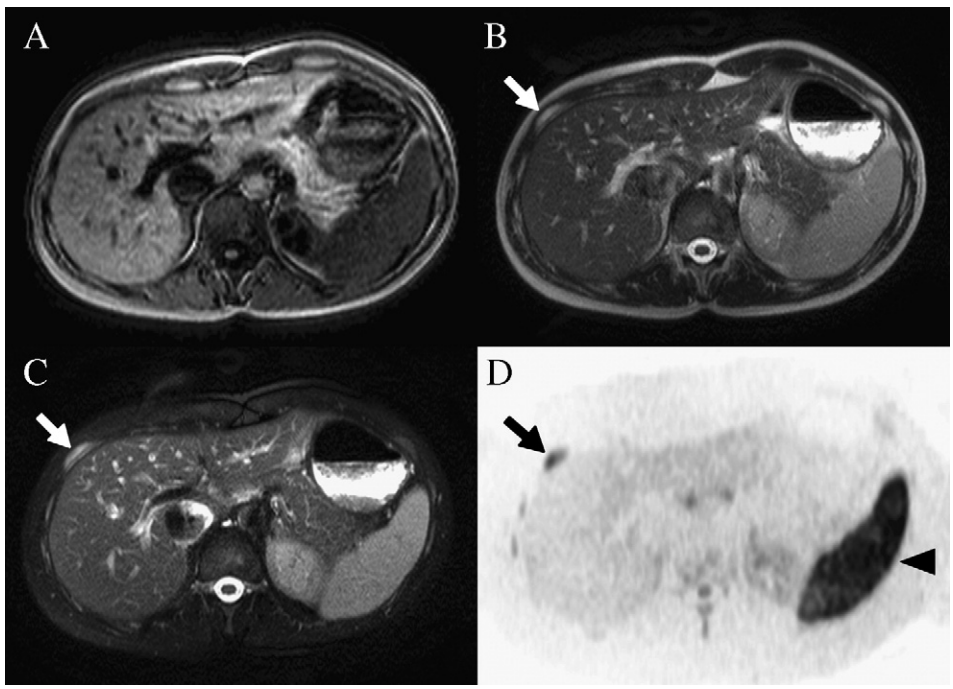

Fig. 1. Axial T1-weighted (A), T2-weighted (B), fat-saturated T2-weighted (C), and (grayscale inverted) DWIBS images (D) at the same level. The T1-weighted image (A) does not show a lesion, but T2-weighted (B) and fat-saturated T2-weighted images (C) show a hyperintense signal in one of the right lower right ribs (white arrows). The lesion is highlighted at DWIBS (D, black arrow). Also note the normal high signal intensity of the spleen at DWIBS (D, arrowhead).