The Egyptian Journal of Radiology and Nuclear Medicine (2014) **45**, 1147–1152

Egyptian Society of Radiology and Nuclear Medicine

The Egyptian Journal of Radiology and Nuclear Medicine

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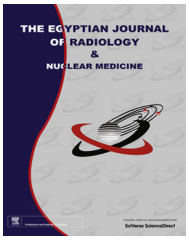

ORIGINAL ARTICLE

Diagnostic value of diffusion weighted magnetic resonance image in early ankylosing spondylitis

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Received 24 December 2013; accepted 25 March 2014
Available online 20 April 2014

KEYWORDS

Ankylosing spondylitis;
Diffusion-weighted MRI,
AS;
Diffusion W;
MRI

Abstract *Background:* Diffusion-weighted MRI (DW-MRI) shows the early changes in microscopical movement of water molecules, hence diagnosis of early sacroiliitis which is one of the diagnostic criteria of seronegative spondyloarthropathies.
Objective: To determine the value of DW-MRI in detection of signal characteristics of the sacroiliac joints in patients with early ankylosing spondylitis (AS).
Patients and methods: Fifteen patients with clinically suspected AS, 20 patients with mechanical low back pain and 20 healthy controls underwent conventional MRI and DWI. Apparent diffusion coefficient (ADC) was measured. In addition ten clinically confirmed AS patients underwent whole body-DWI.
Results: Mean ADC values of both sacroiliac joints in AS patients were $(0.523 \pm 0.15) \times 10^{-3}$ mm^2/s in the ilium and $(0.502 \pm 0.15) \times 10^{-3}$ mm^2/s in the sacrum. There was no significant difference between mechanical LBP and healthy controls. But there was a significant difference between AS and LBP patients. Mean ADC value of focal lesions of clinically confirmed AS was $0.965 \pm 0.25 \times 10^{-3}$ mm^2/s in the sacrum and $0.932 \pm 0.31 \times 10^{-3}$ mm^2/s in the ilium.
Conclusion: Subchondral bone marrow ADC values of sacroiliac joints allow differentiation between inflammatory and mechanical LBP. Furthermore, it may be helpful in evaluating the efficacy of the treatment and determine disease prognosis.

1. Introduction

Ankylosing spondylitis (AS) is a chronic inflammatory disease of unknown cause that affects mainly young adults. Inflammatory back pain and alternating gluteal pain related to sacroiliitis are the leading symptoms in adults with early ankylosing spondylitis and undifferentiated spondyloarthritis (SpA) (1).

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Peer review under responsibility of Egyptian Society of Radiology and Nuclear Medicine.

0378-603X http://dx.doi.org/10.1016/j.ejrnm.2014.03.014

Pain arising from an inflamed sacroiliac joint is typical in ankylosing spondylitis and is always considered a diagnostic criterion (2).

A major challenge in the management of axial spondyloarthritis is the substantial delay in diagnosis, which consistently averages 7–9 years (3). This reflects the lack of specificity of presenting clinical features of the disease, the lack of sensitivity of laboratory markers and the slow rate of radiographic progression in the sacroiliac joints (SIJs) despite ongoing symptoms of inflammatory back pain (IBP) (3).

Imaging studies have always played a prominent role in the diagnosis of ankylosing spondylitis (AS), it yield three major benefits: they ensure the early diagnosis of ankylosing spondylitis in the absence of radiographic sacroiliitis, they provide therapeutic guidance at any time during the course of the disease, and they supply objective information on the degree of inflammation and response to treatment (4).

As diagnostic imaging techniques continue to develop, advanced magnetic resonance imaging (MRI) techniques, such as diffusion weighted imaging (DWI) and whole-body MRI (WB-MRI), have been utilized in the evaluation of patients with suspected early AS (5–7). This technique has proven to be a valuable method for tracing the microscopic structure of tissue. Molecular diffusion is a physical process that is used to describe the Brownian motion of water molecules (8). The apparent diffusion coefficient (ADC), a quantitative parameter calculated from diffusion-weighted images, combines the effects of capillary perfusion and water diffusion in the extracellular extravascular space. When only high b values are applied, the ADC value approximates the true diffusion. Low b values are influenced by both perfusion and diffusion (8). More recently, DWI has been increasingly used in musculoskeletal structures and diseases. Ward et al. (9), analyzed the diffusion characteristics of normal and posttraumatic bone marrow and concluded that increased ADC values were increased in traumatized bone marrow compared with ADC values of normal bone.

The objective of this study was to determine the value of DW-MRI in the detection of active inflammatory changes and signal characteristics of the sacroiliac joints in patients with early ankylosing spondylitis in addition to determining the role of DWI in the differentiation between inflammatory and mechanical low back pain.

2. Patients and methods

Thirty-five patients with simple chronic low back pain with symptoms duration from 6 months to 2 years were recruited from the out- patient clinic of Rheumatology and Rehabilitation Department. Inclusion criteria for the study required the presence of chronic low back pain without a confirmed diagnosis and an age of 16–40 years (mean age: 29 years). Exclusion criteria were current infections (including brucellosis) of the bone and joints, pregnancy, metallic implants, history of traumatic injury, severe disk prolapse, osseous neoplastic or metastatic disease and claustrophobia. We followed the diagnostic algorithm suggested by the Berlin group for the early diagnosis of axial spondyloarthritis (10). The Berlin algorithm is based on the probability of early axial spondyloarthritis in patients with chronic back pain according to the absence or presence of certain clinical features, laboratory tests, and skeletal imaging. The entry criteria were inflammatory back pain and the presence of at least three of seven spondyloarthritis features: family history of spondyloarthritis, heel pain, uveitis, synovitis, dactylitis, good response to non-steroidal anti-inflammatory drugs, and HLA (human leukocyte antigen)-B27 positivity. The result of the algorithm is expressed as a percentage of probability of axial spondyloarthritis (10). The rate above which axial spondyloarthritis is considered a definite diagnosis is 90%. Of thirty-five patients, fifteen patients (13 men and 2 women) had been diagnosed with early AS. The other twenty patients (15 men, 5 women) were diagnosed as simple mechanical low back pain (LBP) because clinical examination, lab test and radiographs did not support the diagnosis of early AS. Twenty age and sex matched healthy volunteers without any history of back pain during the last 6 months were enrolled in our study as a control group. Ten additional patients (7 men, 3 women, age range: 18–39 years, mean age: 27 years) with clinically confirmed AS (disease duration: 3–6 years) were enrolled for WB-DWI.

2.1. MRI examination

All subjects in the AS ($n = 15$), LBP ($n = 20$) and control group ($n = 20$) underwent conventional MRI and DW-MRI of the sacroiliac joints. A 1.5T MR scanner (Siemens, MAGNETOM ASSENZA Muenchen, Germany) with a gradient amplitude of 40 mT/m and a slew rate of 150 T/m/s was utilized with an 16-channel CLT array coil employed for dedicated sacroiliac joint imaging and a built-in body coil for the whole body DWI scan.

MRI Parameters for the sacroiliac joints included: axial spin echo T1-weighted imaging (T1WI, TR 420 ms, TE7.2 ms, NEX 2, matrix 320×192, FOV 36×36), fat-saturated fast spin echo T2-weighted imaging (FST2WI, TR 380 ms, TE 85.5 ms, NEX 2, matrix 256×224, FOV 36×36), oblique coronal short TI inversion recovery (STIR: TR 4100 ms, TE 70.6 ms, TI 150 ms, NEX 4, matrix 288×224, FOV 36×36, 16 slices, slice thickness 7 mm, no slice gap) and axial DWI with a SE-EPI sequence (TR 2000 ms, TE 63.3 ms, NEX 2, matrix 128×128, FOV36×36). Other parameters, including the number of acquired slices (16), slice thickness (7 mm), and interslice gap (none), were kept constant for the above scans. Total scan time was less than 10 min.

WB-DWI was performed in 10 clinically confirmed AS patients. Segmental scanning in the supine position with 30 slices per segment was performed: 7 or 8 segments (i.e., Location 1 through Location 7 or Location 8) were evenly divided between the head and the upper tibia according to subjects' heights. The center frequency (CF) of segments including the head and upper abdomen (i.e., Location 1 and Location 4) was recorded by auto pre-scan functionality, and the mean CF value was calculated and maintained consistent among all subjects. A spin echo, echo planar DWI sequence, was employed with spectral pre-saturation inversion recovery imaging (SPIR; TR 3380 ms, TE 74.1 ms, TI 180 ms, NEX 4, matrix 96×96, FOV 40×40, slice thickness 6 mm, no slice-gaps). The diffusion coefficient of b-value was 600 s/mm^2. Scan time per segment was 2 min 52 s with a total scan time from 20 to 30 min per subject.