Seronegative spondyloarthropathy-related sacroiliitis: CT, MRI features and differentials

Daya Prakash, Shailesh M Prabhu, Aparna Irodi
Department of Radiology, Christian Medical College, Vellore, Tamil Nadu, India

Correspondence: Dr. Shailesh M Prabhu, Department of Radiology, Christian Medical College, Vellore - 632 004, Tamil Nadu, India. E-mail: shailesh182@gmail.com

Abstract
Seronegative spondyloarthropathy is a group of chronic inflammatory rheumatic diseases that predominantly affect the axial skeleton. Involvement of sacroiliac joint is considered a hallmark for diagnosis of seronegative spondyloarthropathy and is usually the first manifestation of this condition. It is essential for the radiologist to know the computed tomography (CT) and magnetic resonance imaging (MRI) features of spondyloarthropathy-related sacroiliitis as imaging plays an important role in diagnosis and evaluation of response to treatment. We present a pictorial essay of CT and MRI imaging findings in seronegative spondyloarthropathy-related sacroiliitis in various stages and highlight common differentials that need to be considered.

Key words: Assessment of SpondyloArthritis international society; computed tomography; magnetic resonance imaging; sacroiliitis; seronegative; spondyloarthropathy sacroiliitis

Introduction
Seronegative spondyloarthropathy is a group of chronic inflammatory rheumatic diseases that predominantly affect the axial skeleton. This group comprises disease entities like ankylosing spondylitis, reactive arthritis, psoriatic arthritis, arthritis associated with chronic inflammatory bowel disease (Crohn’s disease and ulcerative colitis), and undifferentiated spondyloarthropathies.\(^1\) The disease is usually seen between second and fourth decades of life with onset after 45 years being exceedingly uncommon. The presence of human leukocyte antigen (HLA)-B27 is a common feature of all spondyloarthropathies, with approximately 90% patients of ankylosing spondylitis being positive. With the advent of imaging modalities like computed tomography (CT) and magnetic resonance imaging (MRI), increased awareness of this entity, and presence of new treatment options, more and more cases of spondyloarthropathy are being diagnosed at an early stage. It is essential for the radiologist to know the CT and MRI signs of spondyloarthropathy, as imaging plays an important role in diagnosis. Involvement of sacroiliac (SI) joint is considered a hallmark for diagnosis of seronegative spondyloarthropathy and is usually the first manifestation of this condition.\(^1\) Thus, detection of sacroiliitis helps in early diagnosis and treatment. In this pictorial essay, we present the CT and MRI imaging findings in seronegative spondyloarthropathy-related sacroiliitis and highlight the common differentials that need to be considered.

Assessment of SpondyloArthritis International Society Criteria for Spondyloarthropathy

The Assessment of SpondyloArthritis international Society (ASAS) have developed a diagnostic criteria for axial spondyloarthropathy using a combination of clinical, imaging, and laboratory findings [Table 1].\(^3\) According to the ASAS criteria, the imaging findings are based on demonstration of sacroiliitis on MRI and/or radiography. Radiography evaluation for sacroiliitis is based on changes defined according to the modified

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New York criteria. MRI is now recognized to play a pivotal role in the diagnosis of early sacroiliitis and for evaluation of response to treatment. According to the ASAS criteria, the MRI imaging features considered positive for spondyloarthropathy-related sacroiliitis include the following:

(a) Sequence and signal-presence of bone marrow hyperintensity on short TI inversion recovery (STIR) images or contrast enhancement on fat-suppressed T1-weighted (T1W) images;
(b) Site- periarticular or subarticular location; and
(c) Number of lesions- two or more areas of bone marrow hyperintensity/enhancement on a single slice, or in cases of single area of bone marrow hyperintensity/enhancement, the area should be clearly seen on two consecutive slices.

Presence of structural lesions (erosions, sclerosis, subchondral fatty change, capsulitis, enthesitis, and bony bridges) alone on MRI in the absence of bone marrow edema is considered insufficient for the diagnosis of sacroiliitis according to the ASAS criteria, and this is considered to be a prominent limitation.\textsuperscript{[1,2]}

**Normal Anatomy of SI Joint**

The SI joint has two parts, a lower ventral part which is predominantly cartilaginous and an upper dorsal part which is a fibrous joint [Figures 1 and 2]. The cartilaginous segment has smooth and parallel margins, while the fibrous segment shows irregular margins. Bone marrow edema in seronegative spondyloarthropathy-related sacroiliitis predominantly involves the lower and posterior part of the joint. Normal anatomic variants of SI joint include accessory SI joint (seen in the posterosuperior portion of the joint) [Figure 3], bipartite iliac bone plate [Figure 3], and iliosacral complex.\textsuperscript{[1]}

### Imaging Modalities for Evaluation of Sacroiliitis - Advantages and Disadvantages

**Conventional radiology**

Radiography is considered to be a useful screening modality for sacroiliitis; however, plain radiographic changes are seen only after 5 years of disease activity.\textsuperscript{[2]} Hence, it is not useful in detecting early disease in which treatment might help prevent disease progression.
CT
CT is a widely available and relatively less expensive imaging modality, compared to MRI. It can demonstrate erosions, sclerotic changes, and ankylosis better than MRI.\(^1\) It is a useful modality for screening of early disease. However, radiation exposure is a concern and follow-up imaging for disease response should be done with MRI.

MRI
MRI can detect early findings of sacroiliitis like bone marrow edema, capsulitis, and enthesitis. Additionally, it forms an important component of the ASAS criteria. It is helpful in demonstrating the response to therapy and can detect the activity of disease (acute-on-chronic disease). However, it is a relatively expensive modality.

Imaging Protocol and Technique

CT
CT scan of SI joints involves multiplanar oblique coronal and oblique axial scans oriented parallel and perpendicular to the long axis of sacrum.

MRI
The basic protocol includes fast spin echo T1W and STIR T2-weighted (T2W) sequences in oblique, axial and coronal planes for evaluation of SI joint. Although noncontrast MRI findings are sufficient to diagnose spondyloarthropathy-related sacroiliitis, contrast MRI may demonstrate additional supportive signs of sacroiliitis like synovitis, capsulitis, and enthesitis. Post-contrast T1W images may be required in cases of doubtful sacroiliitis on non contrast MRI imaging. Additional fast spin echo T2W sagittal scan of lumbosacral spine and coronal STIR scan of pelvis including bilateral hips can be acquired to assess additional supportive features of seronegative spondyloarthropathy and screen for other causes of low backache.

Imaging Findings in Spondyloarthropathy-related Sacroiliitis on CT and MRI

CT findings
CT findings in spondyloarthropathy-related sacroiliitis [Figures 4 and 5] include the following:
- Subchondral demineralization: It is considered to be an early sign and equivalent of subchondral bone marrow hyperintensity seen on MRI, but is a nonspecific finding
- Erosions: Erosions are seen on the iliac side in early stage of the disease with later involvement of the sacral surface. Early involvement of the iliac surface is because of thinner cartilage on the iliac surface compared to the sacral surface. Erosions are associated with narrowing of joint space
- Subchondral sclerosis: Sclerosis can be focal or diffuse, asymmetrical or symmetrical, measuring more than 5 mm on iliac surface\(^2\)

MRI findings
MRI findings can be classified as those seen in acute, chronic, and acute-on-chronic stages.

Acute stage
- Subchondral bone marrow edema [Figure 6-8]: It is considered to be an earliest imaging sign of sacroiliitis and forms an important component of the ASAS criteria. It can be symmetrical or asymmetrical and typically involves lower and posterior portion of the joint surface
- Erosions: Erosions are defects in joint surface which can be subtle in the early stage. They involve iliac surface in the early stage with the sacral surface getting involved later
- Synovitis and joint effusion: It is seen as hyperintensity within the joint. Contrast MRI can help differentiate synovitis from joint effusion by demonstrating enhancing synovium in synovitis\(^3\)
Capsulitis and enthesitis: Capsulitis is inflammation of anterior and posterior capsules and seen on MRI as STIR hyperintensity or contrast enhancement of the capsule. Enthesitis represents inflammation involving the junctional interface of bone with ligaments and capsule. It is seen as junctional zone T2W hyperintensity which may extend into the surrounding soft tissue.[1,2,5]

Chronic stage

• Subchondral fatty deposition [Figure 9]: It is an important indicator of chronic sacroiliitis. It is seen as subchondral T1W hyperintensity which gets suppressed on fat-saturated images. As an isolated finding, it is nonspecific and represents sequelae of previous inflammation. However, when associated with other findings like erosions, sclerosis, or bony bridging, it helps in diagnosing spondyloarthritis-related sacroiliitis[1,2]

• Subchondral sclerosis: Sclerosis is seen on both iliac and sacral subchondral surfaces, and is seen as T1W and T2W hypointensities on MRI. It should extend at least 5 mm from the SI joint surface

• Erosions: Erosions are seen involving both iliac and sacral surfaces with associated joint space narrowing. Large confluent erosions may result in pseudo-widening of the joints

• Bony bridges and total ankylosis: Fusion of joint surfaces is seen which may be focal, asymmetrical or symmetrical, and complete. The surrounding bone may show subchondral fatty changes.

Acute-on-chronic sacroiliitis

In the presence of acute-on-chronic sacroiliitis, subchondral bone marrow edema may be seen in a background of subchondral fat deposition and other signs of chronic sacroiliitis [Figure 10]. Active erosions may show underlying
bone marrow edema and enhancement on post-contrast scans.

**Associated Findings**

Additional findings, when seen in the surrounding structures in the imaging field, can add substantial value to the diagnosis of spondyloarthropathy. Additional CT and MRI findings [Figures 11 and 12] in routine SI joint protocol include the following:

- **Facetal arthropathy:** It is seen as facet joint erosions, facetal osteophytes, and parafacetal ossification on CT. On MRI, facet joint effusion, facet joint fusion, bone marrow edema, and fatty changes in the superior and inferior facets are seen.
- **Enthesitis:** Screening of pelvis may show significant T2W hyperintensity due to enthesitis at greater trochanter and ischial tuberosity.\(^7\)
- **MRI corner sign and bridging syndesmophytes:** Bone marrow edema involves the anterior and posterior corners of the lower lumbar vertebrae in the acute stage and fatty deposition in the chronic stage.\(^8\) Bridging anterior and posterior syndesmophytes may be seen.
- **Hip joint effusion:** Spondyloarthropathy can have associated hip joint effusion and synovitis.\(^7\)

**Differentials**

Imaging differentials that need to be considered when evaluating for spondyloarthropathy-related sacroiliitis include the following [Table 2]:

- **Infective sacroiliitis:** Infectious sacroiliitis [Figure 13] should be considered in the presence of unilateral joint involvement and disproportionate bone marrow edema involving either iliac or sacral surface with presence of collection extending into the surrounding soft tissue. However, it is important to note that in some early cases of spondyloarthropathy-related sacroiliitis, unilateral joint edema with disproportionate iliac side edema can be seen.\(^9\) In such cases, the presence of surrounding soft tissue collection favors an infective etiology. Infective sacroiliitis is treated with antibiotics based on the organism isolated by CT-guided joint fluid/soft tissue aspiration.

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**Table 2:** Differentials for sacroiliitis depending upon pattern of involvement

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**Figure 9 (A-E):** Findings of chronic sacroiliitis on MRI. (A) Coronal oblique T1W MR image without fat suppression in a 33 year old male with ankylosing spondylitis shows fatty deposition on both iliac (white arrows) and sacral surfaces (black arrows). (B) Corresponding coronal oblique STIR MR image shows suppression of fat signal (white arrows) without any edema. (C) Axial T1W MR image shows multiple subchondral erosions (black arrow). (D) T1W oblique coronal image without fat suppression in another patient shows subchondral sclerosis (thin white arrow), erosion (black arrow), and fatty deposition around the sacroiliac joint (short white arrow). (E) Coronal oblique T1W images without fat suppression through sacroiliac joints show complete joint ankylosis (white arrows) in a 60 year old male with ankylosing spondylitis.

**Figure 10 (A and B):** Acute-on-chronic sacroiliitis. (A) Coronal oblique T1W MR image without fat suppression in a 39 year old female with ankylosing spondylitis shows fat deposition on both sacral sides (black arrows) and iliac sides (white arrows). (B) Corresponding STIR images through sacroiliac joint show subchondral edema (active sacroiliitis) (white arrows), areas of fat suppression (chronic sacroiliitis) (black arrows), and synovitis (thick white arrows).
collection aspiration and blood cultures

- Osteitis condensans illi [Figure 14]: It can resemble subchondral sclerosis seen in chronic stages of sacroilitis on both CT and MRI. It is commonly seen in multiparous woman. Sclerosis is seen to involve the bilateral iliac surfaces in the absence of bone marrow oedema, erosions, and joint space narrowing

- Degenerative changes [Figure 15]: It is associated with marginal osteophytes, periarticular joint space narrowing, and subchondral cysts in the absence of erosion. The area of involvement is typically anterior and middle half of the SI joint compared to involvement of posterior third in spondyloarthropathy-related sacroilitis

- Stress fracture [Figure 16]: Stress fractures can present with unilateral or bilateral sacral bone marrow edema. Non-involvement of iliac surface and visualization of the distinct fracture line helps in differentiation

- Diffuse idiopathic skeletal hyperostosis (DISH) [Figure 17]: Synovial portion of the SI joints is normal with ossification of the iliolumbar ligaments and anterior and superior articular portions of the SI joint. Spine shows characteristic flowing ossifications along the anterolateral aspect of at least 4 contiguous vertebrae
Figure 15: Degenerative arthritis in sacroiliac joints. Oblique coronal CT scan shows osteophytes (thick black arrows), subchondral cyst (thin black arrow), vacuum phenomenon (short white arrow), and subchondral sclerosis (long white arrow).

Figure 16 (A and B): Stress fracture. (A) Oblique coronal STIR MR image in a 70 year old female with left hip pain shows minimal degree of edema in the subchondral region in left sacrum (white arrow). (B) Corresponding T1W coronal image without fat suppression shows hypointense fracture line (white arrow).

Figure 17 (A-D): DISH. (A) Oblique coronal CT scan through sacroiliac joint shows bridging osteophytes in the superior aspect of joint (white arrows), asymmetrical intra-articular fusion of right sacroiliac joint (long black arrow), and flowing anterior osteophytes (short black arrow). (B) T1W coronal MR images show bridging osteophytes in the superior aspect on the right side (white arrow). (C) Corresponding coronal STIR image shows smooth articular surfaces of bilateral sacroiliac joint without erosions (white arrows) and (D) T2W sagittal image through lumbosacral spine shows flowing ossification in the anterior aspect of the vertebral body (white arrow head).

Figure 18 (A-C): Hyperparathyroidism. Oblique coronal CT scan images through sacroiliac joint in a 40 year old female (A, B) show diffuse osteopenia (black arrows) with subchondral erosions (white arrows). Bilateral hand radiographs (C) in the same patient demonstrate generalized osteopenia with subperiosteal bone resorption (white arrows) particularly involving the radial aspects of the second and third middle phalanges.

• Hyperparathyroidism [Figure 18]: Hyperparathyroidism can present with bilateral symmetric or asymmetric SI joint widening with subchondral erosions. Presence of abnormal bone density, subperiosteal, subligamentous erosions, and involvement of other bones helps in differentiation.

Conclusion

CT and MRI are important imaging modalities in early diagnosis of spondyloarthropathy-related sacroiliitis. MRI is particularly helpful in demonstrating early findings of the disease, activity of the disease, and response to treatment. Awareness of CT and MRI findings of spondyloarthropathy-related sacroiliitis in different stages is essential for diagnosis and treatment of this condition.

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