UPDATE IN RADIOLOGY

New ASAS criteria for the diagnosis of spondyloarthritis: Diagnosing sacroiliitis by magnetic resonance imaging

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Abstract Radiographic sacroiliitis has been included in the diagnostic criteria for spondyloarthropathies since the Rome criteria were defined in 1961. However, in the last ten years, magnetic resonance imaging (MRI) has proven more sensitive in the evaluation of the sacroiliac joints in patients with suspected spondyloarthritis and symptoms of sacroiliitis; MRI has proven its usefulness not only for diagnosis of this disease, but also for the follow-up of the disease and response to treatment in these patients. In 2009, The Assessment of SpondyloArthritis international Society (ASAS) developed a new set of criteria for classifying and diagnosing patients with spondyloarthritis; one important development with respect to previous classifications is the inclusion of MRI positive for sacroiliitis as a major diagnostic criterion.

This article focuses on the radiologic part of the new classification. We describe and illustrate the different alterations that can be seen on MRI in patients with sacroiliitis, pointing out the limitations of the technique and diagnostic pitfalls.

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KEYWORDS
Sacroiliitis; Diagnosis; Magnetic resonance imaging; Axial spondyloarthropathies

PALABRAS CLAVE
Sacroileitis; Diagnóstico; Imagen por resonancia magnética; Espondiloartropatías axiales

Nuevos criterios ASAS para el diagnóstico de espodiloartritis. Diagnóstico de sacroileitis por resonancia magnética

Resumen La sacroileitis radiográfica ha formado parte del diagnóstico de las espondiloartropatías desde su inclusión en los criterios de Roma en 1961. Sin embargo, en la última década, la resonancia magnética (RM) ha demostrado ser más sensible para valorar las articulaciones sacroiliacas en los pacientes con sospecha de espondiloartritis y síntomas de sacroileitis, no solo para diagnosticarla, sino también para seguir la evolución de la enfermedad y el tratamiento de estos pacientes. El grupo The Assessment of SpondyloArthritis international Society (ASAS) desarrolló en el año 2009 unos criterios para clasificar y diagnosticar a los pacientes con espondiloartritis, entre los que destacaba la inclusión de un estudio de RM positivo para sacroileitis como criterio diagnóstico mayor.

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Introduction

Under the term spondyloarthritis (SpA) we include a heterogeneous group of chronic rheumatic inflammatory diseases that can affect the axial skeleton predominantly. We can distinguish five (5) different groups: ankylosing spondylitis (AS), arthritis and reactive SpA (formerly known as Reiter’s syndrome), arthritis associated with inflammatory bowel syndrome, psoriatic arthritis and non-radiological axial SpA. They all share clinical manifestations (the most important, the inflammatory lower back pain), and radiological manifestations (sacroiliitis) accompanied by familial aggregation and a strong association with the antigen HLA B27. Overall prevalence of these entities is estimated between 0.23 and 1.8%.2

Traditionally and given the high frequency of joint affection—over 90%, X-raying the sacroiliac joints (SJ) has been essential to diagnose, categorize and monitor SpA.3 Thus the radiographic sacroiliitis is part of the diagnostic criteria of AS since they were established in Rome in 1961,4 and part of the diagnostic criteria of SpA since they were published by Amor et al. in 1990.5 The signs that can be seen in an X-ray translate into structural changes only visible too late which in turn can delay the diagnosis of the disease between 6 and 8 years since symptom onset.1,6

Nevertheless there have been important innovations during the last ten years for the early management of SpA due to the development of new biological therapies with anti-tumour necrosis factor (anti-TNF) antagonists and the growing relevance of magnetic resonance (MR) as elective modality for an early diagnosis of the disease, to evaluate the therapeutic effects and establish prognosis.1,7-12 Nevertheless none of the diagnostic categorizations—not even the Roman criteria or the European Spondyloarthropathy Study Group (ESSG) classification included MR as a diagnostic criteria.5 Back in 2009 the international panel of experts known as the Assessment in SpondyloArthritis International Society (ASAS) developed a series of criteria for the categorization and early diagnosis of axial SpA (the MR-established sacroiliitis was among these criteria).13

The purpose of this study is to introduce this categorization with special attention to radiological issues and describe through images the different lesions we can see in an MRI in patients with sacroiliitis. We will also talk about the limitations of this categorization as well as about mistakes made during diagnosis.

The ASAS Categorization: findings in magnetic resonance and definition of sacroiliitis

ASAS criteria to diagnose axial SpAs were published back in 2009 (Table 1).14 These criteria will be applied to patients <45 years old with lower back pain of 3 or more months duration. Criteria comprise 2 sections: one “radiological section” and one “clinical section”. To qualify for the radiological section a sacroiliitis on a simple radiography or MRI and at least one of the characteristic traits of SpA detailed in Table 1 needs to be confirmed. To qualify for the clinical section the patient needs to have a positive HLA B27 and at least two of the characteristic traits of SpA without radiologic sacroiliitis being mandatory.

ASAS criteria were validated in an international cohort trial with a sensibility and specificity close to 82.9 and 84.4%, respectively as opposed to Amor et al. criteria (sensibility 82.9% and specificity 77.5%) and ESSG (sensibility 85.1% and specificity 65.1%), both adjusted for MRI.15 It is important to highlight that diagnosis in the radiological section showed a 66.2 sensibility and 9733% specificity.15

In an effort to establish common criteria to diagnose sacroiliitis through MRI the ASAS/Outcome Measures in Rheumatology Network (OMERACT) group made up of 8 rheumatologists and 2 radiologists collected the signs of SpA reported on MRI studies and established which would be necessary to diagnose sacroiliitis associated with SpA.14 The lesions found in sacroiliac joints (SJ) on the MRI were categorized into 2 big groups: active (or acute) inflammatory lesions and structural lesions.
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Figure 1  (a) T1-weighted coronal oblique image where we can see one periarticular hypointensity with greater affection of the iliac margin of the right sacroiliac joint (arrow). (b) On the STIR sequence we have one hyperintense zone compatible with bone oedema.

Active inflammatory lesions

Four types of inflammatory lesions in sacroiliitis associated with SpA could be identified: bone oedema and osteitis, synovitis, enthesitis and capsulitis. Bone oedema and osteitis are indispensable to diagnose active sacroiliitis only.

Bone oedema and osteitis

They are highly suggestive of active sacroiliitis. Bone oedema can be found in up to 90% of patients with SpA\textsuperscript{16} if found in other conditions and between 2.6% and 20% in healthy patients.\textsuperscript{15,17}

Oedema was defined as a STIR-weighted signal hyperintensity and it is usually hypointense in T1-weighted sequences (Fig. 1). The intraforaminal sacral bone constitutes the intensity of the reference bone signal. T1-weighted sequence enhancement with fat suppression after the IV injection of paramagnetic contrast (gadolinium) (T1-SG-Gd) shows an increase of vascularization and the perfusion reactive to inflammation and it was categorized as osteitis (Fig. 2).

To diagnose sacroiliitis it was established by consensus that one area of bone oedema/osteitis should be present in at least two consecutive cuts but if there was more than one focus one cut would be enough regardless of its size in both cases (Table 2). Even though bone affectation is typically periarticular (subchondral bone marrow), ASAS criteria do not establish requirements or stipulations when it comes to the distribution of lesions.

Figure 2  Images a and b correspond to the oblique T1-weighted axial images where we can see a lower periarticular sign of both the sacroiliac (arrow in a) and iliac (arrow in b) margins of the left sacroiliac joint. On the T1-SG-Gd sequence (c) we can see the uptake of the described areas compatible with osteitis (arrows).
Table 2  Diagnostic criteria of sacroiliitis through MRI.

Findings required to diagnose sacroiliitis
- The presence of active lesions at the sacroiliac joints (reflecting active sacroiliitis) to meet the criterion of “positive MRI for sacroiliitis” so the ASAS diagnostic categorization can be applied is required.
- EMO (STIR) or osteitis (T1-SG-Gd) are suggestive of spondyloarthritides as long as they affect the subchondral and periarticular areas of the bone marrow*.
- The isolated existence of other active inflammatory lesions (synovitis, enthesitis or capsulitis) without bone oedema or osteitis associated is NOT enough according to the definition of sacroiliitis through MRI.
- Structural lesions (fat deposits, erosions, sclerosis or ankylosis) probably reflect prior inflammation; however its presence without bone oedema or osteitis is NOT enough to diagnose sacroiliitis.

The disturbance of signal is mandatory
- If there is one active lesion only (bone oedema/osteitis) the disturbance of signal needs to be present in at least two (2) consecutive cuts.
- If there is more than just one disturbance of signal (oedema/osteitis) in one cut then only one (1) cut will be necessary.

Synovitis
Synovitis was defined as an increase of signal intensity in the synovial margin of SI joint space similar to vessels in T1-SG-Gd sequences (Fig. 3). STIR-weighted sequences cannot distinguish synovitis from joint liquid.

Enthesitis
It was defined as hyperintensity on STIR-or-T1-SG-Gd-weighted sequences at the intersectional areas of tendons and ligaments (Fig. 4) including the retroarticular space (interbone ligaments). Signal disturbance can spread to bone marrow and adjacent soft tissues.

Capsulitis
Signs of capsulitis are similar to those of synovitis though in this case the abnormal signal intensity it affects the anterior and posterior capsules (Fig. 5). It can spread both medially and laterally towards the periosteum.

Structural lesions
There are four (4) types of lesions showing structural damage, prior inflammatory affection of SI joints: subchondral sclerosis, erosion, periarticular fat deposits in the bone marrow and bone/ankylosis bridges.

Subchondral sclerosis
Subchondral sclerosis was defined as foci or areas with low intensity signal or signal void in all sequences without uptake in the gadolinium-enhanced sequences (Fig. 6). The sclerosis attributable to SpA needs to spread at least 5 mm from the joint space since in healthy individuals small foci of sclerosis can be seen.

Erosions
Erosions appear as bone defects of the joint surface, hypointense on T1 and hyperintense on STIR when active (Fig. 7). Initially they debut as isolated lesions and when converge they can cause joint “pseudo-widening”.

Periarticular fat bone marrow deposit
The fat bone marrow deposit is considered a chronical lesion of SpA because it can be spotted characteristically in areas where active inflammatory lesions are located. Its anatomopathological base is not very well known. It is characterized by an increase of the intensity signal on T1-weighted sequences (Fig. 8). It is an inespecific finding that is present in 27% of healthy individuals.

Bone bridges and ankylosis
They are hypointense lesions in all sequences and sometimes they are surrounded by fat bone marrow deposits. Initially there are “bone episodes” one against the other and eventually they converge creating bridges that go...
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Figure 4  Disturbance of signal intensity in one of the posterior sacroiliac ligaments (arrows) with hypointensity at the T1-weighted coronal oblique image (a), and hyperintensity at the STIR coronal oblique image (b). It is accompanied by signal hypointensity at the osteoligamentous insertion sites at T1-weighted coronal oblique image and signal hyperintensity at STIR compatible with bone oedema (asterisks).

through the joint and in serious cases they erase the joint space (ankylosis) (Fig. 9).

With these signs in mind there was consensus that to diagnose sacroiliitis due to SpA the MRI needs to show foci of bone oedema on STIR or osteitis on T1 Gd+/−SG regardless of the occurrence of other inflammatory or structural lesions.

Study protocol and technical issues

The document written by the ASAS/OMERACT panel also includes technical recommendations for the MRI study of SI joints based on ASAS diagnostic criteria. The study protocol needs to include: one STIR sequence (TR/TE/TI 4000/60/150 ms), one T1-weighted sequence

Figure 5  Superior capsular enhancement of the left sacroiliac joint at the T1-SG-Gd sequence (point of arrow in b) which does not correspond to joint liquid or other signal disturbances at the T2-weighted sequence (a). We can see enhancement of both periarticular bone margins at the left side and the sacral margin of the right side as well fully compatible with osteitis (arrows).
(TR/TE 500/10 ms), one T2-weighted turbo spin echo sequence (TR/TE 4000/60 ms) or one T2-weighted echo-gradient (TR/TE 180/7.15 ms).\textsuperscript{10,14} Later one T1-SG-Gd sequence (TR/TE 660/16 ms) can be added to detect active inflammatory lesions and clear suspicious signs in the study without the help of contrast agents. The image matrix needs to have at least 512 pixels and each sequence consists of at least 10–12 cuts (0.4 mm cut separation), and each cut be 3–4 mm thick. It is recommended that basic sequences (STIR and T1 TSE) are obtained through the oblique coronal plane running parallel to the line that goes through the superior and dorsal margins of S1 and S1 whereas additional sequences can be obtained through the oblique transversal place—parallel to S1 superior vertebral plateau.

In patients allergic to gadolinium or those with impaired renal function, the T1-SG-Gd sequence can be suppressed since it has been proven that STIR and T1-SG-Gd sequences are comparable when it comes to detecting periarticular inflammation\textsuperscript{18} and as we have already seen because establishing other active lesions except for osteitis is not decisive when it comes to diagnosing sacroiliitis. When it comes to structural lesions (sclerosis, fat bone marrow deposit, and ankylosis) the T1-weighted sequence is usually enough to detect these even though T1 SG and T2 TSE or EG allow us to see cartilage better and can therefore be useful to find erosions.\textsuperscript{14,19}

In our institution the standard protocol to study SI joints consists of STIR and T1-weighted sequences both in the oblique coronal plane to detect inflammatory lesions and also consists of oblique transversal T1 and T2 TSE sequences to establish structural lesions. The T1-SG-Gd sequence is not routine and is usually reserved to find coexistent active inflammatory lesions in the presence of bone edema as well as to characterize lesions and other abnormalities of signal intensity seen at the basic sequences related or not to the sacroiliac affection.

**Figure 6** Significant extent hypointensity of both margins of left sacroiliac joint (white circle) at the T2-weighted coronal oblique sequence (a) without enhancement at the T1-SG-Gd coronal oblique sequence (b) compatible with sclerosis. The arrow in (b) is pointing at a marginal enhancement area of sclerosis with hyperintensity in (a) fully compatible with osteitis.

**Figure 7** Marginal irregularities compatible with erosions in both sacroiliac joints (arrows) at the T1-weighted coronal oblique sequence (a), and in the iliac margin of the right sacroiliac joint (arrow) at the T2 TSE coronal oblique image (b).
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Differential diagnosis

Some diseases can simulate the aforementioned inflammatory conditions. It is important to highlight that the inflammation of SI joints attributable to SpA is usually limited to the bone or joint. On the contrary the inflammation and infection associated with septic sacroiliitis usually spreads to soft tissues.\textsuperscript{20}

Arthrosis is more common in the elderly. It can cause unilateral or bilateral, symmetrical or asymmetrical joint inflammation.\textsuperscript{21} SpA-induced sacroiliitis and arthrosis can show common structural changes when the sacroiliac joint has suffered prior inflammatory changes like subchondral sclerosis, slipped joint (suggestive of SpA when the joint is <2 mm in patients under 40 years old) and ankylosis. Osteophytes, neumocysts and joint void are common of arthrosis.\textsuperscript{22} Arthrosis can be associated with small areas of bone oedema too.\textsuperscript{14}

Osteitis condensans ili has a typical location and configuration of both on the MRI and other image modalities (simple radiography and CT). Characteristically joint affection is bilateral, symmetrical and consists of a triangular area of subchondral sclerosis at the anterior inferior iliac margin–wider at its inferior region.\textsuperscript{21} This lesion is typical of middle-aged women and is attributed to stress during pregnancy and delivery.\textsuperscript{23}

Insufficiency fractures typical of the sacrum can cause alterations of signal that might be compatible with bone oedema and osteitis at presentation. Infiltrating the primary or metastasic tumour should be considered in some cases during differential diagnosis.\textsuperscript{14}

ASAS criteria: pros and cons

ASAS criteria show indisputable pros: for the first time they include MRI to diagnose axial SpA, describe the agreed findings we can see in this group of conditions and establish a set of stipulations for the diagnosis of sacroiliitis through MRI which can easily be reproduced. Also the introduction of MRI as a diagnostic tool to find acute SpA lesions allows us to diagnose and manage this condition way before radiological sacroiliitis shows up whose diagnostic delay worsens due to the great inter-observer variability (0–35%), especially in grades 1 and 2.\textsuperscript{24}

Figure 8  Areas of periarticular bone signal enhancement at the T1-weighted coronal oblique sequence (arrows in a) whose signal is suppressed at the STIR sequence (b), suggestive of fat deposits. In (b) we can also see bone oedema next to the left sacral periarticular fat deposit (arrow head).

Figure 9  Ankylosis: the right sacroiliac joint space is erased (arrows) at the echo-gradient T2-weighted transversal oblique sequences (a) and T1-SG-Gd (b), with significant sclerosis of articular margins in (a).
Nevertheless after reviewing the most recent literature on this regard and based on our own experience we can see that these criteria have limitations affecting the diagnostic and prognostic utility of MRI in these patients. Firstly in absence of bone oedema or osteitis the MRI-identified structural lesions are not diagnostic of sacroiliitis. This exclusion is somehow contradictory due to the fact that the other radiological marker of sacroiliitis is based on structural changes seen on the simple X-ray according to New York new modified criteria despite the great inter-observer variability. 25 Also several trials have shown that MRI is not only capable of finding structural lesions before they can be seen on the X-ray without active inflammatory lesions,17,18 but it is also capable of increasing its diagnostic sensitivity from 67% to 81% when erosions are analyzed besides bone oedema without changes in specificity (88%). 27

Secondly even though the ASAS-OMERACT criteria establish the minimum amount of foci of bone oedema or osteitis necessary to consider an MRI a positive MR the number of foci found is not counted. Healthy controls can have isolated foci of hyperintensity on STIR (bone pseudo-oedema) with a frequency close to 27%.26,27 Aydin et al. followed 57 patients with MRIs for 8 years, 28 with inflammatory lower back and positive ASAS criteria of SpA and 19 healthy individuals. Results indicate that the proportion of positive MRI was higher in patients with a clinical diagnosis of SpA (79%) than in controls (22.2%) but they also indicate that if the cut-off point was raised to 2 or more foci of bone oedema the proportion of false positives (healthy controls with a positive MRI) was halved.28

Thirdly these criteria do not reflect the prognostic utility of MR; one agreed universal system capable of quantifying active inflammatory lesions and evaluating the activity of the condition and the therapeutic response has not been developed either. Several authors have highlighted the importance of evaluating the magnitude and severity of periarticular bone oedema to predict the appearance of radiographic sacroiliitis due to the importance of its prognostic utility and assess the response to therapy—very more important considering the high cost of biological therapies.29,30 In the same way different systems to quantify active inflammatory lesions through MR have been developed—Spondyloarthritis Research Consortium of Canada [SPARCC], Berlin, Leeds, etc.11 which based on bone oedema and its magnitude allow us to monitor the activity and damage of the condition as well as the response to therapy. In this sense ASAS-OMERACT criteria do not resolve today’s existing heterogeneity and disparity for the assessment of these parameters.

Taking all this into consideration some authors believe it is necessary to reassess and update the SpA-positive MR criteria including structural findings and quantifying the magnitude, extension and number of areas of hyperintensity in the para-articular bone marrow by developing one international standard method of reading.28,31

A systematic review of literature showed that most articles published had series of very few patients and that there were very few articles of high methodological quality with an adequate sample size and case-control or longitudinal designs. Also in most of these works the gold standard used to assess the diagnostic accuracy of MR was clinical diagnosis which was not independent of the information given by the MRI and whose reproducibility was not evaluated.32

So to validate MR as the diagnostic reference standard of sacroiliitis we need longitudinal studies with large cohorts especially with groups of patients with early SpA and in specific lower back pain.

Conclusion

ASAS criteria to diagnose axial SpA are the first ones to add MRI to diagnose sacroiliitis which is a turning point in the clinical-radiological management of this condition. They describe the different types of lesions we may find (active inflammatory lesions and chronic structural lesions) and establish the diagnostic criteria to be able to diagnose sacroiliitis through MR based on active inflammatory lesions only (bone oedema and osteitis). As radiologists we need to diagnose as sacroiliitis various cases which just do not qualify for ASAS criteria: cases with overt structural damage (erosions, sclerosis and even ankylosis) but without presence of bone oedema. Anyway we need to conduct future research to update these criteria, determine its prognostic value, and see if we are able to come to terms with a universal quantitative method.

Ethical responsibilities

Protection of human and animal subjects. Authors confirm that no experiments have been done with humans or animals during this research.

Confidentiality of data. Authors confirm that in this report there are no personal data from patients.

Right to privacy and informed consent. Authors confirm that in this report there are no personal data from patients.

Authors contributions

1 Manager of the integrity of the study: MEBI.
2 Original Idea of the Study: MEBI.
3 Study Design: MEBI and CLM.
4 Data Mining: MEBI and CLM.
5 Data Analysis and Interpretation: MEBI, CLM, MLRR and RMFQ.
6 Statistical Analysis: Not available.
7 Reference Search: MEBI, CLM, MLRR and RMFQ.
8 Writing: MEBI, CLM, MLRR and RMFQ.
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Conflict of interest

Authors reported no conflict of interest.

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