Concise report

Magnetic resonance imaging of the sacroiliac joints in the early detection of spondyloarthritis: no added value of gadolinium compared with short tau inversion recovery sequence

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Abstract

Objectives. To investigate the additional value of T1 fat-saturated after gadolinium (T1/Gd) compared with T1 and short tau inversion recovery (STIR) sequence in detecting active lesions of the SI joints typical of axial SpA (axSpA) in a prospective cohort study, the SpondyloArthritis Caught Early (SPACE) cohort, and to assess its influence on final MRI diagnosis of the SI joint (MRI-SIJ) based on the Assessment of Spondyloarthritis International Society (ASAS) definition of active sacroiliitis.

Methods. Patients in the SPACE cohort received baseline and 3-month follow-up MRI-SIJ with coronal oblique T1, STIR and T1/Gd sequences. Bone marrow oedema (BME), capsulitis/enthesitis and synovitis and active sacroiliitis according to the ASAS definition were evaluated by three blinded readers.

Results. A total of 127 patients received an MRI-SIJ at baseline and 67 patients also received an MRI-SIJ at 3 months follow-up since the Gd protocol was added some months after the start of the SPACE project. Twenty-five of the 127 patients (19.7%) with a baseline MRI-SIJ and 14 of 67 patients (20.6%) with a follow-up MRI-SIJ presented BME on the STIR sequence sufficient to fulfill the ASAS definition for a positive MRI-SIJ. In eight patients, additional synovitis and/or capsulitis/enthesitis was observed; however, no additional BME was visualized on T1/Gd. One patient, without clinical diagnosis of axSpA, showed synovitis as an isolated finding.

Conclusion. Synovitis and capsulitis/enthesitis are detectable with the administration of Gd. However, they are always observed in the presence of BME. Therefore T1 and STIR sequence alone are sufficient in the MRI assessment that, among others, is used for diagnosing patients with early axSpA.

Key words: spondyloarthritis, gadolinium, MRI, sacroiliitis.

Introduction

SpA is a spectrum of chronic inflammatory rheumatic diseases that share physiopathological and clinical characteristics usually affecting the spine and the SI joints (SIs). Sacroiliitis is defined by the presence of inflammation in one or both SIs, and can be detected by plain radiographs or MRI [1]. Radiographs only show structural changes, but on MRI both inflammatory and structural changes are visible. Especially in early stages of the disease, MRI of the SI joints (MRI-SIJ) is of additional value in the diagnosis of axial SpA (axSpA) since plain radiographs can be normal in the presence of inflammation on MRI-SIJ. Therefore the presence of bone marrow oedema (BME) on MRI-SIJ has recently been included in the Assessment of Spondyloarthritis International Society (ASAS) axSpA classification criteria [2]. Early detection of axSpA is essential to be able to start therapy early, as

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effective medication is available. In addition to early diagnosis of axSpA, MRI-SIJ is also used in the evaluation of treatment [1–3].

Generally, recommended sequences to detect active lesions are short tau inversion recovery (STIR) and T1 fat-saturated after gadolinium (T1/Gd), used in conjunction with T1-weighted sequence. While the STIR sequence shows active inflammation as increased signal intensity due to the presence of increased amounts of free water, T1/Gd is considered more sensitive since it depicts areas of increased vascularization due to increased diffusion of Gd into the interstitial space [4]. There have been studies in which the STIR sequence is recommended over the T1 after gadolinium sequence, but these were studies concerning MRI of the spine [5, 6]. In other studies it is suggested that T1/Gd may improve the diagnostic capacity and the detection of active lesions, compared with the STIR sequence [7–9]. However, these were retrospective studies, and since patient discomfort and costs are a drawback in using T1/Gd sequence, its value ought to be properly determined.

The purpose of this study is to determine the additional value of T1/Gd sequence compared with the T1 and STIR sequences in detecting active lesions in the SIJ typical for axSpA in a prospective cohort study, the SpondyloArthritis Caught Early (SPACE) cohort, and to assess its possible influence on final definition of a positive MRI-SIJ based on the ASAS definition of active sacroiliitis.

Materials and methods

All 127 patients in this study are part of the SPACE cohort. This cohort started in January 2009 and is an ongoing cohort including patients aged ≥16 years with short-term chronic back pain (>3 months, ≤2 years and onset ≤45 years) of unknown origin. At baseline, all patients underwent a diagnostic workup consisting of tests for the presence of acute anterior uveitis, inflammatory back pain (IBP), heel enthesitis, peripheral arthritis, psoriasis and IBD, positive family history for SpA, good response to NSAIDs, elevated ESR or CRP, HLA-B27 positivity and sacroiliitis on MRI and radiographs. Patients with a probable or certain diagnosis of axSpA were included in the follow-up.

MRI-SIJ were performed on a 1.5T machine (Philips Medical Systems, Best, Netherlands) at baseline and after 3 months. The acquired sequences were coronal oblique T1-weighted TSE (TR 550/TE 10), STIR (TR 2500/TE 60) and T1-weighted TSE with fat suppression after i.v. Gd (TR 550/TE 10) with a slice thickness of 4 mm. Gd was administered with a dosage of 0.1 mmol/kg body weight. Written informed consent was obtained from all the participating patients. The SPACE cohort as well as this study on the additional value of gadolinium were approved by the Leiden University Medical Center medical ethics committee.

MRI-SIJ were scored by two trained readers (M.d.H. and R.v.d.B.). When both baseline and follow-up MRI-SIJ were available, these were scored simultaneously. Parameters scored for detecting active lesions of the SIJs typical for axSpA were (i) the presence of BME: a positive MRI-SIJ was defined as the presence of one subchondral lesion of high signal intensity (BME lesion) on at least two consecutive slices or more than one lesion of high signal intensity on a single slice on the STIR and/or T1/Gd images, according to the ASAS/OMERACT definition [1]; (ii) the presence or absence of capsulitis/enthesitis at the posterior cranial side of the SIJ, defined as high signal intensity on the T1/Gd or the STIR; (iii) the presence or absence of synovitis detected on T1/Gd, defined as high signal intensity in the SI joint. The STIR and T1/Gd sequences were all scored in conjunction with T1 TSE images, showing low signal intensity of the BME lesions. In case of disagreement between the two readers, a third reader (V.N.-C.) scored the MRI-SIJs in the same way as described for the primary readers without knowledge of the scores of the first readers. To keep the third reader blinded to the outcomes of the scores, cases without discrepancy were also added. If two out of three readers rated the MRI-SIJ as positive (according to the ASAS definition), the MRI-SIJ was considered as such. All readers were blinded for clinical and laboratory data, the chronological order of the images as well as the report of the radiology department and the scores of the other readers.

Statistical analysis

All the scored abnormalities were categorical with a dichotomous measurement level. Agreement between T1/Gd and STIR sequences was measured by percentage of agreement [10].

Results

At the time of scoring, the SPACE cohort included 157 patients. As the administration of Gd was added to the protocol some months after the start of the SPACE cohort, a baseline MRI-SIJ with Gd administration was obtained in 127 patients, in addition to the STIR and T1 sequences. In 90 patients a follow-up MRI-SIJ after 3 months was also obtained, including 67 patients with an MRI-SIJ with a T1/Gd sequence. At baseline, the average age of the patients was 30.8 (s.d. 8.4) years, mean duration of back pain was 13.4 (s.d. 7.1) months and the average age at onset of the back pain was 29.7 (s.d. 8.4) years. Forty-three patients (33.9%) were HLA-B27 positive and 87 patients (68.5%) had IBP at baseline. Of the patients studied at 3-month follow-up, 25 of the 67 patients (37.3%) were HLA-B27 positive and 49 patients (73.1%) had IBP.

In 102 patients there were no inflammatory abnormalities found on either the STIR or the T1/Gd sequence of the MRI-SIJ. A positive MRI-SIJ according to the ASAS definition was seen in 19.7% of the patients (25/127) at baseline and in 20.9% of the patients (14/67) at follow-up, based on the STIR sequence. In the same 25 patients (baseline) and 14 patients (follow-up), the MRI-SIJ was also positive when judged by the T1/Gd sequence. The location of the BME lesions seen on the STIR corresponded with the location of lesions on the T1/Gd sequence in all patients at both time points. So, in none of
the patients was additional BME found on T1/Gd, resulting in 100% agreement between STIR and T1/Gd sequences.

Eleven of the 25 patients with a positive MRI-SIJ at baseline also had a positive MRI-SIJ at follow-up. Of the remaining 14 patients, 4 patients had a negative MRI-SIJ at 3-months follow-up and in 10 patients the follow-up MRI-SIJ was not taken yet. At follow-up, 20.9% (14/67) of patients had a positive MRI-SIJ. In only 3 of these 14 patients, the MRI-SIJ was negative at baseline, again when judged by STIR or by T1/Gd (Table 1). So, over a period of 3 months, three patients developed BME in the SIJ sufficient enough to meet the ASAS definition of a positive MRI-SIJ. Capsulitis/enthesitis was found in two patients (2.6%) at baseline. In one of these patients (1.2%), capsulitis/enthesitis was also found at follow-up, the other patient did not receive the follow-up MRI-SIJ. Capsulitis/enthesitis was only seen on the T1/Gd. With the STIR sequence, this abnormality was not detected, resulting in a 98.4% overall agreement between STIR and T1/Gd sequences at baseline and 98.9% overall agreement at follow-up. However, at both baseline and follow-up, capsulitis/enthesitis was always detected with the additional presence of BME on the STIR sequence and synovitis on the T1/Gd sequence. Synovitis was only assessed on the T1/Gd sequence and was detected in nine patients (6.3%) at baseline; five of those patients did not have a follow-up MRI-SIJ, and in the remaining four patients (4.6%) synovitis was also shown at follow-up. Out of the eight patients showing synovitis at baseline, seven also showed BME on the MRI-SIJ. All patients with synovitis at follow-up showed BME on the follow-up MRI-SIJ. Fig. 1 shows an example of a patient with capsulitis/enthesitis and synovitis as well as BME. The location of the BME lesions (indicated in the figure with circles) seen on the right image (T1/Gd sequence) corresponds with the lesions on the left image (STIR sequence). The T1/Gd shows additional capsulitis/enthesitis (arrow) and synovitis (arrowhead).

Of the 25 patients at baseline, 22 patients did have axSpA according to the ASAS axSpA classification criteria. The remaining three patients showed no other (clinical) SpA features. Based on the absence of additional SpA features, these three patients could not be classified as axSpA by the ASAS axSpA classification criteria. The seven patients who showed synovitis on the T1/Gd sequence and a positive MRI-SIJ according the ASAS definition also fulfilled the ASAS axSpA classification criteria. The one patient showing synovitis as a single symptom, so without BME, had normal radiographs, was HLA-B27 negative and did not have any other clinical SpA feature.

### Discussion

In this study, the additional value of the intravenous administration of Gd (T1/Gd) in detecting BME, capsulitis/enthesitis and synovitis compared with the STIR sequence was investigated. In addition, we also assessed the influence of T1/Gd on the final evaluation of the MRI based on the ASAS definition of a positive MRI-SIJ. A 100% agreement was found between the STIR and T1/Gd sequence in detecting BME lesions. For the detection of BME lesions, the administration of Gd does not have additional value. This confirms the findings of a previous study by Madsen et al. [11] comparing STIR sequence with a Gd contrast-enhanced sequence to detect active abnormalities at the SIJ. However, that study included patients with chronic fatty lesions rather than patients with early BME lesions. The major focus of the current study is on the early stage of SpA, making this study not only a confirmation but also an important complementation to the findings of Madsen et al.

Our results also show that the presence of capsulitis/enthesitis is better detected with the administration of Gd. Although the T1/Gd sequence enabled the readers to score capsulitis/enthesitis while this was not seen on the
STIR, capsulitis/enthesitis was always present in addition to BME lesions on the STIR sequence and synovitis on the T1/Gd sequence. Synovitis, not detectable with the STIR sequence, was found in eight patients at baseline and four at follow-up on the T1/Gd sequence. So, in an early cohort such as the SPACE cohort, with patients who have ≤2 years back pain complaints, a small percentage of patients (≤7%) show synovitis. All but one patient with synovitis also showed BME on the STIR sequence sufficient enough to meet the ASAS definition of a positive MRI and moreover had a diagnosis of axSpA. The patient with only synovitis did not have any sign related to axSpA. So, synovitis as the only sign on MRI-SIJ can be considered as a false-positive finding in this patient. This is in line with the recommendations by ASAS that the sole presence of synovitis is not enough for a positive MRI-SIJ [12]. So, being unable to detect synovitis on the STIR sequence is not an issue. It confirms the recommendations by ASAS that only the presence of BME is essential in the early diagnosis of axSpA and that the STIR sequence is sufficient to detect BME. Considering all, the administration of Gd for patients of the SPACE cohort was stopped in the beginning of April 2012, leaving the STIR and T1 sequences as only assessed MRI sequences in this cohort.

In summary, we found that the presence of synovitis and capsulitis/enthesitis is detectable with the administration of Gd. However, these parameters are present only in a low percentage of patients with suspected axSpA. Furthermore, synovitis and capsulitis/enthesitis is observed in the presence of BME. We conclude that T1 and STIR sequences alone are sufficient in the MRI assessment to diagnose patients with early axSpA.

**Rheumatology key messages**

- Synovitis/capsulitis/enthesitis is only seen in the presence of bone marrow oedema in axSpA.
- MRI-SIJ with Gd has no additional value compared with T1 and STIR sequences in diagnosing early axSpA.
- No Gd administration saves time and reduces costs, patient burden and risks in axSpA.

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**References**


