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The role of multi-parametric MR imaging in the detection of early inflammatory sacroiliitis according to ASAS criteria

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ABSTRACT

Purpose: To retrospectively evaluate the accuracy of multi-parametric magnetic resonance (MR) imaging including fat saturated (FS) T2-weighted, short-tau inversion recovery (STIR), diffusion-weighted (DW-MR), and dynamic-contrast-enhanced MR (DCE-MR) imaging techniques in the diagnosis of early inflammatory sacroiliitis and determine the additional value of DW-MR and DCE-MR images according to recently defined 'Assessment in SpondyloArthritis international Society' criteria.
Materials and methods: The study included 45 patients with back pain. Two radiologists estimated the likelihood of osteitis in 4 independent viewing sessions including FS T2-weighted, STIR, DW-MR and DCE-MR images. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and area under the receiver operating characteristic (ROC) curve (AUC) were calculated.
Results: Of the 45 patients, 31 had inflammatory back pain. Of 31, 28 (90.3%) patients had inflammatory sacroiliitis diagnosed by clinical and laboratory analysis. FS T2-weighted MR images had the highest sensitivity (42.8% for both radiologists) for detecting osteitis in patients with inflammaory sacroiliitis when compared to other imaging sequences. For specificity, PPV, NPV, accuracy, and AUC levels there were no statistically significant difference between image viewing settings. However, adding STIR, DW-MR and DCE-MR images to the FS T2-weighted MR images did not improve the above stated indices.
Conclusion: FS T2-weighted MR imaging had the highest sensitivity when compared to other imaging sequences. The addition of DW-MR and DCE-MR images did not significantly improve the diagnostic value of MR imaging in the diagnosis of osteitis for both experienced and less experienced radiologists.

1. Introduction

There has been significant progress in the field of axial spondyloarthritis (SpA) over the last decade regarding the diagnosis and management of the disease. The emergence of anti-TNF therapy has further increased the importance of early and accurate detection because the early pre-radiographic axial SpA responds well to anti-TNF therapy [1,2]. The diagnosis of axial SpA is mainly based on the clinical signs associated with imaging and laboratory data. Recently validated and used criteria include 1984 modified New York criteria for ankylosing spondylitis, 1990 Amor criteria and the 1991 European Spondyloarthropathy Study Group criteria for SpA. However these criteria are based on the plain radiography as the imaging modality, and may therefore cause a delay in diagnosis. Since magnetic resonance (MR) imaging has gained wide acceptance in the imaging of pre-radiographic sacroiliitis, the Assessment in SpondyloArthritis international Society (ASAS) proposed new criteria in 2009 which incorporated MR imaging as one of the two arms for the classification of axial SpA. According to the new criteria, active inflammation on MR imaging, highly suggesting sacroiliitis associated with SpA, plus ≥1 SpA features are sufficient to make the diagnosis of axial SpA. Other arm of the ASAS criteria is based on the presence of human leukocyte antigen (HLA)-B27 positivity and ≥2 SpA features. SpA features defined as inflammatory back pain, arthritis, enthesitis (heel), uveitis, dactylitis, psoriasis,

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Table 1
Imaging parameters for sacroiliac joint on the 1.5 T Siemens MR scanner.

	FS T2-weighted MR	STIR MR	DW-MR	DCE-MR
Repetition time (ms)/echo time (ms)	4200–4800/70–80	2300–2650/30–35	2000–2200/80–90	180–190/5.6
Inversion time (ms)	N/A	160	N/A	N/A
Matrix	256 × 256	256 × 256	128 × 128	230 × 256
Flip angle (°)	150	150	90	70
Section thickness (mm)	3	3	4	3
Field of view (cm)	20–25	20–25	20–25	20–25
No. of signals acquired	2	4	4	1
b value (s/mm^2)	N/A	N/A	0, 100, 600, 1000	N/A
Temporal resolution (s)	N/A	N/A	N/A	2

Note: An array spatial sensitivity encoding technique (GRAPPA), parallel imaging factor of 2 was applied to all of the sequences.

Crohn's disesase/ulcerative colitis, favorable response to NSAIDs, family history for SpA, HLA-B27 and elevated CRP [3].

Among the four well described MR imaging findings of active (acute) sacroiliitis (osteitis/bone marrow edema (BME), enthesitis, capsulitis, and synovitis); osteitis/BME is the single mandatory criterion for diagnosis of active sacroiliitis [3]. Although there have been efforts to show the role of MR imaging detecting inflammatory sacroiliitis, radiological studies that compare the diagnostic value of different MR imaging sequences (including diffusion-weighted and contrast enhanced studies) are still limited [4–8]. In this study, the diagnostic performance of multi-parametric MR imaging including fat saturated (FS) T2-weighted, short tau inversion recovery (STIR), diffusion-weighted MR (DW-MR), and dynamic contrast-enhanced MR (DCE-MR) imaging were retrospectively evaluated in the determination of osteitis associated with sacroiliitis in patients with a clinical suspicion of axial SpA. The diagnostic performance of both arms of the ASAS classification criteria, HLA-B27 and MR imaging, were compared for early diagnosis of axial SpA.

2. Materials and methods

2.1. Patient population

This retrospective study was approved by the institutional ethical board with a waiver for informed patient consent. The clinical records were used to identify patients who underwent sacroiliac MR imaging between September 2012 and March 2013 for suspected early inflammatory sacroiliitis. The study included a total of 45 patients. There were 11 men and 34 women with a mean age of 37.2 years (23–49 years). Inclusion criteria were the presence of chronic low back pain (symptoms for > 3 months) without a confirmed diagnosis of SpA, an age of 18–50 years and an age of onset earlier than 45 years. Exclusion criteria were previously diagnosed SpA, current infections (including brucellosis) and malignant processes of the bone and joints. As current infections and malign processes may complicate with bone marrow edema and decrease the accuracy of MRI. An incomplete MR examination (i.e., image distortion or artifacts or patient incompliance with IV injection of gadolinium).

2.2. Clinical and laboratory analysis

The diagnostic algorithm proposed by the ASAS group for the early diagnosis of axial SpA was used (3). The presence of axial SpA was evaluated with certain clinical features and laboratory tests according to ASAS (these included inflammatory back pain, arthritis, enthesitis (heel), uveitis, dactylitis, psoriasis, Crohn's disesase/ulcerative colitis, favorable response to NSAIDs, family history for SpA, HLA-B27 and elevated CRP), following an evaluation by two expert physicians. At least two or three SpA features (clinical findings and laboratory tests), in addition to the inflammatory back pain, were used to make the diagnosis of axial SpA with a high degree of confidence [9]. The BASDAI (Bath Ankylosing Spondylitis Disease Activity Index) scores were also noted.

2.3. MR techniques and image acquisition

All MR imaging examinations were performed in 1.5 T MR scanner (Magnetom Avanto TIM, Siemens, Erlangen, Germany) with a 6 channel phased-array body matrix coil. The SI joints and sacrum were imaged from the anterior border to posterior border in coronal oblique plane that was tilted parallel to the long axis of the sacroiliac joint, and in transverse oblique plane that was perpendicular to the former plane with 3–4 mm slice thickness.

The following imaging series were obtained: (1) the transverse and coronal oblique T1-weighted fast SE images, (2) the coronal oblique STIR images, (3) the coronal oblique FS T2-weighted fast SE images (4) the coronal oblique DW-MR images (b = 0, and 100, 600, 1000 s/mm^2), (5) the coronal oblique DCE-MR images, (6) the transverse and coronal oblique gradient-echo T1-weighted images were also included after dynamic imaging for the investigation of delayed enhancement.

T1-weighted two-dimensional gradient-echo DCE-MR images were acquired starting 30 s before the intravenous administration of gadodiamide (Omniscan; GE Healthcare, Cork, Ireland) at a dose of 0.1 mmol/kg, followed by a 20-mL saline flush at a rate of 2.0 mL/s. DCE-MR images were acquired with a temporal resolution of 24 s for approximately 2 min. Imaging time was approximately 20 min. Detailed image acquisition protocols are given in Table 1 and in Appendix.

2.4. MR image analysis

MR images were retrospectively reviewed by two radiologists (Radiologist A, 6 years of sacroiliac MR imaging experience; and Radiologist B, 4 years of sacroiliac MR imaging experience). The radiologists were blinded to clinical and laboratory findings but they were aware of the clinical suspicion of inflammatory sacroiliitis. The two radiologists independently reviewed the MR images in four independent viewing sessions. They evaluated FS T2-weighted MR, STIR, DW-MR and finally DCE-MR images, respectively. Each MR modality was evaluated individually and any combination of MR techniques were not performed. For each sequential time point, the DCE-MR images were subtracted from the corresponding precontrast images, and both subtracted and delayed postcontrast T1-weighted MR images were reviewed by the radiologists.

2.5. Diagnostic criteria and image interpretation

MR imaging criteria for inflammatory sacroiliitis were based on the ASAS definition [3]. The presence of osteitis was accepted as the single mandatory criterion for active inflammatory sacroiliitis. The criterion for the diagnosis of osteitis on FS T2-weighted images, STIR, and DW-MR images was the visualization of periarticular,