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

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ABSTRACT

In the second part of this review article we will describe the imaging features of non- spondyloarthritis (SpA) pathologies that may mimic sacroiliitis on Magnetic Resonance Imaging (MRI) that readers should be aware (part 2). Based on the established literature, there is currently an "overcall" of sacroiliitis on MRIs. In this setting, differential diagnoses and their imaging features come into play.

In fact, non-SpA related sacroiliac joints (SIJs) pathologies are more commonly found than true sacroiliitis on MRI of the SIJs, even in patients with inflammatory type back pain. An imaging literature review, highlighting "easy-to-use" learning points regarding MRI interpretations in patients with suspected sacroiliitis and/or nonspecific lumbar back pain is presented.

This two-part article aims to be a snapshot of the most common inflammatory versus non-inflammatory entities found on SIJs imaging studies in routine practice, while trying to keep this review article simple, educational and above all, practical.

Keywords: Differential diagnoses; Sacroiliitis; Spondyloarthritis; MRI

INTRODUCTION

In the first part of this article, sacroiliac joints (SIJs) anatomy, imaging modality indications and features that constitute a "positive" magnetic resonance imaging (MRI) of sacroiliitis in adults were described. However, interpretation of imaging findings is critically dependent on the clinical context and, often, neither clinical presentation or images are specific for spondyloarthritis (SpA) or other entities. As such, if an MRI is not diagnostic of SpA, other differential diagnosis must be considered.

In this second part, we present a review the most common differential diagnoses found in clinical practice.

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SACROILIITIS MIMICS – DIFFERENTIAL DIAGNOSIS

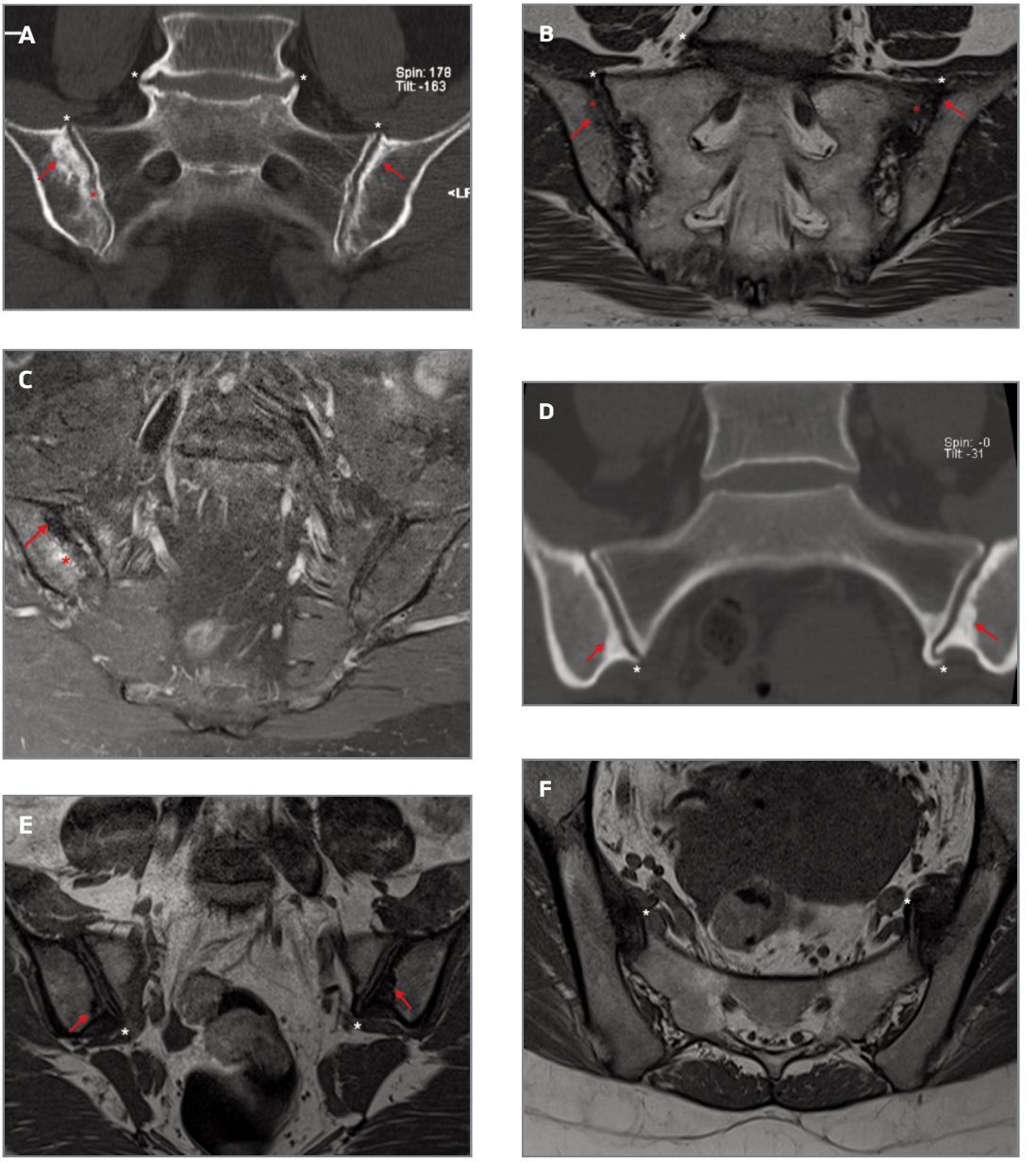
A wide range of conditions can pose diagnostic challenges on MRI. Age, sex, clinical context and laboratory data shortens the imaging differential diagnosis. Prior imaging studies should be used for comparison, when available.

1. ANATOMIC VARIANTS OF THE SIJS

Anatomical variations of SIJ may involve the cartilaginous or ligamentous part of the joint. Intraarticular ossified nuclei are frequent after the age of 13 years and can persist up to the age of 18 years. Attention to normal anatomical structures during growth may help to avoid false positive MRI findings[1]. Normal small vessels are located in transitional cartilaginous-ligamentous portions and may simulate bone marrow edema (BME) small, single foci[2]. Accessory SIJs are the most frequent variant (8-40%), often found between the iliac and the sacral articular sides at the posterior portion of the SIJs, from the level of the first to the second sacral foramena[3-4]. Demir *et al.* have reported a high incidence of degenerative changes within these secondary accessory joints, often with BME, which occasionally may also contribute to pain[3]. Other less common anatomic variants are usually straightforward and don't pose any diagnostic problem (iliosacral complex, bipartite iliac bony plate, semicircular defect in the articular surface, crescent-like iliac bony plates)[3].

2. OSTEOARTHRITIS/DEGENERATIVE CHANGES OF THE SIJS AND LOWER LUMBAR SPINE

2.1. Degenerative changes of the SIJs (Figure 1) are very frequent and include non-uniform joint space narrowing (often only mild), subchondral sclerosis, osteophytosis and intra-articular vacuum phenomenon. Most of the degenerative changes of the SIJs are asymptomatic but some may have low back pain, confounding the clinical picture. Subchondral sclerosis is usually dense, well-defined and with variable thickness, frequently wider and less uniform in the elderly[5]. The prevalence of marginal ossifications/osteophytes increases with age, however they can be seen in young patients, particularly if sports-active/athletes[6]. Occasionally, small erosions can also occur within the spectrum of degenerative changes of the SIJs, especially in elderly overweight women, making it difficult to distinguish from sacroiliitis. However, clinically, the pain is different (mechanical). Not so uncommonly, BME due to mechanical changes also occurs in the SIJs, particularly surrounding sclerotic areas and often limited to the immediate subchondral area, often in the



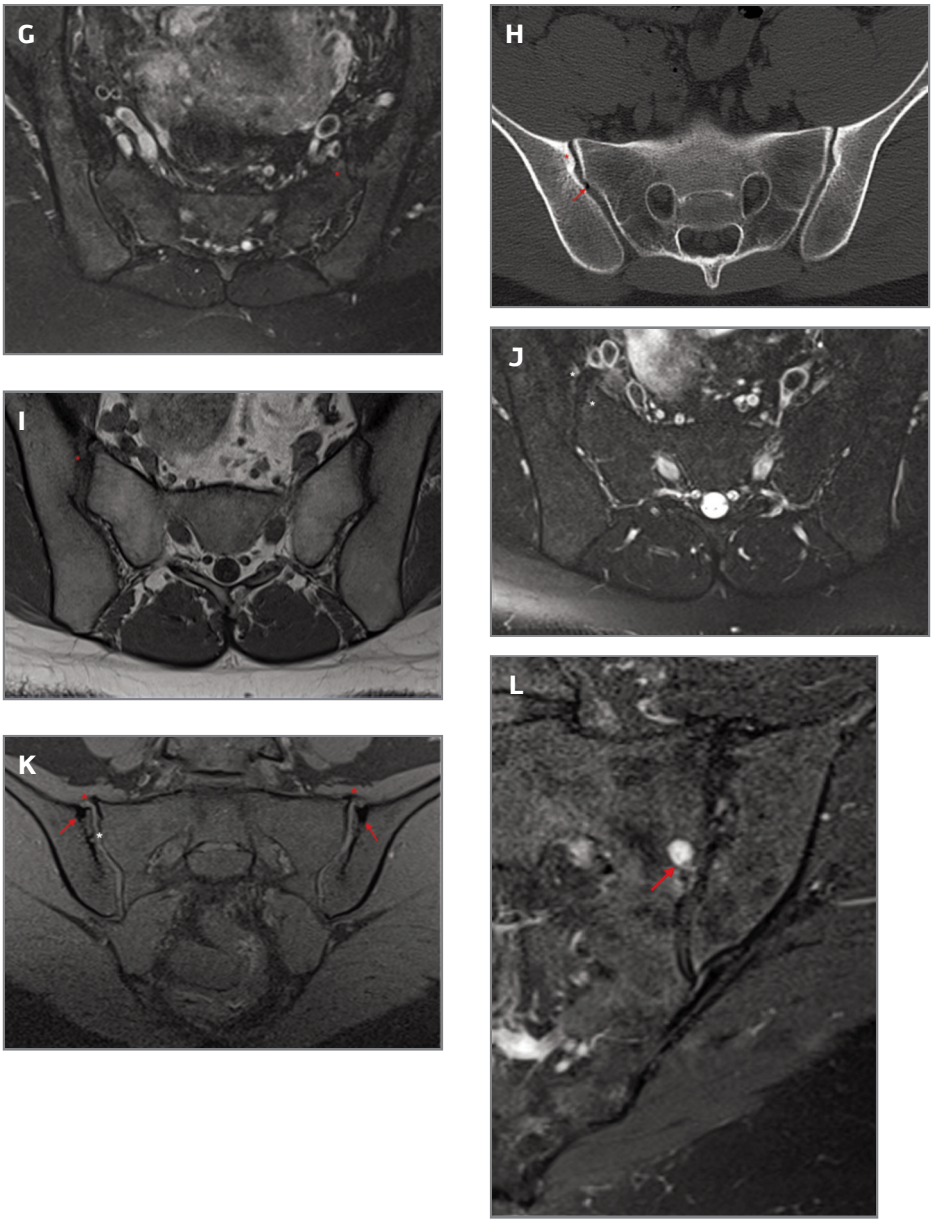


FIGURE 1. Degenerative changes. *64-year-old woman, pain not fulfilling definition for inflammatory low back pain:* **A)** coronal CT image, **B)** coronal oblique T1W and **C)** coronal oblique FS PDW MR images show subchondral sclerosis, more evident on the right iliac side (arrows), osteophytosis (white asterisks in A and B) and subtle minor erosions/cortical irregularity (red asterisk in A and B). Note also the mild BME surrounding the area of subchondral sclerosis (red asterisk in C) -hyperaemia due to mechanical stress in a typical anterior-superior part of the SIJs. *34-year-old male, martial arts fighter*: **D)** coronal CT image, **E)** coronal oblique T1W, **F)** axial oblique T1W and **G)** axial oblique FS T2W MR images depict marked anteroinferior osteophytosis (white asterisks in D, E and F), surrounded by subchondral sclerosis (arrows in D and E), more prominent on the left side, with very mild BME surrounding these changes (red asterisk in G). Notice how the structural changes are best depicted on CT as compared to MRI. *28-year-old male, soccer player*: **H)** coronal CT image, **I)** axial oblique T1W and **J)** axial oblique FS T2W MR images show mild subchondral sclerosis on an anteriorsuperior location, with minor irregularity, more on the right SIJ (red asterisk in H and I) suggesting a mechanical cause, supported by the joint vacuum phenomenon (arrow in H). No frank erosions or fat metaplasia is seen. Notice the subtle BME adjacent to these degenerative/microtraumatic findings (white asterisks in J). *29-year-old female professional ballet dancer:* **K)** coronal oblique FS T1W MR image shows subchondral sclerosis (arrows), osteophytosis (red asterisks) and cortical irregularity, with an erosion (white asterisk) better defined on the superioranterior aspect of the right SIJ. *50-year-old female:* **L)** coronal oblique FS T2W MR image shows a subchondral cyst (geode) in the sacral side of the left SIJ(arrow), cortical irregularity and joint space narrowing.

antero-superior part of the SIJs[7]. Up to 27% of heathy individuals with mechanical back pain show BME in the SIJs[8]. This can be even more extensive in sports-active individuals. In fact, one should be aware that mechanical/overload/microtraumatic changes that occur in sports-active individuals can induce changes in the SIJs, often BME and/or small erosions, an important confounding factor in imaging interpretation. A study of MRI of SIJs in athletes showed BME fulfilling ASAS criteria in 35% of hobby runners and 41% of ice-hockey players[9]. This non-inflammatory BME was more common in the posterior lower ilium, followed by the anterior upper sacrum[10]. Similar results were found in another study with military recruits, who fulfilled the ASAS MRI criteria in 23% and 36% before and 6 weeks after intensive physical training, respectively[11]. Fat deposition is a non-specific finding, but may sometimes be seen in the degenerative setting and even in older healthy individuals[12]. Large erosions, subchondral cysts and ankylosis are rare in osteoarthritis.

Learning Points - osteoarthritis:

- A *young, sports-active individual* may present with BME in the SIJs. Minor erosions, osteophytes and sclerosis can also be seen. Look for age, history and look at the BME distribution (non-inflammatory BME more common in the posterior lower ilium>anterior upper sacrum).
- In *the elderly with SIJs osteoarthritis*, BME can also occur (often in the anterosuperior part of the SIJs). Minor erosions can also be seen. Look for other signs suggestive of degenerative disease (joint space narrowing, subchondral sclerosis, osteophytosis and joint vacuum phenomenon).

2.2. Degenerative changes of the lower lumbar spine are a very common finding in routine MRI of the SIJs. A study of 691 patients undergoing MRI of the SIJs for inflammatory back pain reported L5-S1 degenerative changes as the most common non-inflammatory finding (44%) and it consisted of disc degeneration (32%), facet joint arthrosis (8%) and disc herniation (4%)[10]. In 16% of this set of patients with spinal changes, adjacent BME was seen[10]. Not rarely, low back pain fulfilling the definition of inflammatory back pain indicating axial SpA results from L5-S1 pathology[10].

2.3. Transitional vertebrae, with or without adjacent BME, are found in up to 25% of population[13]. In these patients, BME is more subtle and confined to the immediate surfaces involved in the transitional lumbosacral transitional vertebra (that is, typically located at the enlarged transverse process and the portion of the sacral bone adjacent to it)[13]. As such, the presence of a BME-like pattern at the pseudoarticulation that does not reach the SIJs should not be confused with the usually T2-brighter, subchondral/periarticular BME of the SIJs associated with axial SpA.

3. INFECTIOUS SACROILIITIS

Infectious sacroiliitis is not uncommon but is more frequente in children and young individuals[14]. Clinical history is critical, however, diagnosis is often delayed due to the typically insidious clinical presentation. Changes can be seen on MRI within up to three days after the onset of symptoms[14]. MRI appearance may be similar to that of inflammatory sacroiliitis but is usually more dramatic (Figure 2). Extensive BME is typically present in the acute phase and often unilateral (at least initially). Often, BME in infectious sacroiliitis shows sacral predominance or an even distribution (not an iliac predominance, as in SpA)[10]. Joint fluid (septic arthritis/synovitis), thick capsulitis, peri- and extra-articular edema and fluid collections in the surrounding soft tissues may occur[10,15]. Regional muscle edema is probably the most important predictor of infectious sacroiliitis[10,15]. Infection does not respect the limits of the SIJs and infiltrates throughout the muscles (specially, the iliac muscle). In advanced stages, erosions (often large, >1cm), bony bridges, fatty replacement and ankylosis may also be found[16].

Also, indolent infections should be remembered, such as tuberculosis or fungi. Tuberculous septic arthritis is usually unilateral and an abscess containing calcifications anterior to the SIJs may develop. Erosions may be deep, from both iliac and sacral sides, and SIJs ankylosis may develop.

Learning point – infectious sacroiliitis:

- Features that can point out to infectious sacroiliitis (given the appropriate clinical setting) are that anatomic boundaries are not respected (involvement can be unilateral or bilateral), usually with larger erosions, joint effusion, and more extensive BME and soft-tissue involvement, often with abscesses)

4. OSTEITIS CONDENSANS ILII (OCI)

Osteitis Condensans Ilii (OCI) is reported to affect 0.9 to 2.5% of the population but may be underestimated[17]. It is believed to be caused by mechanical/stress-related remodelling across the SIJs. Usually bilateral and relatively symmetrical, it occurs more often in multiparous

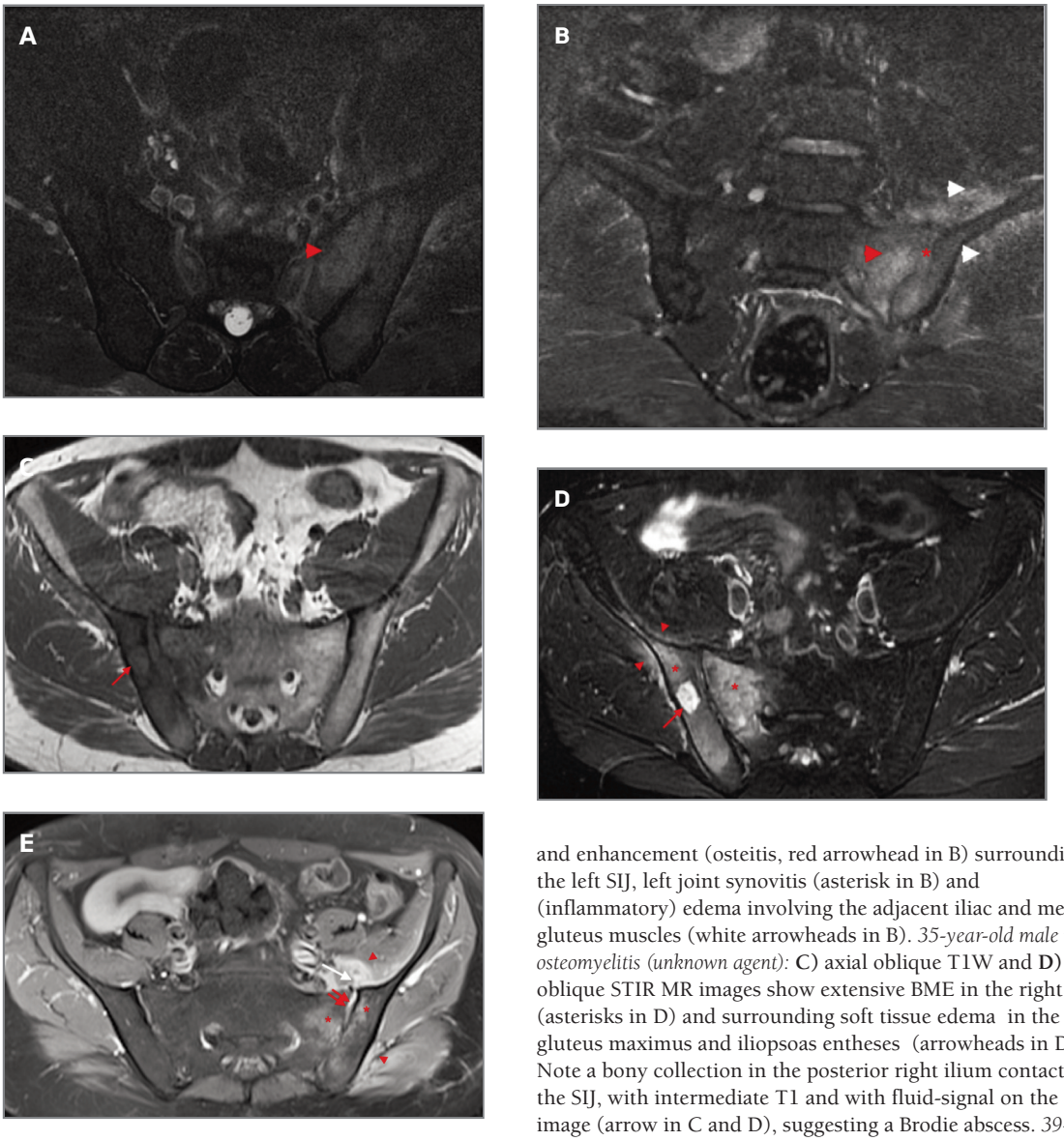


FIGURE 2. Infectious sacroiliitis. *40-year-old male with infectious sacroiliitis caused by Staphylococcus aureus following a skin injury*: **A)** axial oblique FS T2W, and **B)** coronal oblique STIR MR images show extensive BME (red arrowhead in A and B) and enhancement (osteitis, red arrowhead in B) surrounding the left SIJ, left joint synovitis (asterisk in B) and (inflammatory) edema involving the adjacent iliac and medial gluteus muscles (white arrowheads in B). *35-year-old male with osteomyelitis (unknown agent):* **C)** axial oblique T1W and **D)** axial oblique STIR MR images show extensive BME in the right SIJ (asterisks in D) and surrounding soft tissue edema in the gluteus maximus and iliopsoas entheses (arrowheads in D). Note a bony collection in the posterior right ilium contacting the SIJ, with intermediate T1 and with fluid-signal on the STIR image (arrow in C and D), suggesting a Brodie abscess. *39-year old male with sacroiliitis caused by Salmonella typhi:* **E)** axial oblique FS contrast-enhanced T1W MR image shows extensive unilateral osteitis surrounding the left SIJ (asterisks) with joint synovitis (red double arrow), anterior capsulitis (white arrow) and surrounding soft tissue edema/enthesitis (red arrowheads).

females, and in the perinatal period[18-19]. OCI may be related to the increased tilt of the female pelvis. However, men and nulliparous women are also affected[19]. Although most frequently asymptomatic, OCI may also be associated with axial low back pain[20]. Other characteristics are normal inflammatory markers and HLA B27 negativity[18]. The imaging features (Figure 3) are a triangular-shaped, anteriorly located well-circumscribed subchondral sclerosis, mostly in the iliac side (even though sacral sclerosis can also be seen, to a lesser extent), without erosions (even though small erosions can coexist due to degenerative changes) nor joint space narrowing[21,17,22]. According to Ma *et al*, the mean value of the thickest part of sclerosis is about 13mm in OCI patients[18]. Concomitant BME surrounding sclerosis can be seen, especially in the postpartum period. Indeed, it may be more frequent than initially described – the same authors found BME beneath the iliac sub-

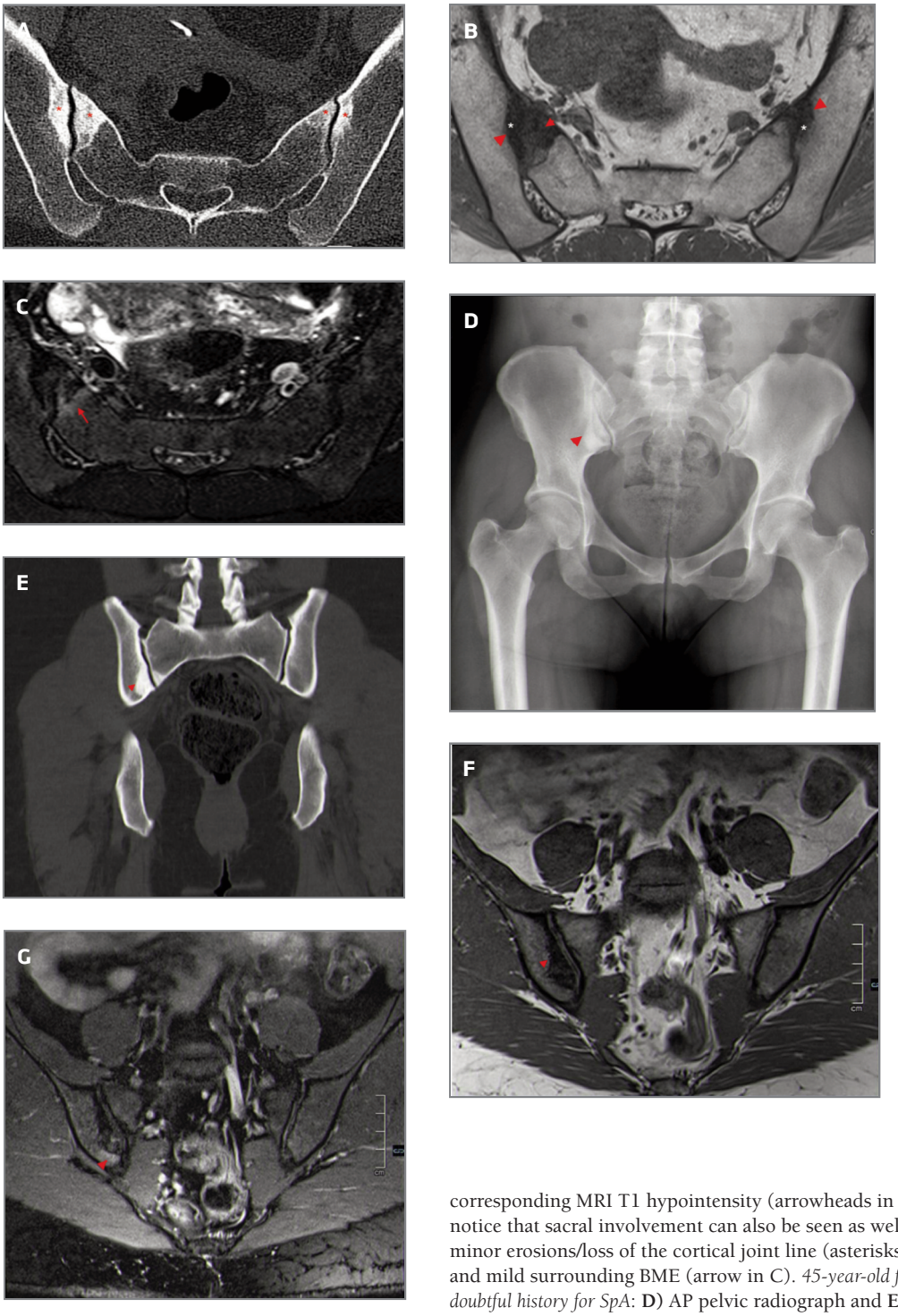


FIGURE 3. Osteitis condensans ilii. *32-year-old male, long-standing lumbar pain:* **A)** axial CT image, **B)** axial oblique T1W and **C)** axial oblique FS T2W MR images show bilateral anterior well-circumscribed triangular area of subchondral sclerosis (asterisks in A), more evident on the right side, involving both the iliac and (less) the sacral side, with corresponding MRI T1 hypointensity (arrowheads in B). Do notice that sacral involvement can also be seen as well as minor erosions/loss of the cortical joint line (asterisks in B) and mild surrounding BME (arrow in C). *45-year-old female, doubtful history for SpA*: **D)** AP pelvic radiograph and **E)** coronal CT image show unilateral triangular area of subchondral sclerosis, mainly on the iliac border of the right SIJ, with minimal involvement of the sacral side (arrowhead). **F)** coronal oblique T1W and **G)** coronal oblique PDW MR images of the same patient show corresponding well-defined area of hypointensity (arrowhead in F) and subtle BME surrounding the sclerotic area (arrowhead in G).

chondral sclerosis in 48% of their patients, mostly centered at the cartilaginous joint part, and 92% of these would also have BME on the sacral side[18]. This BME was both deep (more than 10mm in 39%) and of high intensity (85% graded higher than mild)[18]. This emphasizes the need of differentiating OCI from sacroiliitis. Note also that both OCI and SpA may coexist, leading to a difficult diagnostic challenge. Careful observation of the location and distribution pattern of BME may be helpful in differentiating OCI from early sacroiliitis.

Learning Points - OCI:

- Triangular-shaped, well-circumscribed, subchondral sclerosis (anteriorly located, iliac side > sacral), without gross erosions (minor irregularities and small erosions can exist) nor SIJs narrowing.
- BME surrounding sclerosis can be seen. Careful observation of the location and distribution pattern of BME is helpful in the differential. If there is BME surrounding fat metaplasia, this may suggest SpA may coexist with OCI.
- A practical hint that favors OCI is to look for characteristic imaging features and location in the anterior part of the SIJs, normal inflammatory markers and HLAB 27 negativity.

5. STRESS FRACTURES (FATIGUE AND INSUFFICIENCY)

In healthy, young, active adults, fatigue fractures (abnormal stress on normal bone, Figure 4) occur often in the sacrum[23]. Even though clinically these sacral fractures/stress changes may be confused with sacroiliitis, imaging findings are different, particularly since BME is generally located close to the sacral neuroforamena[23]. In later stages, a hypointense irregular track representing the fracture line can be observed, usually with vertical orientation, surrounded by BME and sparing the SIJs. They are not associated with SIJs structural changes. In the elderly, insufficiency fractures (normal stress on abnormal bone, often secondary to osteoporosis or radiation therapy) may be seen. Besides the age and clinical setting, clues are the characteristic location (sacrum), fracture orientation (vertical oriented), and possible bilateral symmetric findings[24-25].

6. DIFFUSE IDIOPATHIC SKELETAL HYPEROSTOSIS (DISH)

Diffuse Idiopathic Skeletal Hyperostosis (DISH) is a common condition, with an average prevalence of 10% in people >50 years of age[10,26]. Despite the extensive structural changes, DISH is largely asymptomatic. It is a systemic disease characterized by continuous calcifications and ossifications of soft tissues, primarily ligaments and entheses[27], which mainly involve the axial skeleton, but also the peripheral joints. "Flowing osteophytes" occur in the anterior longitudinal ligament and, to a lesser extent, involve the paravertebral connective tissue and the annulus fibrosus (Figure 5A)[27]. The Resnick classification criteria for DISH are based on radiographs and require flowing osteophytes that bridge at least four contiguous thoracic vertebrae. Lite-

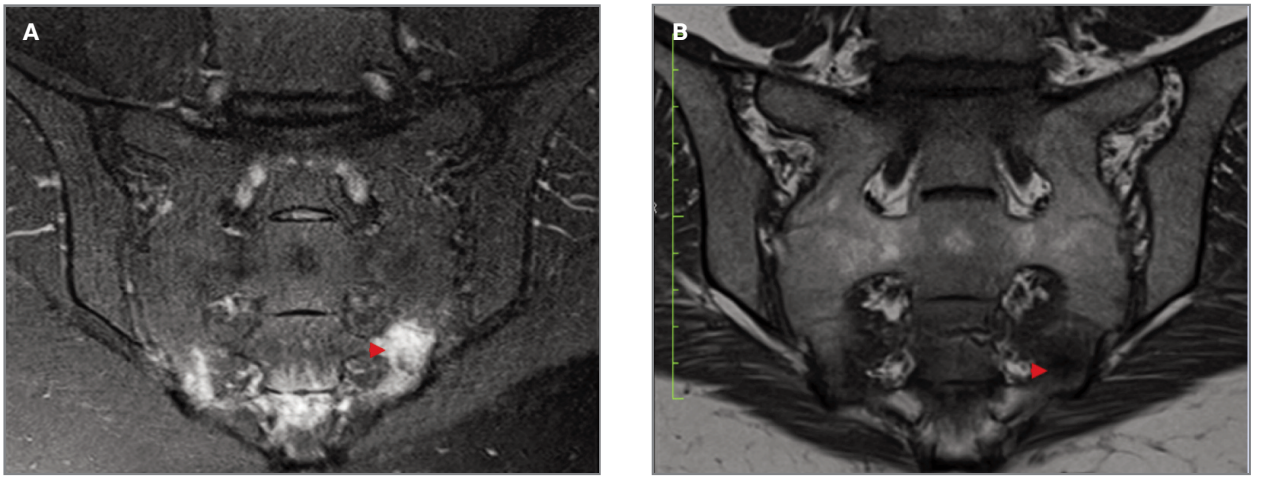
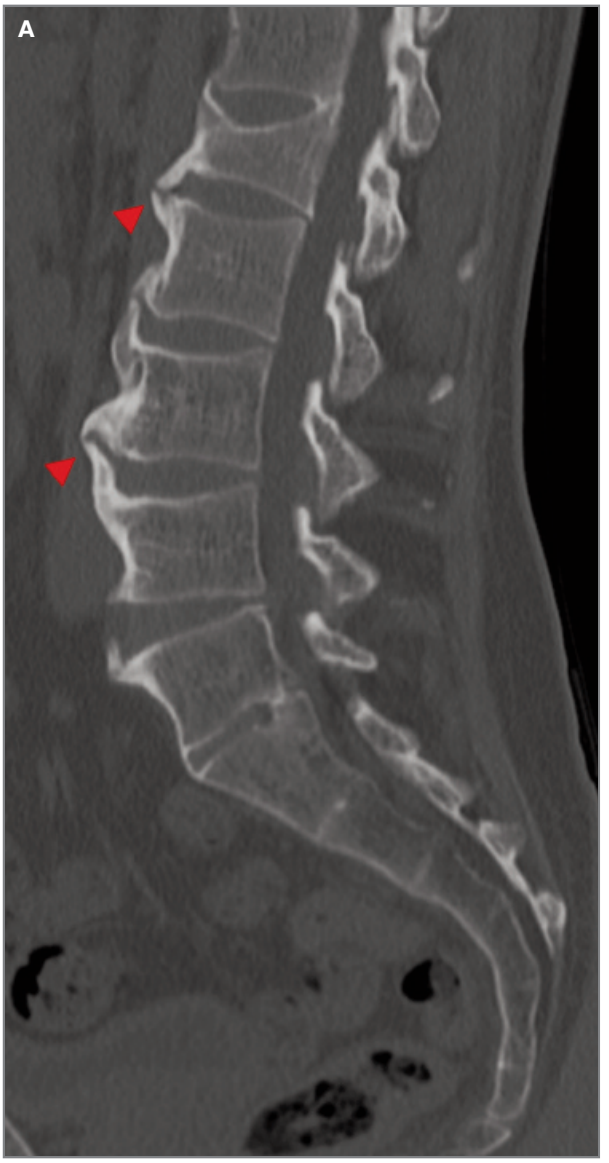
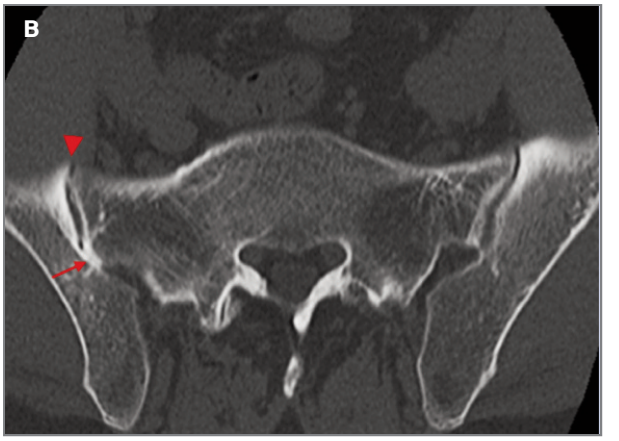
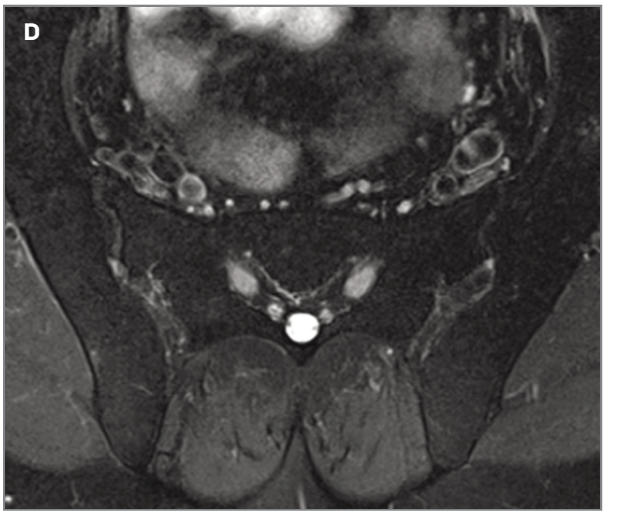


FIGURE 4. Sacral stress fractures. *32-year-old female runner*: **A)** coronal oblique FS T2W and **B)** coronal oblique T1W MR images show BME in the distal sacrum at the level of S3-S4 (arrowhead) with a fracture line visible on T1 (fatigue fracture).







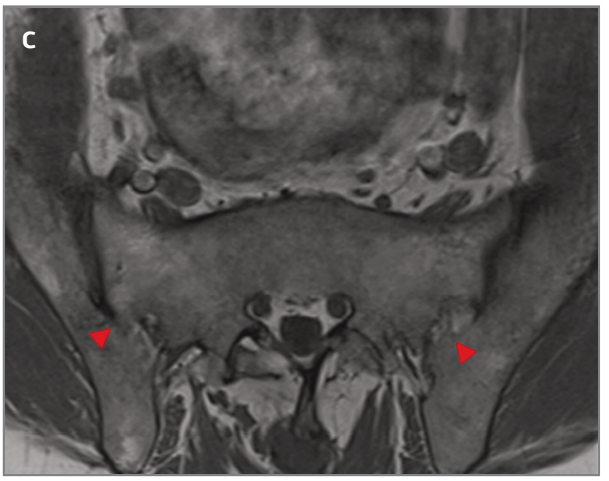


FIGURE 5. **DISH**. *52-year-old male, DISH:* **A)** sagittal CT image of the lumbar spine shows flowing consecutive osteophytes (arrowheads), with disk space sparing; **B)** axial CT image of the SIJs shows posterior bone bridging (arrow) and anterior osteophytosis (arrowhead). Corresponding **C)** axial oblique T1W MR image reveals posterior bridging, more evident on the right (arrowheads); **D)** axial oblique FS T2W MR image shows absence of subchondral BME.

rature shows conflicting results regarding SIJs involvement and there is still a common misconception that SIJs are not involved in DISH[28]. In fact, DISH may also affect the SIJ (Figures 5B-D) and lead to asymmetric intraarticular partial fusion, osteophytes with or without bridging, ossification of the sacrotuberous and iliolumbar ligaments[27-29]. The ligamentous portion of the SIJs (upper portion if the SIJs) may show vacuum phenomena, space narrowing, sclerosis and partial or complete ankylosis. The lower two-thirds of the SIJs are usually spared. Ossification of the joint capsule in the anterior surface of the joint, resembling obliteration of the SIJs on a radiograph, may erroneously be interpreted as SpA bone ankylosis.[27] Subchondral sclerosis, erosions and subchondral cysts are typically absent[27].

Learning Points - DISH:

- SIJs are not spared in DISH! Look for overt, coarse bony/ossified bridges over the anterior and posterior SIJs articular margins and entheseal bridging. Intra-articular ankylosis, not previously included in the criteria for DISH, can also be seen.
- Pelvic locations of DISH are also suggestive (hyperostosis at ligamentous/tendinous attachments in the pelvis)
- Think in alternate diagnosis if there is presence of erosions and subchondral sclerosis.

7. HYPERPARATHYROIDISM

Secondary hyperparathyroidism is a response to low serum calcium levels, usually in the setting of chronic renal failure. It leads to subperiosteal, trabecular, intracortical, endosteal, subchondral, subligamentous or subtendinous bone resorption. Hyperparathyroidism often results in subchondral bone resorption around the SIJs, with irregularity, gross erosions and pseudowidening of the joint (**Figure 6)** that mimic sacroiliitis. This usually occurs bilaterally, relatively symmetrically and is more pronounced on the iliac side. However, joint space narrowing or bone bridging/ankylosis do not develop[30]. Look for other signs of resorption in the pelvis – resorption/erosions, and cysts at the hamstrings, adductor and at the gluteal entheses.

Other imaging findings may also be a clue to the diagnosis - osteopenia, chondrocalcinosis in the pubic symphysis and brown tumors[31,32]. Although brown tumors are more frequent in primary hyperparathyroidism, secondary hyperparathyroidism is much more common, so most brown tumors seen today are associated with secondary hyperparathyroidism. They are usually round, well-defined lesions extending to the bone cortex on radiographs. On MRI, they exhibit low signal intensity on T1W and T2W images with various foci of increased intensity (due to haemorrhage)[33]. The most common site of involvement is the thoracic spine, while sacral involvement is very rare[33].

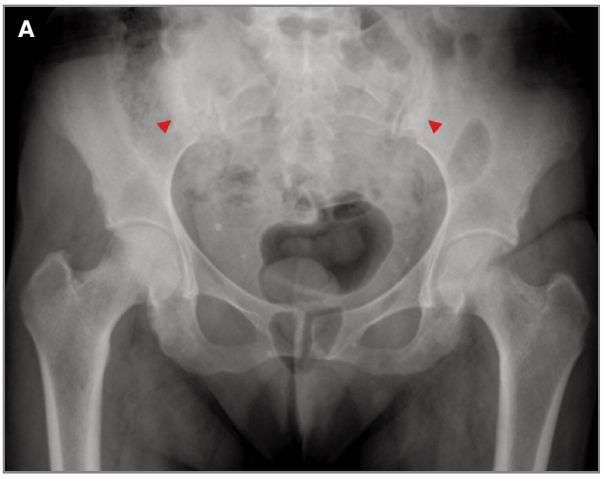
Learning Points - Hyperparathyroidism:

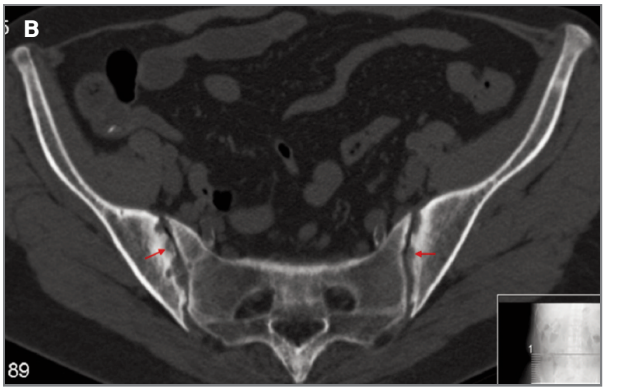
- Subchondral resorption with irregularity, gross erosions and pseudowidening of the SIJs (more pronounced at the iliac side).
- Look for other signs of hyperparathyroidism: signs of resorption in the pelvis - subtendinous resorption at the hamstrings, adductor and at the gluteal origins, bony cysts in ischial and pubic bones; osteopenia, chondrocalcinosis and brown tumors.
- Look for a history of kidney disease (patients often tell they “cannot have contrast”)

8. SYNOVITIS, ACNE, PUSTULOSIS, HYPEROSTOSIS SYNDROME (SAPHO) AND CHRONIC RECURRENT MULTIFOCAL OSTEOMYELITIS (CRMO)

Synovitis, Acne, Pustulosis, Hyperostosis syndrome (SAPHO) and chronic recurrent multifocal osteomyelitis (CRMO) represents a spectrum of autoinflammatory bone diseases (“non-bacterial osteitis”) in which non-infectious inflammatory chronic osteitis, involving both the cortex and the medullary canal (with endosteal and periosteal new bone formation) is the unifying feature, along with skin lesions. SAPHO is considered a rare disease. It may occur at any age but is more frequent <60 years of age[34]. CRMO is the childhood counterpart of SAPHO.

The site of disease involvement is age-related and most patients show polyostotic involvement[34]. In adults, the sternoclavicular junction is the most common location, followed by the spine and SIJs[35]. In children, the metaphysis of long bones and clavicles are most commonly involved[36]. SAPHO/CRMO has variable imaging appearances depending on the stage/age of the lesion and imaging modality (Figure 7) - it starts from BME in the acute stage, followed by osteolytic and later sclerotic and hyperostotic changes, erosions and ankylosis. Within the SIJs, the hyperostotic changes are more common in the iliac side. In a given patient there may be lesions in various stage, active (BME) or chronic (lytic, sclerotic). Usually, they tend to be unilateral, but can be bilateral[37]. One should keep in mind that adult patients with SAPHO have a higher risk of de-





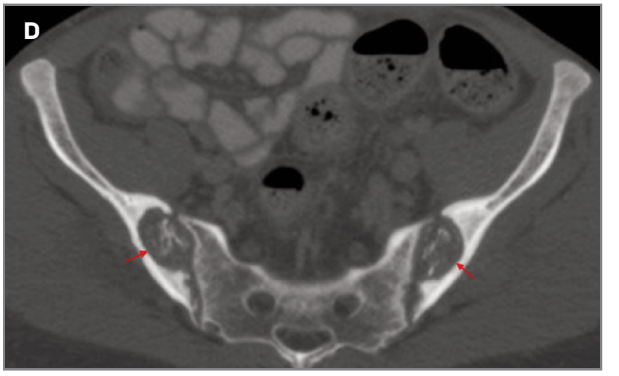


FIGURE 6. Secondary hyperparathyroidism. *49-year-old female, chronic renal disease:* **A)** AP pelvic radiograph and **B)** axial CT image show bilateral sclerosis of the SIJs (arrowheads in A) and subchondral bone reabsorption/erosions, more evident on the right (arrows in B) [Courtesy of Raquel Marques MD, Department of Rheumatology, Centro Hospitalar Universitário Lisboa Norte, Lisbon]. *62-year-old female, persistent lumbar pain and chronic renal disease:* **C)** axial CT image shows severe symmetrical subchondral bone reabsorption (arrows) of the SIJs, more on the iliac side.

veloping sacroiliitis, which is usually unilateral[37]. Ultimately, the diagnosis may be based on the combination of clinical and radiologic findings.

Learning Points - SAPHO/CRMO:

- Osteitis/BME (on either side of the SIJs) precedes erosive changes, sclerosis and hyperostosis in the SIJs (more marked on the iliac side). In practice, look for unilateral or bilateral asymmetric involvement of the SIJs, mainly involving the iliac side, with extensive osteosclerosis.
- One should keep in mind that adult patients with SAPHO have a higher risk of developing sacroiliitis, which is usually unilateral.

9. GOUT

Gout is a metabolic disorder and the most common form of microcrystalline arthropathy[38]. Even though it often affects the peripheral joints, gout may occasionally affect the axial skeleton, including the SIJs, and axial gouty arthropathy may be, in fact, much more common than initially thought[39].

Based on radiographic findings alone, the incidence of SIJs involvement in chronic gout ranges between 7% and 17%[40]. Unfortunately, imaging features of axial gout are nonspecific. Deposition of urate crystals in the cartilage leads to irregular loss of joint space and superimposed degenerative changes. In this instance, it is difficult to distinguish gout from osteoarthritis.

In the chronic phase, intra- and para-articular erosions, often large, with a multilobulated base, and well-defined, thin sclerotic margins that may have overhanging edges are found[41]. They are usually seen in relation to tophi (juxta-articular, intra-articular, subchondral) because they represent intraosseous extension of tophi[42]. Tophus gout has iso- to low- signal intensity on T1W in relation to muscle, but it is quite variable on T2W images, due to differences in calcium concentration within a tophus. Calcifications within tophi are better visualized on computed tomography (CT) than MRI.

BME is usually mild in uncomplicated gout. The joint space is remarkably well preserved and there is no periarticular osteopenia until late in the disease[39]. The lack of subchondral sclerosis also favours gouty sacroiliitis over SpA[42].

Dual-energy CT can be used to detect urate deposits with an overall accuracy of 87–94% [43].

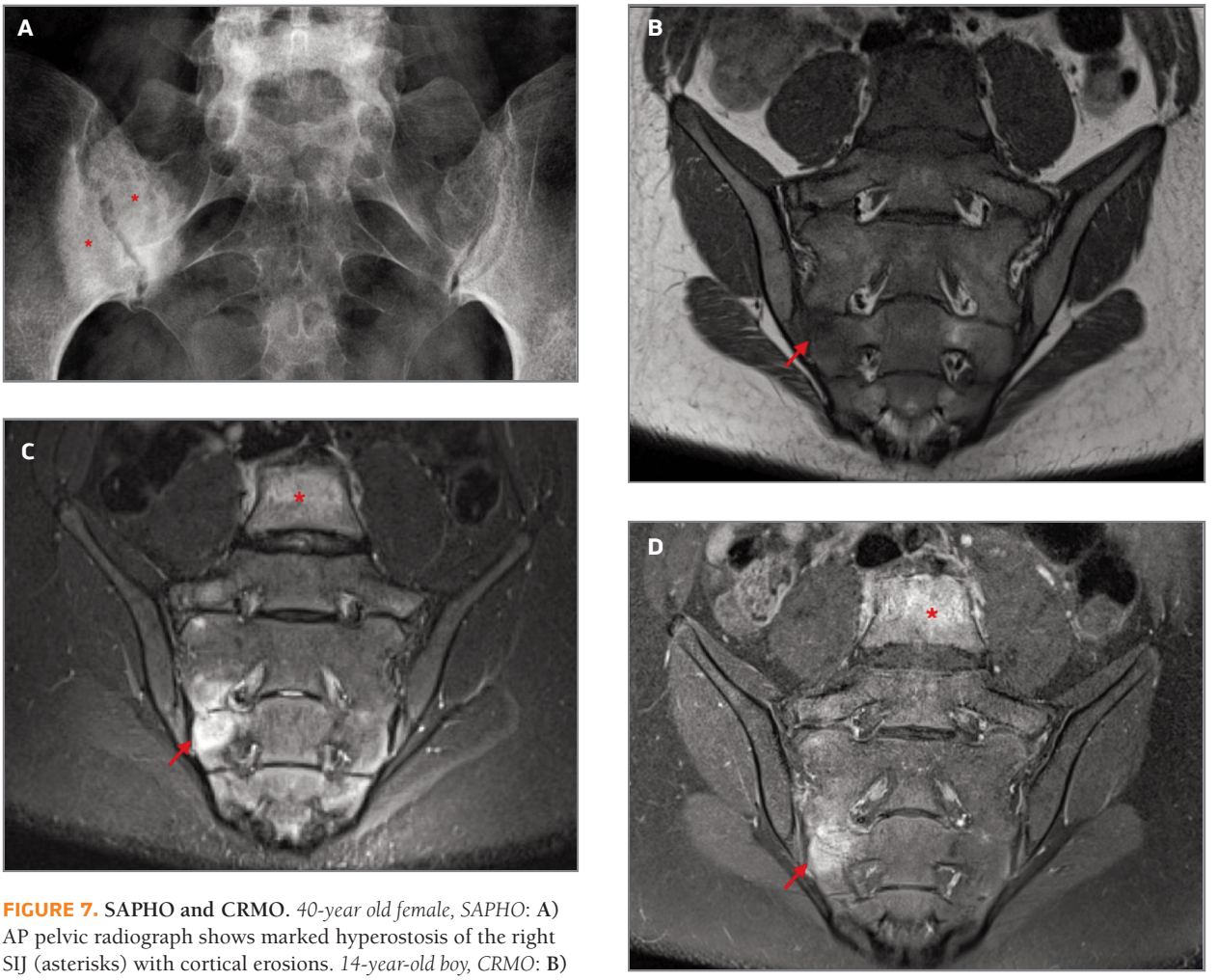


FIGURE 7. SAPHO and CRMO. *40-year old female, SAPHO*: **A)** AP pelvic radiograph shows marked hyperostosis of the right SIJ (asterisks) with cortical erosions. *14-year-old boy, CRMO*: **B)** coronal oblique T1W, **C)** coronal oblique FS T2W and **D)** coronal oblique FS contrast-enhanced T1W MR images show BME in the right sacrum (arrow in C and D) with strong enhancement (arrow in D) in keeping with an acute stage. Concomitant extensive BME in L5 vertebra (asterisk in C and D) and two smaller areas of BME are seen on the upper S1/S2 segments. No sclerotic or lytic/erosive changes are yet seen.

Learning Points - gout:

- A tophus may form at the SIJs (juxta-articular, intra-articular and subchondral) and create large erosions with multilobulated base and well-defined, thin sclerotic borders that may have overhanging edges.
- The absence of subchondral sclerosis and relatively well-preserved joint space favor gouty sacroiliitis over SpA-sacroiliitis.
- To detect urate deposits and confirm the diagnosis, order dual-energy CT.

10. PAGET'S DISEASE

Paget's disease is a chronic bone disorder characterized by excessive bone remodelling, which includes different lytic, blastic and mixed phases[44]. The pelvis is frequently involved. Common findings include cortical thickening and coarsening, enlargement of the bone affected by Paget's when compared to the contralateral side, sclerosis of the iliac wing, thickening of the iliopectineal and ischiopubic lines, acetabular protrusion and enlargement of the pubic rami and ischium[44], which are often asymmetrical (Figure 8). Fusion of SIJs can uncommonly be seen in patients with Paget's, either unilaterally or bilaterally[45]. Because Paget's disease typically does not extend across healthy joints, it has been suggested that, when both SIJs are involved, inflammatory sacroiliitis or other causes of previous joint damage must be present[46,47]. Similarly, concomitant

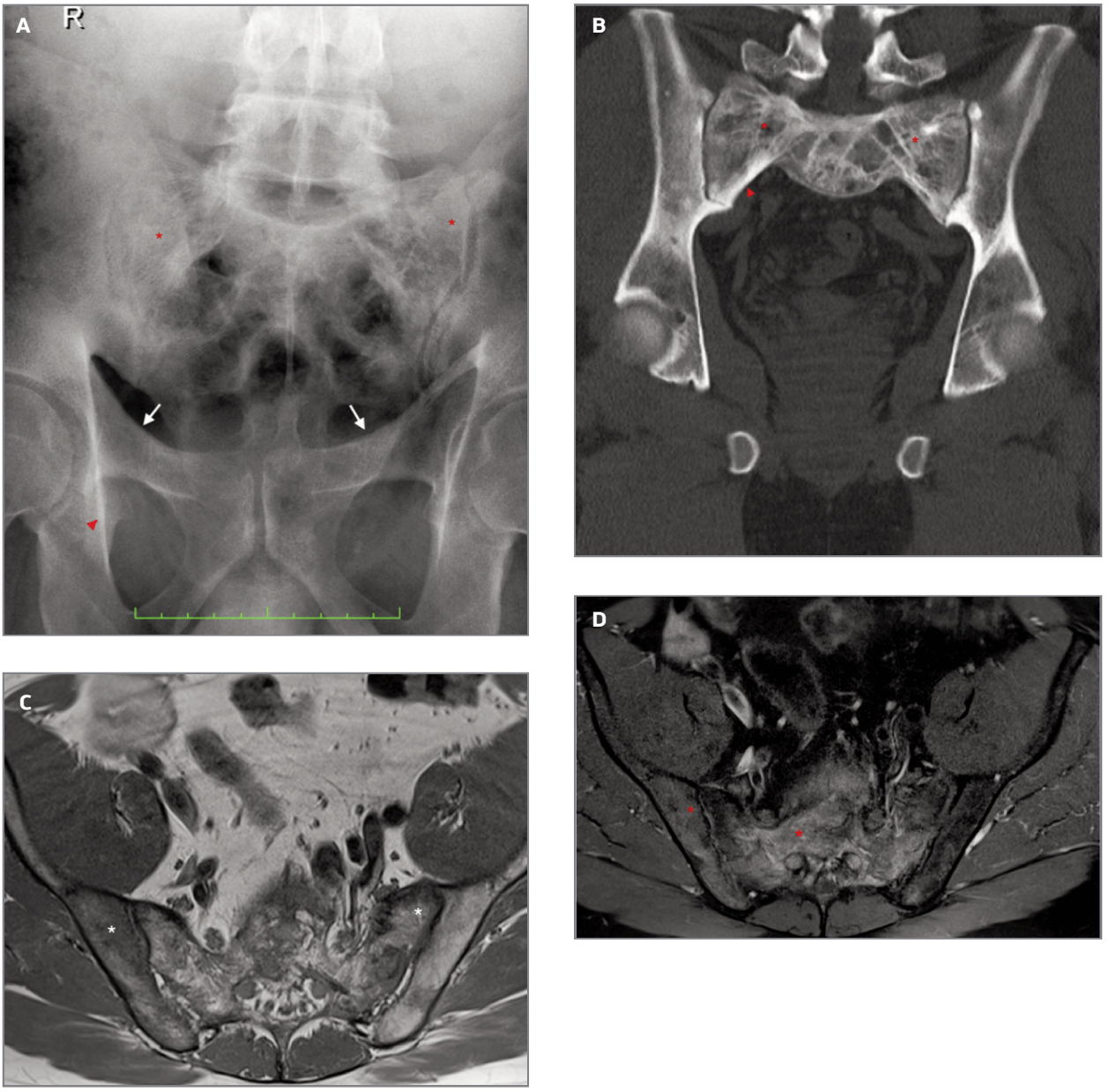


FIGURE 8. Paget's disease. *58-year-old male:* **A)** AP pelvic radiograph reveals trabecular coarsening of the sacrum (asterisks), thickening of the right ischiopubic line (red arrowhead) and, to a lesser degree, of the iliopectineal line (white arrows). **B)** coronal CT image better depicts the course trabecular pattern (asterisks) and cortical thickening (arrowhead). **C)** axial oblique T1W and **D)** axial oblique FS T1W contrast-enhanced MR images confirm this course enlargement of the bony trabeculae with fat marrow in between (asterisks in C) and enhancement after contrast (asterisks in D) probably as a result of granulation tissue.

ankylosis spondylitis and Paget's disease is infrequent but has been reported in literature[46-48].

Learning Points - Paget's disease:

- Must have other Pagetic changes in the pelvis.
- Fusion of the SIJs can be rarely seen in Paget's disease in the course of coexisting sacroiliitis (not Paget's itself).

11. MISCELLANEOUS

11.1. Sarcoidosis: One of the rarest manifestations of osseous sarcoidosis is involvement of SIJs, usually in a unilateral fashion but bilateral cases have been des-

cribed, may be due to sarcoid osteitis or granulomatous joint infiltration[49]. Radiographic findings of sarcoidosis are similar to those of inflammatory sacroiliitis. Multiple bony "punched out" lesions may coexist. MRI is very sensitive for bony changes in sarcoidosis, but not specific[50]. MRI may aid in choosing a biopsy site[51].

In the presence of known clinical sarcoidosis, the diagnosis of bone sarcoidosis should be considered if there is involvement of the SIJs, since these joints may be involved without a typical inflammatory back pain history[50]. It is rare but there are reports of sarcoidosis coexisting with SpA[52-54].

Learning Point – Sarcoidosis:
May mimic SpA in radiographs. In the presence of known clinical sarcoidosis, the diagnosis of bone sarcoidosis should be considered if there is concomitant involvement of the SIJs.

11.2. Behcet's disease: Arthritis/arthralgia are the most common rheumatologic findings in Behcet's. However, even though it has symptoms of SpA, most studies report no difference in the prevalence of sacroiliitis in Behcet's disease to that of the general population. Nevertheless, joint involvement can be an early manifestation in Behcet's disease[55].

Learning Point - Behcet's disease:
Look for the right clinical context.

11.3. Bone tumors/pseudotumors: usually a straightforward imaging diagnosis. However, then can coexist in SpA patients and/or be a source of low back pain**.** The sacrum is a common site for metastases and myeloma[56]. The most common primary sacral tumors are chordoma (25-40%), followed by giant cell tumor, aneurysmal bone cyst, chondrosarcoma, osteosarcoma and Ewing sarcoma[56]. Sacral meningeal cysts (*Tarlov/perineural cysts)* are frequently found incidental pseudotumors and represent abnormal dilatations of the meninges within the sacral canal or foramina, and may cause low back pain.

Learning Point - Tumors/pseudotumors:
Can be a source of pain or be incidental in SpA patients. They are usually a straightforward imaging diagnosis.

CONCLUSION

MRIs of the SIJs in patients with a clinical suspicion of axial SpA sacroiliitis commonly demonstrate non-inflammatory disease. We reviewed the ASAS criteria for a "positive" MRI (part I) and took a practical snapshot at the most common non-inflammatory causes of SIJs involvement that may mimic sacroiliitis in daily practice (part II).

MRI interpretation will be boosted by adequate clinical information and/or by adequate patient referral from rheumatology centers. However, even with the engagement of both sides, rheumatologists and radiologists, there will still be cases where neither clinical presentation or images are specific for SpA or other entity. In such instances, interdisciplinary discussions are needed to constantly increase our understanding of the disease and decide on the best approach for a given patient.

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