All that glitters is not inflammatory - a review of the differential diagnosis of spondyloarthritis in the spine and sacroiliac joints

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Learning objectives

- To discuss the role of the imaging modalities that are available for the assessment of patients with spondyloarthritis.
- To review the characteristic imaging findings in the spine and sacroiliac joints of patients with spondyloarthritis following the distinction of active inflammatory lesions and structural lesions established by the ASAS/OMERACT MRI study group.
- To enumerate and discuss several conditions and potential pitfalls that can simulate the imaging findings of spondyloarthritis in the spine and sacroiliac joints, and to provide key features that can help to avoid misdiagnosis.

Background

The term *Spondyloarthritis* (SpA) comprises a group of chronic inflammatory rheumatic diseases that predominantly affect the axial skeleton and are often associated with human leukocyte antigen HLA-B27. Ankylosing spondilitis is the most representative entity of this group that comprises other disorders including psoriatic arthritis, arthritis related to inflammatory bowel disease, reactive arthritis (Reiter syndrome), juvenile spondyloarthritis and undifferentiated forms.

The field of SpA has experienced important changes in the last decade, mainly caused by the advent of new effective therapies for the treatment of ankylosing spondylitis, such as the tumour necrosis factor (TNF)- alfa inhibitors (anti-TNF). Establishing a prompt and accurate diagnosis of SpA is crucial since the earlier the therapy is initiated, the better the patient’s prognosis. Before the implementation of MRI, the assessment of SpA on imaging relied primarily on conventional radiography. This fact caused a significant delay in the diagnosis considering that radiography only depicts structural changes and is unable to detect early inflammatory lesions. Therefore, the ASAS developed new classification criteria for axial SpA including MRI for the first time, thus allowing early diagnosis and the assessment of treatment response due to the capacity of this technique to detect active inflammation. The new classification criteria raised sensitivity and specificity up to 82.9% and 84.4% respectively.

According to the ASAS classification criteria, a patient with at least 3-month history of back pain and less than 45 years old can be classified as having axial SpA if either sacroiliitis is present on imaging (radiography or MRI) and at least one additional clinical or laboratory feature is present (the" imaging arm"), or if human leukocyte antigen B27 is positive and at least two additional features are present (the "clinical arm") (Fig 1). The
sensitivity and specificity for the imaging arm alone was found to be 66.2% and 97.3% respectively. With the advent of this new classification criteria, imaging gained a key role in the diagnosis of SpA.

**Images for this section:**

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<th>ASAS Criteria for the classification of axial spondyloarthropathy</th>
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<td>(in patients with at least a 3-month history of back pain who are less than 45 years old at the onset of pain)</td>
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<td><strong>“Imaging arm”:</strong></td>
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<td>• Sacroiliitis on imaging</td>
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<td>• Plus at least one clinical feature of spondyloarthropathy</td>
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<th>Sacroiliitis on imaging:</th>
<th>Clinical features of spondyloarthropathy:</th>
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<td>• Acute inflammation at MR imaging with bone marrow edema or osteitis</td>
<td>• Inflammatory back pain</td>
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<td>• Definite radiographic changes according to the modified New York criteria (Sacroiliitis grade &gt;2 bilaterally or 3-4 unilaterally)</td>
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<td>• Family history of spondyloarthropathy</td>
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<td>• HLA-B27</td>
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**Fig. 1**
Findings and procedure details

A) IMAGING MODALITIES:

1) Conventional Radiography:

Radiography remains the first imaging technique to be performed when sacroiliitis is suspected due to its availability, relatively inexpensiveness and usefulness in case it provides positive findings. Nevertheless, it can only depict chronic bony changes that usually require several years to become noticeable, therefore radiography is not suitable for early diagnosis, but are still widely used in monitoring disease progression. The modified New York criteria are used for the diagnosis of sacroiliitis radiographically (Fig 2). The ASAS recommends to image the entire pelvis, thus allowing the assessment of the hip joints as well as the SI joints, considering that they are affected in 25% of patients with SpA.

Regarding the spine, radiographs of the cervical and lumbar spine should be obtained (radiographs of the thoracic spine are more difficult to evaluate due to superposition). Radiograph can only detect chronic bony changes, but it is superior to MRI for the detection of ankylosis and syndesmophytes (Fig 25).

2) Scintigraphy:

In the past, scintigraphy was used to improve the sensitivity of conventional radiography for early stage disease. Unfortunately, it lacks specificity to be used in isolation and no longer plays an important role in the management of patients with spA.

3) Ultrasound:

Ultrasound has a limited value due to its inability to evaluate properly deep structures such as the sacroiliac joints, specially the cartilaginous portion, and the spine. Nevertheless, it has been used to assess superficial soft tissues, including the posterior ligamentous portion of the sacroiliac joints or the supraespinal ligaments, apart from the assessment of peripheral joint involvement that may occur. It has also an established role for guiding diagnostic and therapeutic injections into the sacroiliac joints.

4) Computed tomography:
Because of its high spatial resolution, computed tomography provides a more detailed assessment of the bony anatomy of the spine and sacroiliac joints. Particularly, structural damage can better be depicted with CT in comparison with conventional radiography (Fig 3 and 4). Unfortunately, it has important drawbacks including radiation exposure and the inability to detect active inflammatory changes and fatty degeneration of bone marrow (considered an early sign of chronic changes). Therefore, CT is not an image technique to be considered in early stages.

5) Magnetic resonance imaging (MRI):

With the outcome of the Assessment of Spondyloarthritis international Society (ASAS) classification criteria for axial and peripheral SpA, magnetic resonance imaging (MRI) gained a key role in the evaluation of patients with suspected SpA. MRI can detect early inflammatory spinal and sacroiliac lesions before they can be seen in radiographs or computed tomography becoming the most sensitive and specific imaging modality for the detection of axial SpA in early stages (Figs 5, 6, 7, 20 and 21). Furthermore, MRI has a similar sensitivity to CT in detecting early structural changes and a superior ability to detect fatty deposits (Figs 9 and 23), with the benefit that involves no radiation. It also plays an important role in the evaluation of the response to treatment and complications and in ruling out other disorders that may be confused with axial spondyloarthritis clinically.

MRI protocol:

- For the assessment of the sacroiliac joint, a coronal oblique sequence parallel to the long axis of the sacrum is performed at most institutions, including a T1-weighted turbo or fast spin-echo sequence and a fat-saturated T2-weighted turbo or fast spin-echo or a STIR sequence. Axial oblique sequences (T1-weighted turbo or fast spin-echo sequence and a fat-saturated T2-weighted turbo or fast spin-echo or a STIR sequence) are normally added for a better evaluation of the posterior ligamentous portion.

- In spine, the standard imaging protocol includes a sagittal T1-weighted turbo or fast spin-echo sequence and a sagittal fat-saturated T2-weighted turbo or fast spin-echo or a STIR sequence. Axial sequences are useful for the assessment of posterior elements whereas coronal slices of the entire spine may be added for better evaluation of the costo-vertebral and costo-transverse joints and facet joints.

Fat-saturated T1-weighted turbo or fast spin echo sequences after the administration of paramagnetic contrast material may be added to the standard protocol for additional information (for instance, detection of osteitis or differentiation between joint fluid and synovitis). However, it is under debate whether the administration of contrast material
provides additional benefit. Regarding the differential diagnosis, it can be useful for the identification of other entities that may simulate the imaging findings of axial SpA in conventional sequences. We do not routinely administer contrast media in our institution.

A) SACROILIAC JOINTS:

A.1) Anatomic considerations

The sacroiliac joints are a complex S-shaped articulation centrally located in the human body between the sacrum and the iliac bones that act as a weight-bearing joint transmitting the forces from the spine to the extremities. They are composed of two well-differentiated components:

1) A lower ventral part that was classically considered a synovial joint, but it really has anatomic characteristics of a symphysis with hyaline cartilage firmly attached to bone by fibrotic tissue. Only the inferior one-third and the anterior-most aspect of the superior component are truly synovial. The cartilage is thinner in the iliac than in the sacral facet of the joint, explaining why the changes in inflammatory arthropathies are initiated and are more profuse in the iliac aspect.

2) An upper dorsal portion traversed by strong interosseous ligaments consistent with a syndesmosis.

A.2) Imaging findings:

A.2.1) Active inflammatory lesions

They may reflect an early stage in the course of the disease and can only be detected confidently with MRI, particularly with fluid-sensitive sequences (such as fat-saturated T2-weighted turbo or fast spin-echo or STIR sequences) or with contrast-enhanced T1-weighted fat-suppressed images.

The ASAS has listed the following findings suggestive of active inflammatory lesions:

1) Bone Marrow Edema (BME): BME is depicted as areas of high signal intensity on STIR or T2-weighted fat-suppressed images and of low signal intensity on T1-weighted images that have to be located periarticularly (Fig 5). The sacral interforaminal bone
marrow signal intensity is considered the reference for normal bone marrow. Osteitis is defined as areas of hyperintense bone signal intensity identified in fat suppressed T1-weighted images after the administration of contrast material, indicating increased vascularity. Subchondral or periarticular BME and osteitis constitute key features as their presence is mandatory for the definition of a "positive MRI" according with the ASAS/OMERACT MRI working group.

2) Synovitis: Synovitis is reflected by hyperintense signal intensity in the synovial portion of the SI joints in fluid-sensitive sequences that enhances after the administration of contrast material, differentiating it from joint fluid. The sole presence of synovitis is not sufficient for the definition of sacroiliitis in MRI.

3) Enthesitis: Enthesitis is characterized by high signal intensity in fluid-sensitive sequences and after the administration of gadolinium at the enthesis (sites where ligaments and tendons attach to bones, particularly at the posterior ligamentous portion of the joints) (Fig 6 and 7). Signal abnormality may extend to adjacent bone marrow and soft tissues.

4) Capsulitis: Capsulitis is depicted as increased signal intensity in fluid-sensitive sequences and with enhancement on fat saturated T1-weighted images at the anterior and posterior capsule of the joint (Fig 7).

A.2.2) Structural lesions

1) Subchondral sclerosis: Subchondral sclerosis is characterized on MRI as low signal intensity areas in all pulse sequences that have been previously described, and do not enhance after contrast material administration (Fig 5). On conventional radiography and CT, they appear as hyperdense areas located periarticularly (Fig 3). It should extend at least 5mm from the SI joint space to be attributable to spA, since small periarticular sclerotic areas can be found in healthy individuals due to physiological or degenerative changes.

2) Erosions: Erosions are seen as bony defects at the joint margins of the cartilaginous portion. Erosions initially appear as single lesions, usually at the iliac margin of the joint where the cartilage is thinner (Fig 3). With progression they become confluent causing apparent widening of the joint space (Fig 8). On MRI erosions are characterized by low signal intensity on T1-weighted images and high signal intensity in fluid-sensitive sequences if active (Fig 5 and 9).
3) **Periarticular fat deposits:** Fat depositions appear as hyperintense areas on T1-weighted images and hypointense on STIR or fat suppressed T2-weighted images (Fig 9 and 10). Fat deposits constitute a non-specific finding, usually related to previous inflammation that can only be depicted on MRI.

4) **Bony bridges/Ankylosis:** Ankylosis results from the fusion of the bone surfaces of the joint in the late course of the disease. When several adjacent bony bridges are present, the joint space may have a blurred appearance. On MRI, bony bridges appear as low signal intensity on all pulse sequences, usually surrounded by fat deposits (Fig 10).

A.2.3) **Differential Diagnosis:**

1) **Anatomic variants and Pitfalls:**

**Blood vessels** in their course adjacent to the sacroiliac joint may simulate bone marrow edema, synovitis or joint fluid on MRI fluid sensitive sequences. Vessels are typically seen as linear or tubular structures that tend to ramify or connect with other vessels on consecutive slices (Fig 11).

The "coil effect" is a technical artifact that makes normal structures which are next to the coil appear hyperintense on MRI. Consequently, they can be mistaken for active inflammatory lesions on fluid sensitive sequences. It is normally seen on the lower part of the sacrum and sometimes the iliac bone on coronal sequences, in contrast to bone marrow edema related to sacroiliitis which is typically periarticular. Furthermore, coil effect also involves soft tissues close to the receiver, such as the subcutaneous fat layer, a feature that is not seen on spondyloarthropaties (Fig 12).

2) **Osteitis condensans ilii:**

Osteitis condensans ilii is characterized by a localized unilateral or bilateral area of sclerosis in the ileum adjacent to the sacroiliac joint, with a triangular shape. This condition is usually an incidental finding in multiparous women and it is believed to be caused by mechanical stress across the sacroiliac joint. On MRI is seen as an area of low signal intensity in all pulse sequences. The typical appearance and presentation guides to the correct diagnosis. There should not be erosions or active inflammatory lesions such as bone marrow edema on MRI (Fig 13).

3) **Osteoarthritis:**
Osteoarthritis constitutes the most frequent and challenging entity in the differential diagnosis of SpA due to its prevalence and the fact that are some imaging features that can be shared by both. It is more conspicuous in women that in men in the same age group, and tend to progress faster in multiparous women.

Structural changes such as subchondral sclerosis, joint space narrowing and areas of ankylosis can be observed in both, although joint space narrowing below 2 mm in a patient younger than 40 years old favors the diagnosis of SpA. Conversely, osteophytes, intraosseous pneumatoceysts and intraarticular vacuum phenomenon are typical features of osteoarthritis (Fig 14), although the later can occasionally be seen in patients with SpA and it is regarded as a sign of inactivity. Erosions are typical structural changes associated with SpA.

Active inflammatory lesions, which can only be depicted with MRI, are normally associated with SpA, even though small areas of subchondral bone marrow edema can sometimes be identified in patients with osteoarthritis, which tend to be less prominent that in SpA.

Furthermore, osteoarthritis usually involves the anterior and middle thirds of the sacroiliac joints and is commonly associated with degeneration of the pubic symphysis.

4) Diffuse idiopathic Skeletal Hyperostosis (DISH):

DISH is characterized by bone formation affecting tendons, ligaments, joint capsule and periosteum that tends to involve the spine and it is commonly seen in elderly individuals. In sacroiliac joints, bridging ossifications can be found on the anterior aspect of the joint. When seen on conventional radiography it may simulate the presence of subchondral sclerosis, despite the fact that no erosions should be identified. Such false impression must not occur with cross sectional imaging techniques like CT or MRI (Fig 15).

5) Septic Arthritis:

Infection of the sacroiliac joint is uncommon, representing only 1%-2% of all septic arthritis and osteomyelitis. It is most commonly caused by Staphylococcus aureus.

Septic arthritis and SpA share common findings, including erosions and signal intensity abnormalities on MRI, with enhancement after the administration of contrast media. Nevertheless, it exhibits other distinguishing features like unilateralism and the involvment of surrounding soft tissues with the possibility to form an abscess or bone sequestrum (Fig 16 and 17). The diagnostic approach should also consider the history, clinical signs and symptoms and laboratory results.
6) Insufficiency bone fractures and stress response:

Insufficiency fractures are common in the sacrum and are caused by concentration of vertical body forces that are transmitted from the spine to the sacrum and then to the lower limbs. Findings are often very subtle or completely occult on plain radiographs. On MRI edema is typically extensive, extending towards midline, an unusual location in SpA. The diagnosis is facilitated by demonstration of the fracture as a hypointense linear image that is better delineated on fluid sensitive sequences (Fig 18).

Altered biomechanics caused by determinate sports activities may induce physiologic bone response to repeated stress, resulting in bone marrow edema on MRI that can be erroneously attributed to SpA when seen adjacent to sacroiliac joints (Fig 19).

7) Bone tumors:

Signal intensity abnormality associated with certain osseous tumors might simulate the presence of bone marrow edema, particularly those entities that may exhibit hypointensity on T1 weighted images and hyperintensity on fluid sensitive sequences, among which are Ewing sarcoma, leukemia or osteosarcoma. Clinical presentation as well as other imaging features, including the extension of the abnormal signal intensity and the presence of soft tissue component or matrix mineralization is helpful for differential diagnosis (Fig 20).

B) SPINE:

B.1) Anatomic considerations:

The spine is composed of 33 vertebrae (7 cervical, 12 thoracic, 5 lumbar, 5 sacral and 4 coccygeal) although the number can range from 32 to 35. The vertebra is divided into the body or anterior bone mass and the posterior elements or the neural arch (that it is comprised of two pedicles, laminae and transverse and articular processes and a spinous process).

B.1.1) Articular surfaces:

B.1.1.1) The intervertebral disc: Composed of three distinct parts:
• Vertebral endplate: Hyaline cartilage that covers the superior and inferior surfaces of the vertebral body.
• Nucleus pulposus: The central component of the intervertebral disc, constituted mainly of water. Therefore, it appears bright on fluid-sensitive MRI sequences.
• Annulus fibrosus: The peripheral component of the intervertebral disc. Its outer ring-like fibers are firmly attached to the superior and inferior aspects of the vertebral body by means of Sharpey fibers.

B.1.1.2) Zygoapophyseal or facet joints: They are synovial joints between the superior and inferior articular processes.

B.1.1.4) Costovertebral and costotransverse joints: Formed between the head of the rib and the vertebral body and between the tubercle of the rib and the transverse process respectively. They are synovial joints found in the thoracic spine.

B.1.2) Ligaments:

B1.2.1) Anterior and posterior longitudinal ligaments: Ligaments that run across the anterior and posterior margin of the vertebral bodies respectively, from the skull to the sacrum.

B1.2.2) Craniocervical and interspinous ligaments

B.2) Imaging findings:

B.2.1) Inflammatory lesions:

1) Spondylitis: Characterized by low signal intensity on T1-weighted images and high signal intensity in fluid-sensitive sequences and fat-suppressed T1-weighted images after the administration of contrast material within bone marrow at the corners of the vertebral bodies (Fig 21). Detection of anterior or posterior spondylitis in three or more sites is highly suggestive of axial spondyloarthritis, especially in young patients, according with the ASAS/OMERACT MRI working group.

2) Spondylodiscitis: Depicted as low signal intensity on T1-weighted images and high signal intensity in fluid-sensitive sequences, with enhancement after the administration of contrast media within bone marrow at cortical endplate adjacent to the intervertebral
disc, frequently at both sides. Sometimes the signal abnormality can also be visible in the intervertebral space, simulating inflammatory discitis.

3) **Costovertebral arthritis:** Better depicted as edema near the joint and extending to pedicles, posterior margin of the vertebral bodies and adjacent rib.

4) **Facet joint arthritis:** Characterized by low signal intensity on T1-weighted images and high signal intensity in fluid-sensitive sequences and fat-suppressed T1-weighted images after the administration of contrast media within the joint space, usually associated with edema extending to pedicles (Fig 22). Sometimes edema can extend to adjacent soft tissues.

5) **Enthesitis of spinal ligaments:** It is seen as edema and enhancement at the bone insertion sites of the supraspinal, interspinal and flava ligaments, usually associated with edema extending to adjacent bone and sometimes to surrounding soft tissues.

**B.2.2) Structural lesions:**

1) **Fat deposits:** Visualized as high signal intensity on T1-weighted images at the vertebral corners and vertebral endplates (Fig 24). Sometimes it can be detected at other sites such as facet or costovertebral joints and spinous processes. They reflect areas of previous inflammation that can only be identified with MRI. Evidence of fat deposits at the vertebral corners, especially if several sites are affected is highly suggestive of axial sPA according with the ASAS/OMERACT MRI working group.

2) **Erosions:** They can be identified as a disruption of the cortical line usually found at the vertebral corners (when visualized on conventional radiography is referred to as Romanus lesion) and vertebral endplates (that corresponds with the Andersson lesion) (Fig 4 and 8), although other sites such as the facet or costovertebral joints and spinous processes may be affected. On MRI, erosions are characterized by low signal intensity on T1-weighted images and fluid-sensitive sequences (Fig 23).

3) **Syndesmophytes:** They represent ossification of the outer fibers of the annulus fibrosus (Sharpey fibers) that occur in long-standing disease. They can be identified as thin vertically oriented ossifications on the peripheries of the disc space that arise from the vertebral corners, being commonly bilateral and symmetric (Fig 21). Syndesmophytes differ from pseudosyndesmophytes in the latter being thick and irregular, with a wide implantation base at the vertebral corners, associated with certain forms of
spondyloarthritis, mainly psoriatic arthritis. They are better visualized on conventional radiography and CT.

4) **Ankylosis**: Represents bony fusion between contiguous vertebrae through the disc space or at the attachment sites of the annulus fibrosus (bridging syndesmophytes) (Fig 23). Bony fusion may also occur at the apophyseal (Fig 22) or costovertebral joints (Fig 25). On MRI it appears as hypointense in all pulse sequences, sometimes surrounded by areas of fatty replacement.

**B.2.3) Differential Diagnosis:**

1) **Pitfalls:**

Phase-encoded motion artifact occurs as a result of tissue or fluid motion during scan and manifests as ghosting in the direction of phase encoding. When it projects over normal anatomic structures may simulate the presence of pathology. In MRI of the spine, it might be caused by cerebrospinal fluid motion, usually in the anterior to posterior direction, resembling edema when projected over vertebral bodies. Identifying the flowing structure and noting that the artifact is in line with it and exhibits a similar shape is important for the diagnosis (Fig 26).

2) **Diffuse idiopathic Skeletal Hyperostosis (DISH):**

Spinal involvement in DISH is characterized by exuberant ossifications along the anterolateral aspects of at least four contiguous vertebral bodies (so called "Forestier-Rotes-Querol disease") that can be confused with syndesmophytes or pseudosyndesmophytes related to SpA (Fig 15). The morphology of the ossifications and the absence of disc space, facet or costovertebral joint involvement are helpful findings for the differential diagnosis. No inflammatory lesions should be identified on MRI. It might be accompanied by ossification of other structures in different anatomic locations (Fig 27).

3) **Scheuermann´s disease:**

Scheuermann´s disease is a deformity in the thoracic or thoracolumbar spine in which adolescents and young adults (usually less than 18 years old) have an increase kyphosis associated with back pain in 20-30% of cases. It is characterized by vertebral wedging with endplate irregularity, disc space narrowing and intravertebral disc herniation
(Schmörl’s nodes). The characteristic morphology acquired by the vertebral bodies and the typical location help to guide the diagnosis (Fig 28).

4) Degenerative changes:

Osteophytes related to osteoarthritis can be confused with syndesmophytes or pseudosyndesmophytes characteristic of SpA. Firstly, osteophytes are usually linked to other degenerative findings, for instance disc space narrowing, bone sclerosis or subchondral cysts, and no other lesions related to SpA should be recognized. Secondly, osteophytes are typically horizontally oriented initially, although they may adopt a vertical morphology later, with the possibility to form bony bridges. In contrast, syndesmophytes or pseudosyndesmophytes have a vertical orientation. Furthermore, syndesmophytes originate from the vertebral corners, as they represent ossification of the Sharpey fibers, whereas osteophytes typically arise 1-2 mm above or below the vertebral corners, as they avoid these fibers. Syndesmophytes are characteristically thin and most commonly bilateral and symmetric, on the other hand pseudosyndesmophytes are thick and irregular and usually unilateral and asymmetric.

Vertebral endplate degeneration and subchondral bone marrow changes are classified in three categories based on MRI. Type 1 Modic changes that related to inflammation show decreased signal intensity on T1-weighted images and increased signal on T2-weighted images (Fig 29). Type 2 Modic changes are characterized by high signal intensity in T1 and T2-weighted images caused by fatty replacement (Fig 30 and 34). Type 3 Modic changes are seen in advanced chronic stage and are identified by decreased signal in T1 and T2-weighted images corresponding to sclerosis (Fig 31). Confusion between type 1 and 2 Modic changes and spondylodiscitis and fat deposits related to SpA is a common pitfall. Modic changes are usually associated with degenerative changes of the intervertebral disc whereas spondylodiscitis and fat deposits related to SpA can be accompanied by other inflammatory or structural lesions. Nevertheless, differentiation between both entities can be difficult, therefore the clinical presentation and laboratory test results should also be kept in mind for the differential diagnosis.

5) Schmörl´s nodules:

Schmörl’s nodules refer to herniation of the intervertebral disc through the vertebral body endplate into the spongiosa. They may occur spontaneously or in association with other disorders including Scheuermann’s disease (Fig 28). On conventional radiographs and CT Schmörl’s nodules are characterized by lucent lesions usually with a sclerotic margin often in the middle or posterior portion of the vertebral body, most commonly affecting the inferior endplate. In the acute stage Schmörl’s nodules can show adjacent edema on MRI. Later on in the process, Schmörl’s nodules can be associated with
adjacent fat deposits and finally sclerosis. This appearance could be confused with erosions related to SpA. However, Schmörl’s nodules are commonly associated with degenerative changes and no other inflammatory lesions or structural changes indicating SpA should be identified (Fig 32). The diagnostic approach should also consider the clinical presentation.

6) Vertebral fractures:

Acute vertebral fractures show bone marrow edema that could be confused with inflammatory spondylitis when it tends to involves the whole vertebral body (referred to as "massive inflammatory lesion" according to the Canada-Denmark MRI in ankylosis spondylitis working group), although this finding is uncommon. Vertebral fractures are often associated with loss of the vertebral height. On MRI, a hypointense linear image parallel to the vertebral endplate could be identified on fluid sensitive sequences, corresponding to the fracture line (Fig 33). Clinical context is also different, and vertebral fractures are commonly seen in elderly patients with osteoporosis.

7) Infectious spondylodiscitis:

Infectious spondylodiscitis is an infection of the intervertebral disc and adjacent vertebral bodies caused by an infective organism that most commonly results from hematogenous spread from a distant source.

Radiographs may be normal, particularly in the early course of the disease. The initial signs include disc space narrowing with ill definition of the vertebral endplates that evolves to bone destruction. On MRI, inflammatory changes of the vertebral endplates is visualized as high signal intensity in fluid sensitive sequences and low signal intensity on T1-weighted images, in association with endplate irregularity and destruction (Fig 34 and 35). This appearance can be confused with inflammatory spondylodiscitis (Andersson lesion) and distinction between both can be challenging. Infectious spondylodiscitis is found only in 33% of patients with SpA and is commonly accompanied by other findings that suggest this disorder. Furthermore, infectious spondylodiscitis is usually associated with soft tissue involvement and paraspinal and/or epidural abscesses might be identified, a peculiarity that makes the diagnosis more evident. In addition, patient’s history, clinical symptoms and laboratory test results should also be considered.

8) Bone tumors:

Vertebral hemangioma is the most common primary spinal lesion and usually constitutes an incidental finding that is present in as many as 27% of MRI spinal examinations. Typical hemangiomas are characteristically hyperintense on T1 and T2
weighted images secondary to the amount of fat or vessels and interstitial edema respectively. When seen adjacent to vertebral corners, they might be mistaken with fat deposits. The distinctive round or oval shape with sharp margins and the absence of other inflammatory lesions lead to the correct diagnosis (Fig 36).

**Metastases** are the most common vertebral tumor. On MRI metastases are commonly hypointense on T1-weighted images with variable signal intensity on T2-weighted images and fluid sensitive sequences. In some patients, depending on the signal characteristics, metastases may simulate the presence of multiple inflammatory lesions (Fig 37). Certain tumors might exhibit similar signal intensity on MRI, thus resembling inflammatory lesions like spondylitis. Clinical presentation as well as other imaging features such as marked hypointensity on T1-weighted images and the presence of soft tissue component or matrix mineralization are useful for the differential diagnosis.

*Images for this section:*

![Images for section](image)

**Grading of radiographic sacroiliitis according to the modified New York criteria:**

- **Grade 0:** Normal.
- **Grade 1:** Suspicious changes.
- **Grade 2:** Minimal abnormality with small localised areas with erosions or sclerosis, without alteration of the joint space.
- **Grade 3:** Unequivocal abnormality with moderate or advanced sacroiliitis with one or more of: erosions, evidence of sclerosis, widening, narrowing or partial ankylosis.
- **Grade 4:** Severe abnormality with complete ankylosis.

*Fig. 2*
32-year-old man with bilateral sacroiliitis related to inflammatory bowel disease: 
**A)** Anteroposterior (AP) radiograph showing bilateral sacroiliitis with joint space narrowing, erosions and subchondral sclerosis (white arrows). 
**B and C)** Axial and coronal oblique CT images depicts multiple small erosions (red arrows) and mild subchondral sclerosis (yellow arrowheads) bilaterally.

**Fig. 3**
Sagital CT images obtained in a 55-year-old man with ankylosis spondylitis shows erosions of vertebral endplates (red arrows) and facet joints ankylosis (yellow arrows).

Fig. 4
Bone marrow edema in a 27-year-old-man with ankylosing spondylitis depicted as high signal intensity on coinciding coronal and axial STIR sequences (A and C) and low signal intensity on coinciding coronal and axial T1-weighted images (B and D) (yellow asterisks). Erosions (red arrows) and subchondral sclerosis (yellow arrowheads) are also evident.
Axial T1-weighted (A) and STIR (B) image obtained in a 33-year-old man shows mild signal intensity abnormality at the attachment site of ligaments of the posterior aspect of the right sacroiliac joint (red arrow) consistent with enthesitis and bone marrow edema (yellow asterisks).
Coronal oblique T1-weighted (A) and STIR (B) image obtained in a 29-year-old-man demonstrates signal intensity abnormality at the attachment site of ligaments of the posterior aspect of the right sacroiliac joint consistent with enthesitis (yellow asterisks) and left sacroiliac joint capsulitis (red arrow).
A) AP radiograph of sacroiliac joints in a 33 year-old female shows bilateral extensive subchondral sclerosis and multiple erosions that cause an apparent widening of the joint space ("pseudowidening") consistent with bilateral grade 3 sacroiliitis (white arrows).

B) Lateral projection of the cervical spine in the same patient demonstrates erosions at the superior endplates of C4 and C5 consistent with Andersson lesions (red arrows).

Fig. 8
Axial T1-weighted (A) and STIR (B) images obtained in a 53-year-old-man demonstrates areas of subchondral high signal intensity on T1 and low signal intensity on STIR bilaterally representing fat deposits (yellow asterisks). Multiple bilateral erosions are also evident (white arrows) along with bone marrow edema (red arrow).

Fig. 9
42-year-old man with long-standing ankylosis spondylitis and complete ankylosis of the sacroiliac joints (white arrows) and spine evident on AP radiograph (A). Coronal oblique STIR and T1-weighted images (B and C) and axial T1-weighted image (D) also depict extensive periarticular fat deposits (yellow asterisks).

Fig. 10
Coronal oblique STIR images demonstrate hyperintense tubular structures coursing adjacent to the sacroiliac joints in a symptomatic patient (yellow arrows)

Fig. 11
“Coil effect”: Coronal oblique STIR image in a asymptomatic patients shows increased signal intensity in the lower part of the sacrum and adjoining soft tissues.

Fig. 12
A) AP radiograph of the pelvis demonstrates a triangular-shaped sclerotic area in the right iliac bone in an asymptomatic 42-year-old female consistent with unilateral osteitis condensans ilii (yellow arrowheads).

B) Coronal CT image obtained in a 45-year-old female patient showed incidentally the presence of subchondral sclerosis in the iliac margin of the sacroiliac joints (yellow arrows) with mild joint space narrowing in according to bilateral osteitis condensans ilii.

Fig. 13
A) Axial CT image demonstrates incidentally right iliac subchondral sclerosis and anterior osteophytes in a 68-year-old patient with no history of SpA.

B) Axial CT image shows the presence of intra-articular gas in the sacroiliac joints (white arrows) and a small intraosseous pneumato cyst in the right iliac margin (red arrow).

C) Axial CT image depicts right anterior osteophytes (yellow arrows) and a subchondral cyst containing gas, consistent with an intraosseous pneumato cyst in the left sacral margin (red arrow).

Fig. 14
Consecutive axial CT images in a 45-year-old male shows prominent anterior bridging ossification in the anterior aspect of the sacroiliac joints (yellow arrows) (A) in a patient with evidence of exuberant ossifications in the anterior aspect of four contiguous vertebral bodies (“Forrestier-Rotes-Querol disease”) (red arrows) (B), according with diffuse idiopathic skeletal hyperostosis (DISH).
Axial T1-weighted image (A) and axial and coronal STIR images obtained in a 32-year-old female presenting with one week history of left sacroiliac pain and fever shows prominent bone marrow edema adjacent to the left sacroiliac joint (yellow asterisk) and extending to surrounding soft tissues (red arrows), consistent with left sacroiliac septic arthritis.

**Fig. 16**
21-year-old woman presenting with fever and pain in the right gluteal region radiating to the lower limb for 6 days:

A) AP radiograph of the whole pelvis showed no abnormalities.

B) Axial and coronal CT images depicted subtle joint space narrowing of the right sacroiliac joint (red arrow), free intraperitoneal fluid (blue asterisk) and enlargement of the right iliac and piramidal muscles (yellow asterisks).

C) Axial STIR and T1-weighted images demonstrating extensive bone marrow edema adjacent to the right sacroiliac joint (yellow asterisks) and extending to adjoining soft tissues (yellow arrows) along with free intraperitoneal fluid (blue asterisks) suggesting septic arthritis.

Patient underwent empiric antibiotic therapy with significant improvement in the following weeks.
56-year-old woman who undergone previous radiotherapy due to rectal adenocarcinoma. Coronal oblique T1-weighted (A) and STIR (B) images show bilateral well defined fracture lines (red arrows) with surrounding edema extending to the left iliac bone (yellow asterisks). (C) AP radiograph of the pelvis showed no abnormalities.
A) Coronal oblique STIR image in a 17-year-old man who practised equestrian sport and presented with right sacroiliac pain depicts subtle subchondral edema in the iliac margin of the right sacroiliac joint (yellow arrow). No additional clinical or laboratory features of SpA were present. B) Coronal oblique STIR image performed 4 months later shows complete resolution of the edema.

Fig. 19
53-year-old man with long-standing ankylosing spondylitis. (A) AP radiograph of the entire pelvis demonstrates bilateral sacroiliac joint ankylosis (grade 4) (white arrows) with left hip involvement (indicated with a yellow circle). On coronal MRI images, marked hipointensity of the bone marrow adjacent to the right sacroiliac joint is noted on T1 (being lower than the muscle signal intensity) (B) corresponding with high signal intensity on STIR (yellow asterisks) (C) with soft tissue component (red arrow). Diffuse large B-cell lymphoma was confirmed with percutaneous ultrasound-guided biopsy.

**Fig. 20**
Sagital STIR (A and C) and T1-weighted (B and D) images of the cervical and dorsal spine show edema at the anterior corners of two adjacent vertebral bodies at the cervical spine and at the posterior corners of two adjacent vertebral bodies at the dorsal spine, in a 37 year-old female with spondylarthritis related to bowel inflammatory disease and confirmed bilateral sacroiliitis, suggesting posterior spondylitis (indicated with a yellow circle). Sagital T1-weighted image of the cervical spine also demonstrates the presence of syndesmophytes (red arrows).

Fig. 21
Sagittal STIR (A) and T1-weighted (B) images of the cervical spine demonstrate bone marrow edema adjacent to a facet joint (indicated with a yellow circle) in a 46-year-old male with long-standing ankylosing spondylitis, suggesting facet arthritis. Bony fusion of a inferior facet joint is also evident on sagittal T1-weighted image (red arrow).

Fig. 22
Sagittal and T1-weighted (A) and T2-weighted (B) images of the dorsal spine depict erosions at the vertebral corner and endplates of dorsal vertebral bodies (yellow arrows). Partial bony fusion between two adjacent vertebral bodies is also noted (red arrow).

Fig. 23
Sagittal and T1-weighted of the cervical spine shows multiple fat deposits at the corners and endplates of the vertebral bodies in a 46-year-old male with long-standing ankylosis spondylitis (yellow arrows).
AP and lateral radiographs of the lumbar spine in a 49-year-old patient with long-standing ankylosing spondylitis demonstrate fusion of vertebral bodies and posterior elements referred to as “bamboo spine”

Fig. 25
**Phase-encoded artifact**: Consecutive hyperintense lineal images due to cerebrospinal fluid motion (yellow arrows) projecting over the anterior margin of the vertebral bodies (red arrows), a finding that might be confused with edema.

**Fig. 26**
Prominent ossifications principally along the anterior aspect of the vertebral bodies can be recognized on the lateral radiograph (A) and sagittal T1 (B) and T2-weighted images (C) in a 68 year-old man with diffuse idiopathic skeletal hyperostosis (DISH). Note that there is no significant disc space narrowing and no typical features of SpA. Involvement of the knees can also be appreciated (D).

Fig. 27
A) 16-year-old man with dorsal back pain and increased kyphosis. Vertebral wedging, endplate irregularity and disc space narrowing can be seen in four adjacent vertebral bodies (T9-T12) consistent with Scheuermann's disease (yellow arrows).

B) Sagittal T1, T2 weighted and STIR images in a 14-year-old with Scheuermann's disease show multiple and contiguous involvement of vertebral bodies with anterior wedging, antero-posterior elongation, endplate irregularity, associated Schmorl nodes and disc space narrowing.
**Type 1 Modic changes**: Decreased signal intensity on T1-weighted image and increased signal on T2-weighted and STIR images can be appreciated at the anterior endplates of two adjacent vertebral bodies reflecting edema. Disc signal intensity abnormality with space narrowing is also appreciated. Differentiation between type 1 Modic changes and edema related to SpA can sometimes be extremely difficult.
**Type 2 Modic changes**: Increased signal intensity can be noted at vertebral endplates on T1 and T2-weighted images coexisting with disc signal intensity abnormality with space narrowing at L5-S1. Differentiation between type 2 Modic changes and fat deposits related to SpA can sometimes be extremely difficult.

![Fig. 30](image-url)
**Type 3 Modic changes:** Decreased signal intensity can be noted at vertebral endplates on T1 and T2-weighted images, accompanied by disc signal intensity abnormality with space narrowing and osteophytes at L3-L4.
**Schmörl nodes**: Cortical defects at the superior endplate of L3 and L4 consistent with Schmörl nodes can be appreciated (yellow arrows) along with signal intensity abnormality and bulging of the intervertebral disks and intersomatic space narrowing.

**Fig. 32**
Sagital MR images obtained in a 62-year-old patient with dorsalgia shows vertebral body height loss of D7 with coexisting edema and a subtle fracture line parallel to the inferior endplate (white arrows).

Fig. 33
56-year-old man with lumbar infectious spondylodiscitis due to native valve endocarditis. Vertebral endplates edema (blue asterisks) with bone and disk space enhancement after contrast administration (green arrows) in L1-L2 and L4-L5 levels, consistent with infectious spondylodiscitis caused by S. hominis. Note vertebral endplate degeneration with high signal intensity in T1 and T2 representing type 2 Modic changes at L2-L3 and L3-L4 (yellow asterisks).

Fig. 34
D10-D11 infectious spondylodiscitis with endplate irregularity, extensive bone destruction and coexisting soft tissue component (yellow arrows) on lateral radiograph (A) and sagittal CT image (B). On MRI marked irregularity with signal abnormality and enhancement of vertebral endplates (C). Infectious spondylodiscitis caused by S. warneri was confirmed by percutaneous CT-guided biopsy (D).

Fig. 35
Round hyperintense lesion on T1 and T2-weighted image next to the posteroinferior corner of L3 found incidentally, consistent with **vertebral hemangioma** (yellow arrows).
Multiple lesions involving the vertebral bodies that are markedly hipointense on T1-weighted image (compared to the intervertebral discs), hipointense on T2-weighted image and hyperintense on STIR, in a 62 year-old man with bronchogenic carcinoma stage IV, consistent with bone metastases.

Fig. 37
Conclusion

As imaging has become an integral part of the assessment of patients with SpA, it is crucial for radiologist to be familiar not only with its typical imaging features but with other entities and potential pitfalls that could simulate the imaging findings of SpA in order to provide an adequate diagnosis and avoid side-effects that may be caused by therapy.

Personal information

References


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