Are we overcalling sacroillitis on MRI? Differential diagnosis that every rheumatologist should know – Part I

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ABSTRACT

Diagnosing early spondyloarthritis (SpA) remains a challenge in routine practice, especially in its axial form (axSpA). Magnetic resonance imaging (MRI) is capable of detecting early bone marrow edema (BME) in the sacroiliac joints (SIJs), a key criterion for the diagnosis of active sacroiliitis according to the "imaging arm" of the Assessment of Spondyloarthritis International Society (ASAS) classification. However, despite MRI having superior reliability compared to radiographs and being recognized as a crucial imaging biomarker of SpA, it has several limitations, including its limited specificity and sensitivity. There is currently a concern about a potential "overcall" of sacroiliitis on MRIs. In this setting, differential diagnoses and their imaging features come into play.

In this two-part article, we will review both the imaging features that suggest a "positive" MRI in SpA and the most common differential diagnoses.

In order to understand the pathophysiology of sacroiliitis and the spectrum of developing lesions, one needs to be familiar with the complex SIJs anatomy, both on radiographs and on cross-sectional imaging studies (particularly MRI). As such, in the first part of this series of articles, we provide a brief background on the anatomy and different imaging modalities used in this clinical setting and we review the imaging criteria for a "positive" MRI of the sacroiliac joints in adults (part of the imaging arm of the ASAS classification, in addition to the modified New York criteria).

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INTRODUCTION

Spondyloarthritis (spondyloarthritides, SpA) are a group of inflammatory entities which share overlapping clinical, imaging, genetic and laboratory features, that are often associated with human leukocyte antigen (HLA)-B27 positivity and seronegativity for rheumatoid factor[1,2]. Based on the dominant clinical features, they can be subdivided into two main groups: axial SpA (where sacroiliitis is the cornerstone) or peripheral SpA (where peripheral joints arthritis, dactylitis and enthesitis dominate)[2]. These groups of diseases comprise ankylosing spondylitis, arthritis associated with inflammatory bowel disease, reactive arthritis, psoriatic arthritis and undifferentiated SpA[3]. An additional group is juvenile spondyloarthritis (JSpA).

Clinically, the diagnosis of axial SpA is often challenging, particularly in its earlier stages and in the young-adult population (when it typically starts), when no evident sign of disease is found on physical examination nor on radiographs or when non-specific back pain is the main symptom[4]. The aforementioned picture may lead to misdiagnosis and delay access to/introduction of appropriate treatment with further disease burden[5]. In this setting, imaging – particularly Magnetic Resonance Imaging (MRI) – is fundamental for an early SpA diagnosis. MRI is capable of detecting bone marrow edema (BME) in the SIJs, a key feature that may support the diagnosis of axSpA in the appropriate clinical context. Active sacroiliitis on MRI is one of the elements of the imaging arm of "imaging arm" of the Assessment of Spondyloarthritis International Society (ASAS) classification criteria[4,6]. However, BME is not an exclusive and specific feature of SpA-related sacroiliitis and may also be seen in asymptomatic individuals and in non-SpA diseases/sacroiliitis[1,7]. Furthermore, non-SpA related SIJs pathologies are more com-

monly found on MRI studies than SpA-related sacroiliitis, even in patients with inflammatory back pain[1]. The aim of this article is to review the SIJ anatomy, imaging modality indications, features that are suggestive of a "positive" MRI of sacroiliitis in adults (part I) and to review the most common differential diagnoses (part II).

1. ANATOMY OF THE SIJS

To understand the imaging features of sacroiliitis, one must first understand the complex SIJs anatomy. SIJs have a central location, between the sacrum and the iliac bones, and a vertical as well as anterolateral orientation in the transverse plane. Obliquely orientated undulating joint facets provide stability to the SIJs, which are surrounded and additionally empowered by ligaments and muscles.

The SIJs are composed of two main anatomic compartments (Figure 1): a C-shaped cartilaginous portion, which lies inferiorly/anteriorly and resembles a symphysis with hyaline cartilage firmly attached to the bone by fibrous tissue. This portion was formerly called the "synovial portion" but, in fact, only a small part (lower third) of this cartilaginous component has a true synovial-lined joint capsule; and a ligamentous portion (syndesmosis), which lies superiorly/posteriorly, contains strong interosseous ligaments and has irregular borders[8,9]. One may grossly think of SIJs as a block, placed anteriorly (anteroinferior part) with a tendency to fall anteriorly and inferiorly into the pelvis, held in place by tight ligaments posteriorly (postero--superior part).

2. THE ROLE OF IMAGING

The role of imaging in the setting of axial SpA has been extensively studied and, over time, different modalities have been incorporated into several SpA classification criteria, ranging from the New York criteria (NY, 1966), the Modified New York Criteria (mNY, 1984), the AMOR criteria (1990), the European Spondyloarthropathy Study Group criteria (1991) and the most recent and popular, the Assessment of Spondyloarthritis International Society (ASAS) criteria[10]. According to the ASAS criteria (imaging arm), both radiographs and MRI play a critical role in the classification of SpA[4,10,11]. Sacroiliitis on imaging is defined as

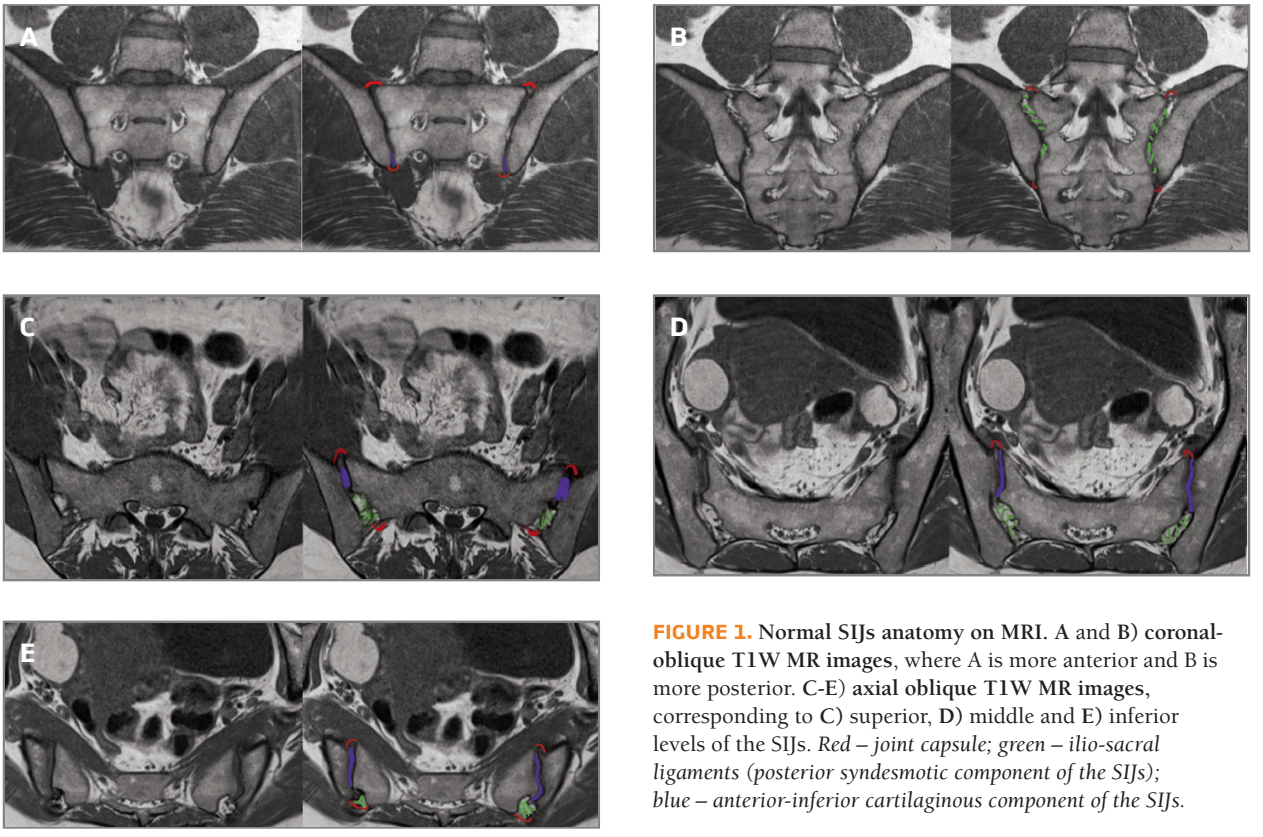


FIGURE 1. Normal SIJs anatomy on MRI. A and B) coronal-oblique T1W MR images, where A is more anterior and B is more posterior. **C-E) axial oblique T1W MR images,** corresponding to **C)** superior, **D)** middle and **E)** inferior levels of the SIJs. *Red – joint capsule; green – ilio-sacral ligaments (posterior syndesmotic component of the SIJs); blue – anterior-inferior cartilaginous component of the SIJs.*

"definite radiographic sacroiliitis according to mNY criteria" and/or as active sacroiliitis on MRI ("positive" MRI)[10]. It important to note that the ASAS classification criteria are not diagnostic criteria. The diagnosis of axSpA can only be made by the rheumatologist based on the combination of clinical, laboratory and imaging features. None of the above classification criteria are 100% sensitive or specific.

2.1. Radiographs

Radiographs can demonstrate structural changes, which are: erosions, subchondral sclerosis, articular space width irregularities and bone ankylosis. The 1984 mNY criteria for AS have represented the mainstay in the diagnosis of sacroiliitis for a long time[12]. They comprise both three clinical criteria and a fourth, which is the radiographic criterion of unilateral sacroiliitis grade 3 or 4, or bilateral sacroiliitis grade 2 or higher[4]. This radiographic criterion is based on the 1966 New York 5-point-grading system of structural SIJs damage.

The radiographic evaluation of SIJs has a significant limitation resulting from the complexity of the SIJs anatomy and its double obliquity, the anterior tilt of the sacrum and the lateral tilt of the joint space - all together summated on an anteroposterior or posteroanterior image. In addition, significant intra- and inter-observer variability and low agreement among readers have been reported, despite a number of attempts to improve standardisation[13]. Furthermore, a negative pelvic radiograph cannot exclude the diagnosis of SpA due to its low sensitivity for early disease, mainly due to its inability to visualize BME (non-radiographic axial SpA), thus contributing to a delay in diagnosis[14-15]. Nonetheless, radiographs are readily available, inexpensive, may exclude other pathology, and if positive, as in advanced sacroiliitis, they can be very useful. Therefore, according to EULAR (European League Against Rheumatism) and the European Society of Musculoskeletal Radiology (ESSR), radiography (anteroposterior view of the pelvis) is still considered the initial imaging modality in SpA and a useful baseline imaging technique to document progression of the structural changes[3,16]. Additional radiographic views (including oblique and Ferguson views) do not improve sensitivity over the standard anteroposterior view of the pelvis[3,16].

2.2. MRI

MRI allows direct visualization of the joint anatomy and abnormalities of the cartilage, capsule, synovium, subchondral bone and ligaments. ASAS and ESSR both state that MRI is the most sensitive imaging modality to detect early sacroiliitis[3,17-20] and is the technique of choice for the detection of early/active lesions in the SIJs, particularly in cases of negative radiographs in a patient with suspected SpA (non-radiographic axial SpA)[9,21,22]. It should be noted that some patients with negative Xrays and without active sacroiliitis on MRI can still have a diagnosis of axSpA in the presence of the adequate clinical-laboratory features (e.g. a patient with inflammatory back pain, arthritis, uveitis, HLA-B27 positivity and elevated CRP). This possibility is also reflected in the clinical arm of the ASAS classification criteria. MRI overcomes the limitations related to superposition of structures on radiographs and easily depicts periarticular BME (increasing agreement amongst readers) and improves follow-up by allowing monitoring of BME, assessment of response to therapy from an imaging perspective and depicting associated structural changes[3,23].

MRI protocols of the SIJs are well established in the literature[3,4] and should be strictly followed. Even though they are beyond the scope of this article, a brief mention should be made to the use of contrast (gadolinium). Adequate water-sensitive-sequences (fat-suppressed proton-density-weighted(W), fat-suppressed T2W and/or short tau inversion recovery (STIR) sequences) are used in reference centers, and, in most cases, gadolinium offers no additional benefit both in adults and in children, which is in line with the 2015 evidence-based EULAR recommendations and the 2016 update by ASAS MRI group[16,24].

In children, gadolinium use has been more debated, especially given concerns about nephrotoxicity and intracranial gadolinium deposition[25]. In addition, one needs to realize that the SIJs are usually not affected in isolation in SpA in both age groups (even more rarely in children), and the remaining locations would probably require contrast (cumulative effect). A 2018 study with 99 MRI studies in patients <21 years for suspected sacroiliitis showed abnormal enhancement in 5% of cases, but all of these had other features of active sacroiliitis that were depicted on water-sensitive sequences, and contrast did not identify additional cases[26].

In selected cases, when joint effusion is the only finding, gadolinium may help to confirm the presence of synovitis - but interestingly, authors that state that contrast is essential to identify synovitis, do not report effusions[27,28]. Others report that all cases with synovial enhancement have effusions, also depicted on water-sensitive sequences[29,30]. A thin rim of synovial en-

hancement may be normal in children, but this is difficult to prove and more research is needed[26]. In adults, synovitis alone is not sufficient to constitute a "positive MRI" for SpA-related sacroiliitis, whereas BME is well depicted on water-sensitive sequences[17].

2.3. Is there any room for CT?

Computed Tomography (CT) allows for direct visualization of structural changes with a higher spatial resolution than radiographs and MRI. CT has greater sensitivity and entails less inter-observer variability compared to radiographs, which explain why CT is useful in revealing subtle lesions and/or assessing incidental lesions on the radiographs[23,31]. In addition, CT better depicts the osseous anatomy and is especially helpful in children and adolescents where normal osseous SIJs structures vary considerably.

However, its inability to detect active inflammatory lesions and its higher levels of radiation exposure, particularly in this young population, dissuades its routine use. CT is performed mainly in equivocal cases, to either better depict small erosions and bone bridging, or to explore differential diagnosis. New emerging techniques such as low radiation CT (dual-energy) may have a role in the near-future, corroborated by the emerging role of structural changes, particularly, erosions, in the evaluation of SpA[23].

3. LOOKING FOR A "POSITIVE" MRI STUDY FOR SPA-RELATED SACROILIITIS

According to the ASAS criteria, labelling and MRI as suggestive of SpA in an adult is based on the evaluation of active inflammatory ("sacroiliitis") and structural postinflammatory changes (Table I)[4]. A "positive" MRI is defined by the clear presence of BME on MRI in subchondral bone; structural damage lesions seen on MRI may contribute to a decision by the observer that inflammatory lesions are genuinely due to SpA but are not required to meet the definition. A limitation regarding the definition of a positive MRI in axSpA is the age range of 18 years to 46 years of enrolled study subjects. Care should be taken in the extrapolation of these criteria to individuals outside this age range due to lack of data[23].

3.1. Active Inflammatory Lesions on MRI

Active inflammatory findings of the SIJs are (Table I, Figure 2): BME/osteitis (primary criterion) and enthesitis, capsulitis and synovitis (secondary criteria)[4,24]. BME, enthesitis and capsulitis are observed on water-sensitive and contrast-enhanced T1W sequences whilst synovitis may be seen on post-contrast images only; fat suppression increases their visibility. These active changes precede erosions in the initial, non-radiographic phase of SpA, and allow early diagnosis and treatment. Treatment with biologic agents will lead to a reduction or disappearance of BME in the majority of patients, representing a decrease in inflammatory infiltrates, with fatty replacement and/or sclerotization remaining a sign of past inflammation.

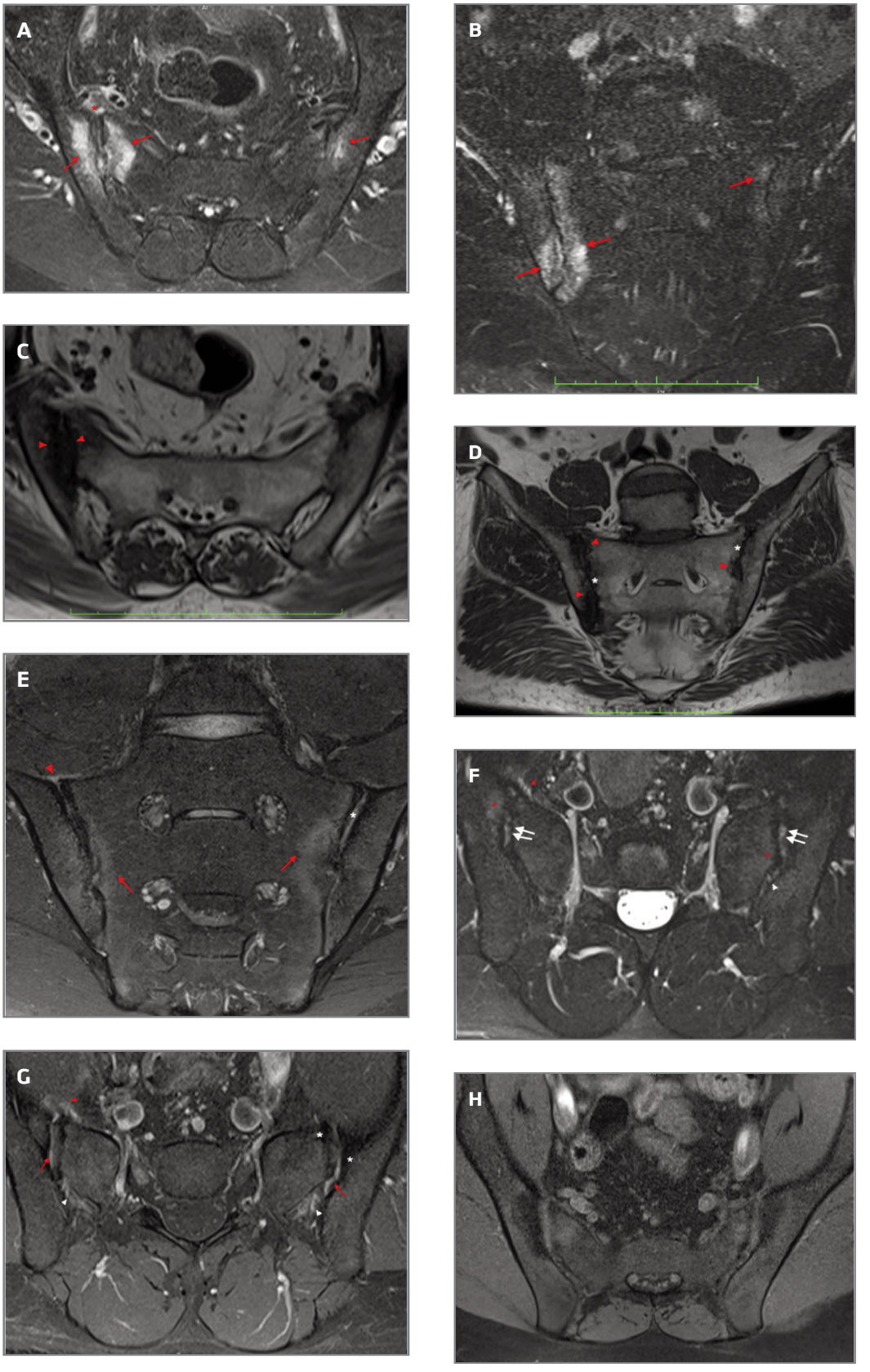
BME (Figure 2A-B, 2F, 3B and 3F) is defined by increased signal intensity in the bone marrow on water-

TABLE I. TYPES OF MRI LESIONS IN THE SIJs ACCORDING TO THE ASAS CRITERIA

Types of MR lesions in the SIJs	
Active inflammatory lesions	**Chronic post-inflammatory (structural) lesions**
BME/osteitis*	Subchondral sclerosis
Capsulitis**	Erosions
Synovitis**	Backfill
Enthesitis**	Fat metaplasia
	Bone bridges/ankylosis
• Active inflammatory lesions are better seen on fluid-sensitive (STIR, FS T2W, FS PDW) and contrast-enhanced FS T1 sequences. • Synovitis, is the exception, which is only depicted on contrast-enhanced FS T1 sequences.	• Chronic inflammatory lesions are usually better seen on T1W sequences

*Primary criterion; **Secondary criteria

Abbreviations: BME: Bone marrow edema; MRI: Magnetic Resonance Imaging; SIJs: Sacroiliac Joints; STIR: Short tau inversion recovery; PDW: proton-density-weighted; FS=fat-suppressed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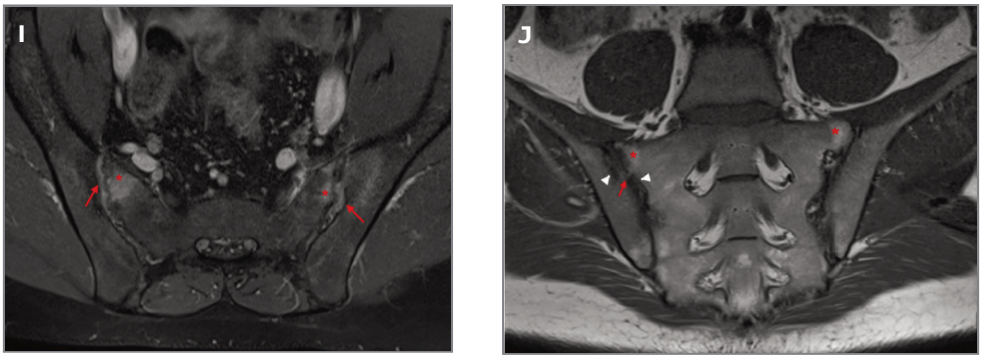


FIGURE 2. Inflammatory lesions on MRI as defined by ASAS criteria. *59-year-old male, ankylosing spondylitis:* **A)** axial oblique fat-supressed (FS) T2W, **B)** coronal oblique FS T2W, **C)** axial oblique T1W and **D)** coronal oblique T1W MR images show bilateral subchondral BME, more extensive on the right SIJ (arrows in A and B). Capsulitis is also seen on the right (red asterisk in A). Note also concomitant structural changes on T1W images - subchondral sclerosis (red arrowheads in C and D) and erosions (white asterisks in D). *41-year-old male, ankylosing spondylitis:* **E)** coronal oblique FS contrast-enhanced T1W MR image shows thickening of the right capsule with enhancement due to capsulitis (arrowhead), bilateral osteitis (arrows) as well as joint synovitis, more on the left side (asterisk). *39-year-old, female, probable psoriatic arthritis*: **F)** axial oblique FS STIR and **G)** axial oblique FS T1W contrast-enhanced MR images show subtle bilateral joint effusion on the STIR image (double white arrows in F) that corresponds to joint synovitis after contrast (red arrows in G). Note also the coexisting subtle BME (asterisks in F), capsulitis (red arrowheads in G and F), enthesitis (white arrowheads in G and F) and anterior subchondral sclerosis, more on the left SIJ (white asterisks in G). *28-year-old male, Yersinia Reactive Arthritis:* **H and I)** axial oblique FS T1W MR images before and after contrast show joint enhancement due to joint synovitis (arrows in I). Osteitis is seen bilaterally, more extensive on the sacral side (asterisks in I). **J)** coronal oblique T1W MR image shows erosions (white arrowheads) and fat metaplasia (asterisks). Do also note a bone bridge on the right (arrow).

sensitive and/or contrast-enhanced fat-suppressed T1 sequences in the SIJs (osteitis is the term which may be used for an equivalent-enhancing area on contrast-enhanced T1W images (Figure 2E and 2I). According to the ASAS criteria (Table II), the presence of BME/osteitis defines 'active sacroiliitis' on MRI when it is located in a typical subchondral/periarticular area and is sufficiently evident - if there is one BME lesion only, it should be present in at least two consecutive slices, if there is more than one signal abnormality on a single slice, one slice may be enough[3,17]. The more intense the signal, the more likely it is to reflect active inflammation[32]. BME is a MRI feature with moderate sensitivity (65%) and specificity (74%) for diagnosis of SpA in adults patients with inflammatory back pain[33]. Specificity increases if concomitant capsulitis, enthesitis, erosions or bone ankylosis are present. To avoid overcalling sacroiliitis, caution is advised when BME is scarce and not semilunar-shaped, and when there are no secondary findings to support the diagnosis[34]. Also, BME in the superior anterior part is generally related to mechanical overload, not SpA-related inflammation (despite the same clinical criterion of low back pain). Furthermore, in the absence of additional imaging features of SpA in the SIJs (enthesitis, synovitis, capsulitis) or spine (syndesmophytes), two small lesions measuring <1cm are not sufficient to suggest axSpA, particularly when located in the proximal or distal margins of the

TABLE II. LEARNING POINTS: "POSITIVE" MRI CRITERIA FOR SACROILIITIS ACCORDING TO THE ASAS CRITERIA

Learning Points - "Positive" MRI Criteria for Sacroiliitis are defined by:
• BME clearly present (in 2 consecutive slices in the same location or at least two locations in the same slice) and,
• BME in a subchondral/periarticular location.
• BME may be associated with other secondary active changes
• BME may be associated with other structural changes

Abbreviations: BME: Bone marrow edema; MRI: Magnetic Resonance Imaging

SIJs[14]. The former is likely to represent overload-related lesions, whereas the latter may represent enthesopathy or MRI artefacts.

Learning Point

• Periarticular BME, even as a sole finding, is a prerequisite for a "positive" MRI for sacroiliitis in an adult.

Other active inflammatory lesions (capsulitis, enthesitis and synovitis) are suggestive of sacroillitis, provided that concomitant subchondral BME is present (Table III)[3,4,17]. Capsulitis (Figure 2A, 2E-G and 5E) according to 2009 ASAS definition, is defined by thickening of the SIJs capsule with signal hyperintensity on water-sensitive and on contrast-enhanced fat-suppressed T1 sequences[3]. It involves the anterior and/or posterior capsule. However, since there is no capsule or synovium in the proximal two thirds of the joint (anteriorly, the SIJs capsule gradually continues into the periosteum of the iliac and sacral bones and thus corresponds to an enthesis) periarticular inflammation in this region represents enthesitis (Figure 2F-G and 5E) which is characterized by signal hyperintensity on water-sensitive and on contrast-enhanced fat-suppressed T1 images at ligaments and/or entheses (where tendons attach to bone)[9]. A common site to look for enthesitis is the retroarticular space (interosseous ligaments). Enthesitis may present as an increased signal both within the fibrous part of the enthesis as well as BME in the area of the enthesis anchoring in the bone. Synovitis (Figure 2E, 2G, 2I, 5B and 5E) is reflected by hyperintensity on contrast-enhanced fat-supressed T1-weighted images in the SIJs. Contrast is necessary for depicting synovitis, because water-sensitive sequences do not differentiate between synovitis and physiologic joint effusion, as mentioned above. Synovitis on MRI as a single feature (without BME) is a rare finding[3,17] and indicates a different pathology than SpA. The name "synovitis" may be a misnomer since there is only synovium in the lower part of the cartilaginous component of the SIJs.

3.2. Chronic (structural) lesions on MRI

Chronic (structural) lesions are believed to reflect previous sacroiliitis. They include erosions, subchondral sclerosis, periarticular fat metaplasia, fat deposition in the intra-articular space (backfill) and ankylosis (Table I, Figure 3)[4,24]. These structural changes increasingly gain importance for diagnosis and follow-up. However, they are likely to reflect a postinflammatory stage and, while having very high specificity[35], they do not suffice for the definition of a positive MRI examination for sacroiliitis.

Erosions (Figure 2D, 2J and 3C-H), probably the most important structural changes, are defined as a discontinuity or blurring of either the cortical sacral or iliac bones, which appears with low signal intensity on both T1W and STIR sequences, together with loss of the bright signal from adjacent marrow on T1 sequences[32]. Additional T2 gradient-echo or fat suppressed T1W sequences (without contrast) can help to detect erosions. Erosion may appear as either single and localized, or multiple and contiguous. Due to cartilage thickness, erosions appear initially on the iliac side (thinner cartilage), developing later on the sacral side (thicker cartilage) of the cartilaginous part of the SIJs. They may also occur in the posterior syndesmotic part of the joint in the course of enthesitis. Initially erosions tend to be single and, with progression, become confluent and cause pseudowidening of the SIJs. They may be active (filled with inflamed tissue) and consequently present with concomitant BME[36]. Erosions may be present on MRI when radiographs are normal or inconclusive. The presence of erosions indicates long-lasting disease and may reflect more severe disease with greater spinal inflammation[32].

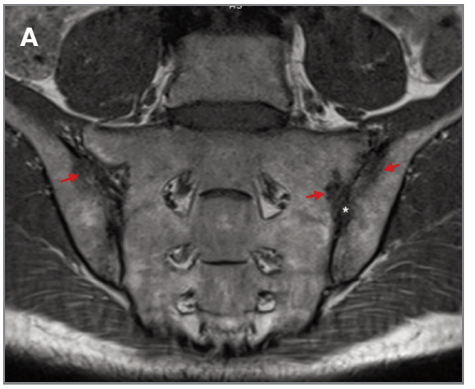
Integration of structural changes may enhance diagnostic utility[23]. Of all the structural features, ero-

TABLE III. LEARNING POINTS: ACTIVE INFLAMMATORY LESIONS IN SACROILIITIS

Learning Points - Active inflammatory lesions in sacroiliitis:

- Periarticular BME, even as a sole finding, is a prerequisite for a "positive" MRI for sacroiliitis in an adult.
- The sole presence of synovitis, capsulitis and/or enthesitis (secondary criteria), without concomitant BME (primary criterion) is compatible but not sufficient for the definition of active sacroiliitis on MRI in an adult.

Abbreviations: BME: Bone marrow edema; MRI: Magnetic Resonance Imaging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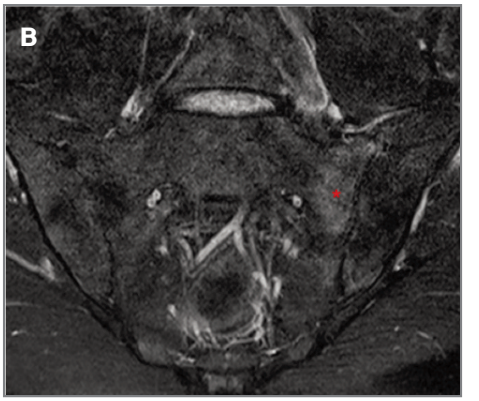
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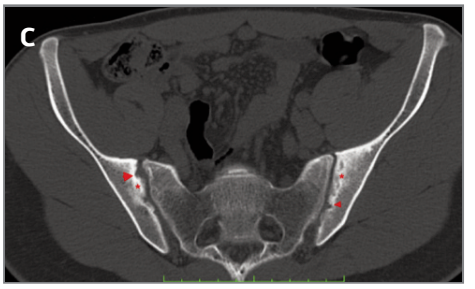
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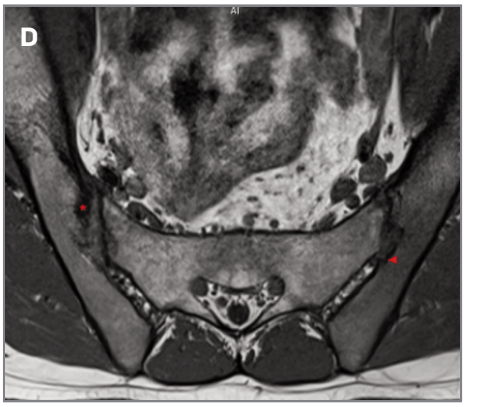
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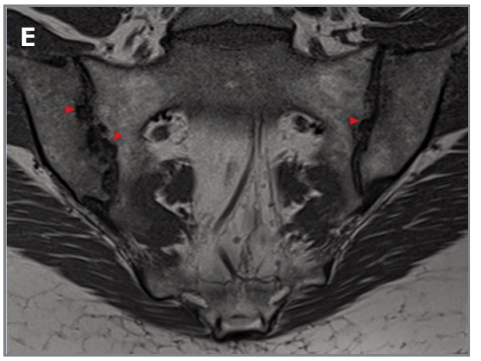
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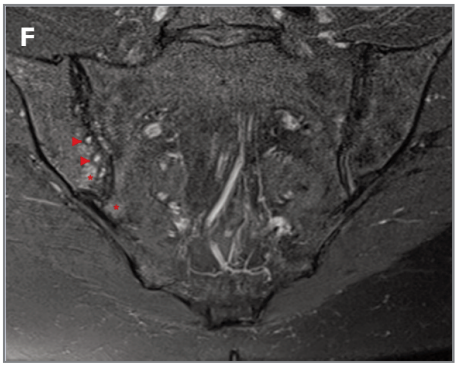
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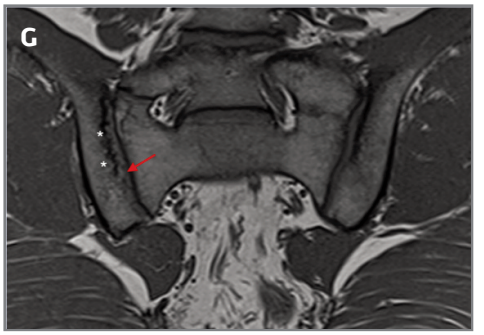
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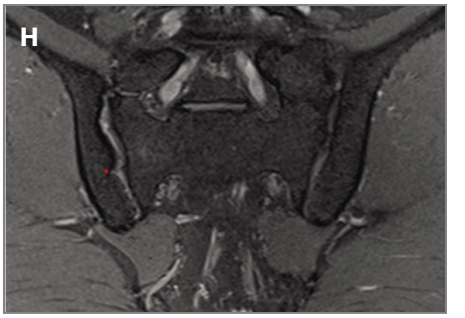
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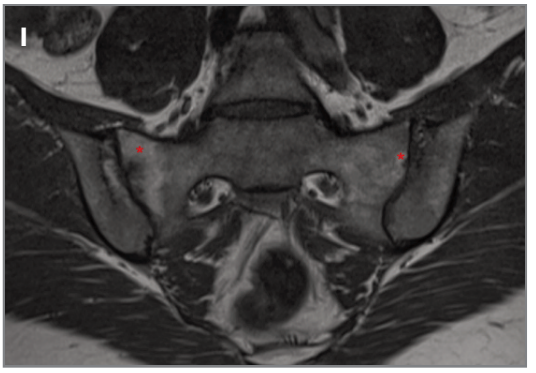

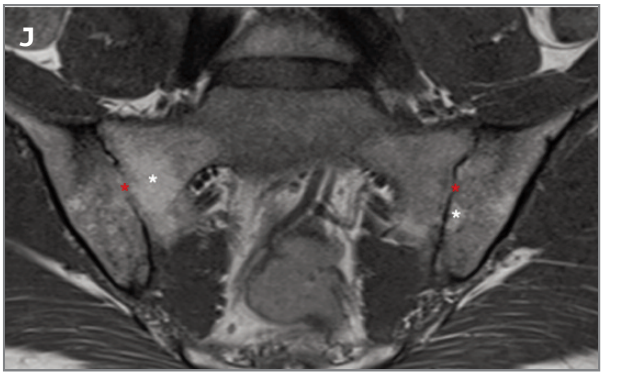

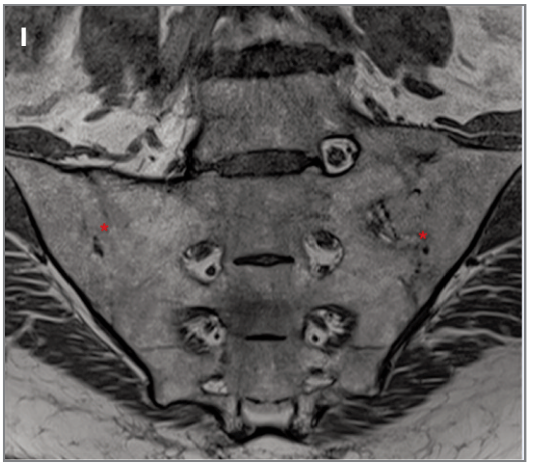

FIGURE 3. Chronic post-structural lesions on MRI as defined by ASAS criteria. *31-year-old female, ankylosing spondylitis*: **A)** coronal oblique T1W and **B)** coronal oblique FS T2W MR images show subchondral sclerosis (arrows in A), with joint space narrowing, more on the left (asterisk in A). Note also still ongoing inflammation BME on left SIJ (asterisk in B). *18-year-old male, juvenile ankylosing spondylitis:* **C)** axial CT image and **D)** axial oblique T1W MR image reveals bilateral erosions (arrowhead), more on the iliac side, with joint space pseudowidening and surrounding subchondral sclerosis (asterisks). *57-year-old female, ankylosing spondylitis:* **E)** coronal oblique T1W and **F)** coronal oblique STIR MR images depict multiple erosions, more marked on the right side (arrowheads in E) filled with inflamed T2-hyperintense tissue (arrowheads in F, active erosions), with surrounding fatty metaplasia and residual BME (asterisks in F). *28-year-old female, psoriatic arthritis:* **G)** coronal oblique T1W and **H)** coronal oblique FS T1W MR images show erosions in the right SIJ (asterisks in G and H) and associated backfilling (arrows in G). Erosions are nicely depicted on FS T1 MR images. *Another patient, suspected for ankylosing spondylitis:* **I)** coronal oblique T1W MR image shows periarticular fat metaplasia (asterisks). *54-year-old male, ankylosing spondylitis:* **J)** coronal oblique T1W MR image shows bilateral joint space narrowing with bone bridging/partial ankylosis (red asterisks), surrounded by fat metaplasia (white asterisks). **K)** Coronal oblique T1W MR image shows almost complete bone ankylosis of the SIJs (asterisks).

sion has by far the highest positive likelihood ratio for the diagnosis of SpA – the incorporation of erosions in the MRI evaluation of the SIJs has been showed to increase sensitivity from 67% to 81%, without changing specificity[33]. As such, they man play a new or additional role in classification systems (MORPHO proposal criteria)[19,23,37]. However, a recent update by the ASAS MRI working group concluded that the definition of a "positive" MRI should continue to primarily depend on the imaging features of "active sacroiliitis", and not include erosions as a primary feature for the time being, as there is no consensus as to how erosions should be defined on MRI or how it should be classified[24].

Subchondral sclerosis (Figure 2C-D, 2G, 2J, 3A and 3C-D) is represented by areas with blurry margins which have low signal intensity on all sequences and no enhancement after gadolinium. With disease progression, they tend to become wider, as opposed to osteoarthritis (in which they are more well-defined and narrower)[22]. Sclerosis attributed to SpA should extend at least 5mm from the articular space in the iliac side and/or at least 3mm in the sacral side[17].

Subchondral fatty bone marrow replacement /fat metaplasia (Figure 2J, 3F and 3I-J) represents fat conversion in inflammatory, often periarticular, bone marrow areas. It is characterized by increased signal on T1W sequences with signal loss on fat suppressed images and no enhancement[17]. It is the only structural change that is visible on MRI, but not on radiographs or CT. Fat metaplasia is a non-specific finding but, like sclerosis, may indicate previous inflammation/long-standing disease and resolution of inflammation (prior BME) with the development of fatty metaplasia in the same area and, later, the development of bone ankylosis.

Backfill (Figure 3G) represents the presence of fat (high-signal on T1W sequences) within an erosion or erosive cavitation at the articular surface[38]. It may reflect resolution of inflammation and tissue repair at sites of erosions, and is thought to be a key intermediary in the development of bone ankylosis[38].

Bony ankylosis (Figure 3J-K) is characterized by confluent high T1 signal intensity across the SIJs space, with obliteration of the articular cortical margin[35], and represents the end-stage disease. It starts from single bone bridges which may progress to partial or finally a complete ankylosis of the joint[35].

Learning point:

• Despite increasing importance of structural changes, particularly erosions, to date, the sole presence of structural changes, without concomitant BME, is not sufficient for the definition of active sacroiliitis on MRI[23-24]. (Table IV).

3.3. How about MRI criteria in children?

Classification of the pediatric population remains a challenge. Unlike adults, the diagnostic value of chronic back pain or inflammatory back pain criterion, which in adults is a base for referring for MRI, is not so evident in children. MRI assessment of sacroiliitis in children is not well studied. Many different classification schemes have been proposed for children, but none includes imaging as a criterion[4,39-41]. Recent studies have postulated the usefulness of MRI in JSpA. Furthermore, adult imaging criteria (radiographic mNY and ASAS MRI criteria) have been empirically applied to the pediatric population, with children increasingly being referred for MRI. However, the adult ASAS definition for sacroiliitis has a low sensitivity in children and there is still a lack for a clear definition for "positive" MRI for sacroiliitis in this age group. In addition to findings seen in adults, some reported the importance of the single bone marrow lesion as diagnostic for JSpA[42], and others found that synovitis alone may be specific without the need for BME in JSpA[27,43]. Some also paid attention to the normal ossification process in children where BME could be seen as a normal finding[44] - the high prevalence of ossified nuclei in the joint space in children and adolescents could be the cause of the observed BME[44]. As previously mentioned, the use of contrast for diagnosing sacroiliitis in children with JSpA is questionable and should not be administered on a regular basis[26]. A recent study showed that a children-specific definition of "positive" MRI for sacroiliitis including BME visible on one slice only, synovitis and/or capsulitis, may improve diagnostic utility and increase relevance of MRI in rheumatology guidelines in a near future[45].

Learning Point:

• The adult ASAS definition for a positive MRI needs *some adjustments* for children, including small BME le-

TABLE IV. LEARNING POINTS - CHRONIC INFLAMMATORY LESIONS IN SACROILIITIS:

Learning Points - Active inflammatory lesions in sacroiliitis:
• Integration of the assessment of structural changes, particularly erosions, may enhance diagnostic utility of MRI; however, to date the ASAS guidelines did not add any structural change to the definition of "positive" MRI
• As such, the sole presence of erosions, sclerosis, fat metaplasia, backfill and/or ankylosis, without concomitant BME, is not sufficient for the definition of active sacroiliitis on MRI in an adult.

Abbreviations: BME: Bone marrow edema; MRI: Magnetic Resonance Imaging

TABLE V. LEARNING POINTS - MRI IN JUVENILE SpA

Learning Points - Active inflammatory lesions in sacroiliitis:
• The adult ASAS definition for a positive MRI needs some adjustments for children, including small BME lesions that are only visible on one slice or synovitis /capsulitis may be sufficient for a "positive" MRI in children (but more studies are needed)
• The use of contrast for diagnosing sacroiliitis in children with juvenile SpA is questionable, and should not be administered on a regular basis.

Abbreviations: BME: Bone marrow edema; MRI: Magnetic Resonance Imaging; Juvenile SpA: JSpA

sions that are only visible on one slice or synovitis /capsulitis *may be sufficient* for a "positive" MRI in children (but more studies are needed).

4. HOW ABOUT NON-SPA – RELATED SACROILLITIS ON MRI?

MRI features in patients with SpA may fluctuate, highlighting the limited sensitivity of MRI for diagnostic purposes if it would be used as the only evaluation tool. Studies show that MRI is moderately sensitive (50--95%) and specific (47-90%) for the diagnosis of SpA in adults in the adequate clinical setting[12,19,23,46]. If BME is used as a sole MRI criterion and the potential incremental contribution of structural lesions are not considered, the sensitivity is lower (35-42%)[47,48]. This points out the increased importance of looking for structural changes along with the clear presence of BME, and the need of clinical contextual interpretation in order to make a correct diagnosis of "sacroiliitis" in SpA. Age <45, male sex, HLAB27 positivity are among other parameters that will increase specificity of periarticularly located BME towards SpA. If the contextual interpretation of MRI is not suggestive of SpA, other differential diagnosis come into play.

Recent studies estimated that 23-33% of patients referred for MRI due to clinical suspicion of SpA had alternative non-inflammatory conditions, and that 41%-50% had normal SIJs on MRI[33]. Jans *et al* showed that non-inflammatory disease was indeed more common than sacroiliitis on MRI of the SIJs in patients with inflammatory type back pain[33]. Klang *et al* studied a population of patients under 40 years with low-back pain on lumbosacral CT and found some degree of SIJ changes in 14% of this population, and unequivocal sacroiliitis in 3,3%[49]. Slobodin *et al* found sacroiliitis in 3.7% of patients on abdominal CTs performed for other indications in a population aged 18-55 years--old[50]. As such, interpretation of MRI findings in daily practice is critically dependent on the clinical context.

Learning Point:

• Even in patients with inflammatory low-back pain, it is important to consider non-inflammatory disease because chronic or inflammatory low back pain has low specificity for axSpA.

CONCLUSION

Imaging modalities, particularly MRI, play a key role in the diagnosis and follow-up of patients with axSpA. Interpretation of MRIs of the SIJs in adult patients suspected to have axSpA is based on the presence of active inflammatory (BME/osteitis, capsulitis, synovitis, enthesitis) and structural postinflammatory lesions (erosions, sclerosis, fat metaplasia, backfill and ankylosis). Active lesions are particularly useful for the diagnosis and assessment of potential ongoing inflammation. Structural lesions gain importance for both diagnosis and follow-up. These lesions were reviewed in this article, in addition to a short description of different imaging modalities and normal SIJs anatomy.

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