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HOW SENSITIVE AND SPECIFIC ARE MRI FEATURES OF SACROILIITIS FOR DIAGNOSIS OF SPONDYLOARTHRITIS IN PATIENTS WITH INFLAMMATORY BACK PAIN?

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Objective: **To determine the sensitivity and specificity of MRI features of sacroiliitis in spondyloarthritis (SpA).**
Materials and methods**: A retrospective study reviewed MRI of the sacroiliac (SI) joints in 517 patients with inflammatory back pain. Sensitivity, specificity, positive and negative likelihood ratios of active and structural lesions of sacroiliitis with final clinical diagnosis as golden standard was calculated.**
Results: **MRI showed active inflammation in 42% of patients (bone marrow oedema (BMO) (41.5%), capsulitis (3.3%), enthesitis (2.5%)) and structural changes in 48.8% of patients (erosion (25%), fat infiltration (31.6%), sclerosis (32%) and ankylosis (7.6%)).**
BMO was the MRI feature with the highest sensitivity (65.1%) for diagnosis of SpA. Capsulitis (99%), enthesitis (98.4%), ankylosis (97.4%) and erosion (94.8%) had a high specificity for diagnosis of SpA, whereas BMO (74.3%), sclerosis (75.8%) and fat infiltration (84.0%) were less specific. BMO concomitant with enthesitis, capsulitis or erosions increased the specificity. Concomitant presence of BMO and sclerosis or fat infiltration decreased the specificity.
Conclusion: **BMO is moderately sensitive and specific for diagnosis of SpA in patients with inflammatory back pain. BMO concomitant with enthesitis, capsulitis, ankylosis or erosion increases the specificity. Concomitant fat infiltration or sclerosis decreases the specificity for diagnosis of SpA. Of all lesions, erosion had by far the highest positive likelihood ratio for diagnosis of SpA.**

Keywords: Spine, MR – Arthritis.

Spondyloarthritis (SpA) is a group of inflammatory joint conditions sharing common clinical, radiological, genetic and even therapeutic characteristics and are often associated with the presence of human leukocyte antigen (HLA)-B27 (1-5).

Early diagnosis of SpA has gained significance for rheumatologists as new medical treatment options have become available (6). MRI of the SI joints shows active inflammatory and structural lesions of sacroiliitis long before radiographic changes become evident (7, 8).

Active sacroiliitis on MRI is an important classification criterion. MRI is regarded 'positive' for sacroiliitis if bone marrow oedema (BMO) is clearly present (8). Other MRI features representing active inflammation of the SI joint such as enthesitis or capsulitis alone are not sufficient for a 'positive' MRI for sacroiliitis. Structural lesions in sacroiliitis are sclerosis, fat infiltration, erosion and finally ankylosis (8).

These active and structural changes of the SI joints, in particular the presence of BMO, may also be present in patients presenting with non-rheumatological entities that clinically mimic sacroiliitis such as degenerative disease, lumbosacral transitional anomaly, spondylolysis, fracture, infection and tumor (9, 10).

The aim of this study is to determine the sensitivity and specificity of MRI features of sacroiliitis in SpA. Also, we sought to find if BMO concomitant with other MRI features of sacroiliitis may increase the sensitivity and specificity for diagnosis of SpA.

Materials and methods

The retrospective study was approved by the institutional ethics committee.

Study group

All participants, aged 16-45 years old, were recruited from the hospital rheumatology outpatient clinics in a tertiary care center and were referred for MRI of the SI joints with clinical suspicion of sacroiliitis. Clinical criteria for 'inflammatory type' back pain included a. age at onset < 40 years, b. insidious onset, c. improvement with exercise, d. no improvement with rest, e. pain at night (8). Patients who underwent back surgery were excluded from the study.

From March 2005 to February 2013, 517 patients were included in the study (185 (35.8%) men, 332 (64.2%) women), with a median age of 33.3 years (range 16.1-44.9).

We recorded from the clinical files if patients fulfilled the ASAS (Assessment of SpondyloArthritis international Society) classification criteria for axial or peripheral SpA (8). 210 patients (114 women, 96 men), with a median age of 30.8 years (range 16.1-44.9) were classified to have SpA (89.5% axial SpA, 10.5% peripheral SpA). The ASAS classification of these patients was considered the gold standard (8).

307 patients were not diagnosed with SpA (89 (29%) men, 218 (71%) women), with a median age of 34.7 years (range 16.2-44.9). In this group, MRI findings were normal in 211 patients. In 96 patients non rheumatologic findings were present: L5-S1 degenerative changes in 57 patients (60.6%), lumbosacral transitional anomaly in 25 patients (4.8%), hip joint disease in 10 patients (1.9%), osteitis condensans ilii in 12 patients (2.3%), DISH in 3 patients (0.6%), tumor in 5 patients (1%), fracture in 4 patients (0.8%) and infection in 1 patient (0.2%).

Magnetic resonance imaging

MRI was performed on a 1.5T MRI unit (Avanto/Symphony, Siemens Medical, Erlangen, Germany). The SI joints were imaged in a body flexed array coil (Siemens Medical, Erlangen, Germany). Sequence protocol included: semicoronal (along long

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axis of the sacral bone perpendicular to the S2 vertebral body) T1-weighted turbo spin echo (TSE) (slice thickness (ST): 3 mm; repetition time/echo time (TR/TE): 595/20 ms); semicoronal STIR (ST: 3 mm; TR/TE/TI: 5030/67/150 ms); axial fat-saturated (FS) T2-weighted TSE (ST: 4 mm; TR/TE: 4000/77 ms); axial STIR (ST: 5 mm; TR/TE/TI: 7540/67/150 ms). As per ASAS guidelines, no contrast-enhanced pulse sequences were obtained (8).

Image review

The MR images were reviewed for the presence of active or structural lesions of sacroiliitis by 2 musculoskeletal radiologists with 10 and 14 years of experience (LJ,WH), who were blinded to clinical and other imaging findings.

- Active lesions of sacroiliitis included BMO, enthesitis and capsulitis (8). BMO was defined as 'positive' for sacroiliitis if high T2 FS/STIR signal of the ilium or sacrum typically located periarticularly was present. If there is one signal (lesion) only, this should be present on at least two slices. If there is more than one signal on a single slice, one slice was considered to be enough (8). Enthesitis was defined high T2 FS/STIR signal of an enthesis representing BMO, soft tissue inflammation or joint/bursal fluid. Capsulitis is seen as high signal on STIR images involving the anterior or posterior capsule of the SI joint (7, 8).
- Structural lesions of sacroiliitis consisted of sclerosis, fat infiltration, erosion and ankylosis. Sclerosis is depicted as low signal subchondral bands extending at least 5 mm by all sequences. Erosions are low T1 signal bone defects at the joint margin that may occur throughout the cartilaginous joint compartment. Fat deposition depicts as periarticular high T1 signal in the bone. Ankylosis of the SI joint appears as low signal by all sequences bridging the SI joint and may show high T1 signal if bone marrow is present (8).

Representative images are presented in Figs. 1-6.

Statistical analysis

Statistical analysis was performed using software package SPSS 20.0 for Windows (SPSS, Chicago, IL, USA). Basic descriptive statistics were performed where appropriate.

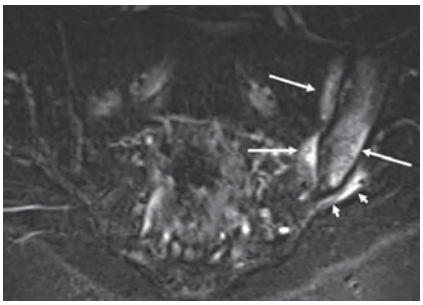
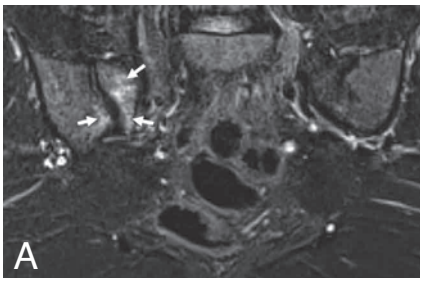


Fig. 1. — BMO and capsulitis of the SI joint in a 22-year-old male with spondyloarthritis. Semicoronal STIR image shows BMO (arrows) of the left SI joint with concomitant posterior capsulitis (short arrows).



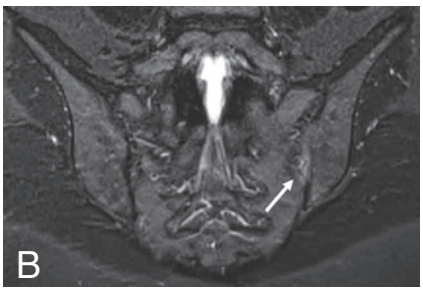


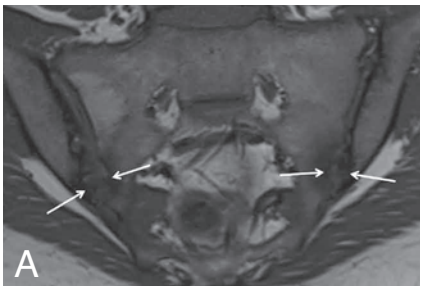
Fig. 2. — BMO and enthesitis of the SI joint in a 24-year-old female with spondyloarthritis. (A-B) Semicoronal STIR images show BMO (arrows) of the right SI joint with concomitant enthesitis of the left retroarticular ligaments (long arrow).

Diagnostic utility of active and structural lesions of sacroiliitis for diagnosis of SpA were determined by calculating sensitivity, specificity, positive and negative likelihood ratio for consensus reader data with final clinical diagnosis as golden standard.

Results

Active MRI lesions in sacroiliitis

MRI showed active lesions in 42% of patients (bone marrow oedema (BMO) (41.5%), capsulitis (3.3%), enthesitis (2.5%). BMO was the MRI feature with the highest sensitivity (65.2%) for diagnosis of SpA, with a specificity of 74.6%. Presence of enthesitis and capsulitis had a low sensitivity, but a very high specificity for diagnosis of SpA.



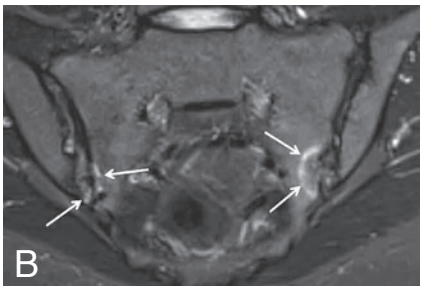
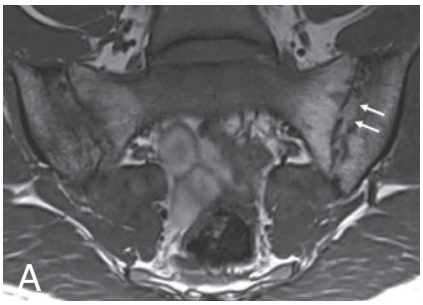


Fig. 3. — BMO and concomitant erosion of the SI joint in a 26-year-old female with spondyloarthritis. A. Semicoronal T1-weighted MR image shows extensive erosions of the SI joints (arrows). B. Semicoronal STIR image shows BMO of both SI joints (arrows).



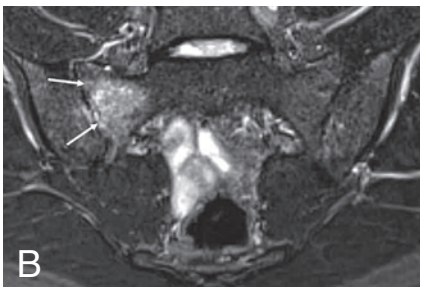


Fig. 4. — BMO and ankylosis of the SI joint in a 33-year-old male with spondyloarthritis.

Semicoronal (A) T1-weighted and (B) STIR MR images show ankylosis of the left SI joint (short arrows) with concomitant BMO of the right SI joint (long arrows).

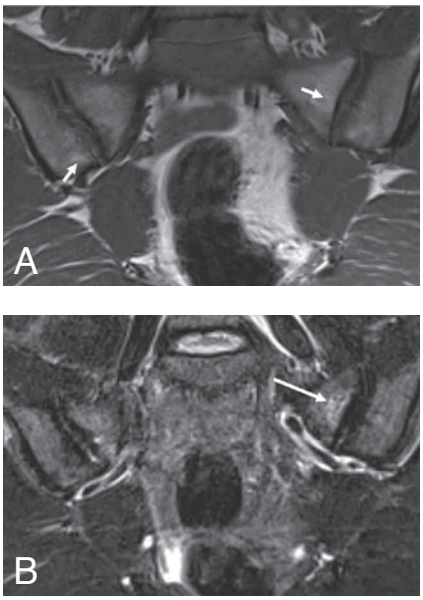


Fig. 5. — BMO and fat infiltration of the SI joint in a 44-year-old female with degenerative joint changes.Semicoronal (A) T1-weighted and (B) STIR MR images show fat infiltration of the SI joints (short arrows) with concomitant BMO of the left SI joint (long arrow).

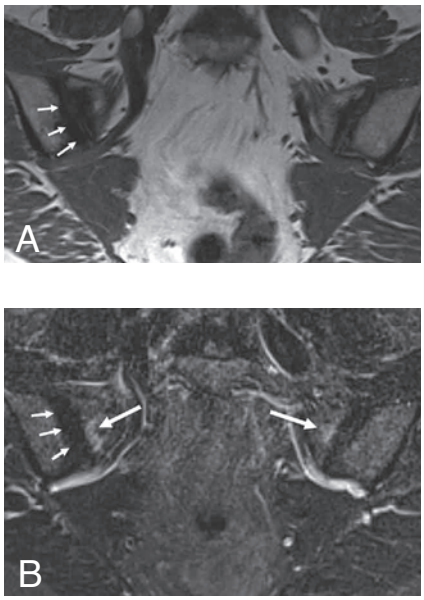


Fig. 6. — BMO and sclerosis of the SI joint in a 44-year-old female with degenerative joint changes. Semicoronal (A) T1-weighted and (B) STIR MR images show sclerosis of the right SI joint (short arrows) with concomitant BMO of both SI joints (long arrows).

Table I. — The sensitivity, specificity, positive and negative likelihood ratios of MRI features of sacroiliitis for the diagnosis of SpA.

	N	Sensitivity %	Specificity %	LR+	LR-
ACTIVE					
BMO	215	65.2	74.6	2.56	0.47
Enthesitis	13	3.8	98.4	2.38	0.98
Capsulitis	17	6.7	99.0	6.7	0.94
STRUCTURAL					
Sclerosis	167	43.3	75.6	1.77	0.75
Fat infiltration	164	54.8	84.0	3.42	0.54
Erosion	130	54.3	94.8	10.4	0.48
Ankylosis	39	14.8	97.4	5.7	0.87

(N = number of patients; LR+ = positive likelihood ratio; LR- = negative likelihood ratio; BMO = bone marrow oedema).

Table II. — The sensitivity, specificity, positive and negative likelihood ratios of BMO concomitant with other MRI features of sacroiliitis for the diagnosis of SpA.

	N	Sensitivity %	Specificity %	LR+	LR-
BMO	215				
+ Enthesitis	10	5.1	96.1	1.31	0.99
+ Capsulitis	17	10.2	96.1	2.67	0.93
+ Sclerosis	109	57.0	60.3	1.43	0.71
+ Fat infiltration	112	67.9	75.6	2.78	0.42
+ Erosion	120	76.6	80.8	3.99	0.29
+ Ankylosis	26	16.8	96.1	4.31	0.87

(N = number of patients; BMO = bone marrow oedema; LR+ = positive likelihood ratio; LR- = negative likelihood ratio).

Structural MRI lesions in sacroiliitis

MRI showed structural lesions in 48.8%. Erosion had a moderate sensitivity but high specificity. Ankylosis had a low sensitivity but very high specificity for diagnosis of SpA. Sclerosis and fat infiltration had moderate sensitivity but lower specificity compared to ankylosis and erosion. Of all lesions, the presence of erosion had the highest LR+ (10.4) for diagnosis of SpA (Table I).

Diagnostic utility of lesions in sacroiliitis

Capsulitis (99%), enthesitis (98.4%), ankylosis (97.4%) and erosion (94.8%) had a high specificity for diagnosis of SpA. Fat infiltration (84.0%), sclerosis (75.6%) and BMO (74.6%) were less specific. BMO concomitant with enthesitis, capsulitis or erosions increased the specificity. Concomitant presence of sclerosis or fat infiltration decreased the specificity.

BMO concomitant with ankylosis, erosion and fat infiltration had a moderate higher positive likelihood ratio (LR+) for diagnosis of SpA, compared to the LR+ of concomitant presence of enthesitis and sclerosis (Table II).

Discussion

Early assessment of inflammation in the course of SpA gains importance in the light of new therapeutic strategies. The value of MRI of the SI joints is well established and resulted in a definition of a 'positive MRI' for sacroiliitis (8, 11, 12). In the current ASAS criteria of axial SpA MRI plays an important role: a 'positive MRI' is a key criterion for disease classification (8, 13, 14).

However, in daily radiology practice it remains challenging to decide if demonstrated BMO is sufficient to really represent active sacroiliitis as seen in SpA. In our study we found a moderate sensitivity (65%) and -in this context more importantly- only a moderate specificity (74%) of BMO of the SI joints for diagnosis of SpA. These figures are similar to the figures published in the paper by Weber et al., who also reported on the limitations of using BMO as a single criterion in the current ASAS definition of a 'positive' MRI (16). We confirmed their findings, and also showed that concomitant fat infiltration and sclerosis decrease the diagnostic value of MRI. This is not surprising, since these features are commonly seen in degeneration,

with mechanical back pain mimicking inflammation in these patients (15).

Our study showed that the concomitant presence of other features of active sacroiliitis such as enthesitis or capsulitis, indicating an ongoing true inflammatory process, increased the specificity. The presence of structural lesions also contributes substantially to the diagnostic utility of MRI for diagnosis of SpA. The concomitant presence of erosions and ankylosis – both hallmarks of the disease – also increased the specificity (8). On the other hand, the concomitant presence of fat infiltration and sclerosis decreased the specificity for diagnosis of SpA, which may be explained by the presence of the same MRI features in degenerative processes (15).

Weber et al stressed the importance of erosions as an MRI feature of SpA (16-17). In our study we found that of all lesions of the SI joints, the presence of erosion had the highest LR+ (10.4) for diagnosis of SpA. This finding confirms that erosion could play a role as a new or additional criterion in future classification systems, especially as it improves the specificity of MRI of the SI joints for diagnosis of SpA.

In our study we also found a very high specificity of enthesitis (98%) and capsulitis (99%) for diagnosis of SpA. However, as these lesion were not commonly seen (in 4% and 6% respectively), they might not be as useful as classification criteria. Still, the presence of enthesitis or capsulitis may be particularly helpful in equivocal cases or may indicate that active inflammation is present at a certain stage in the disease process.

There are some limitations to our study. Firstly, MRI was the only imaging technique, without correlation with radiography or CT. Secondly, the patient population represented referrals from a single tertiary center; referral patterns for sacroiliitis may vary elsewhere. This will particularly affect the reported likelihood ratios. Thirdly, as MRI is included as a criterion in the current ASAS classification, there is a risk of circular reasoning. Finally, we only studied patients with inflammatory back pain clinically suspected of SpA, no control group of age and sex-matched individuals was studied for comparison.

In conclusion, we found that BMO is an important MRI feature of sacroiliitis with a moderate sensitivity and specificity for diagnosis of SpA in patients with inflammatory back pain. The specificity increases if concomitant enthesitis, capsulitis, erosions or ankylosis is present, but decreases if concomitant fat infiltration and sclerosis is demonstrated. Of all lesions, erosion has by far the highest positive likelihood ratio for diagnosis of SpA.

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