Sacroiliitis - Findings on Conventional Radiography, CT and MRI studies

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Learning objectives

- To review the anatomy of the sacroiliac joints.
- To review the findings of sacroiliitis on radiography, CT and MRI studies
- Highlight the differences of findings between CT and MRI studies

Background

The sacroiliac joint is comprised by the osseous surfaces of the sacrum and the ilium; there are two: one on the right and another on the left (1). It is constituted by two different parts: the lower and ventral part has smooth and parallel margins and is a C-shaped cartilaginous articulation (fig. 1), the superior and dorsal part has very irregular edges and is a syndesmosis - a fibrous joint in which the bony surfaces are united by interosseous ligaments (fig. 2) (1,2). The cartilaginous portion has the anatomical characteristics of a symphysis, only in the distal third of the joint the iliac margins resemble a synovial joint (2,3). The hyaline cartilage that covers the articular surface of the sacrum is thick, while the ilium is lined by a thinner layer of fibrocartilage and this is why the pathologic changes are initiated and are more prominent on the iliac side (1,3).

In normal population the sacroiliac joint space is influenced by age, gender, bone mass index and childbirth (4). Below the 40 years old the joint space is 2.49 ±0.66mm and above that age there is a high incidence of joint space narrowing (less than 2mm) and non-uniform joint space (4). Obese patients, multiparous women (with 3 or more childbirths) had a high prevalence of non-uniform joint space as well as shortening of joint space in multiparous women (4).

A common incidental finding is an anatomic variant of the sacroiliac joint; the most common is the accessory sacroiliac joint (present in about 16% to 17.5% patients) which is located between the medial aspect of the posterior superior iliac spine and a rudimentary transverse tuberosity just lateral to the second sacral foremen (fig. 3) (4,5). The second more common anatomical variant is the iliosacral complex (iliac projection inserting to a complementary sacral recess), the third is bipartite iliac bony plate (iliac bones look as bipartite) and the fourth is semicircular defect in the articular surface (4). It is important to know the variations because they could be mistaken with joint abnormalities or exostosis (3,5).

Sacroiliitis is an inflammation of one or both sacroiliac joints and frequently causes inflammatory back pain of varying intensity, although some patients remain asymptomatic. Sacroiliitis is characteristic and a common finding of
Spondyloarthropathies, but not a specific feature (6). Spondyloarthropathies comprises five entities differentiated mainly on a clinical basis: ankylosing spondylitis, reactive arthritis (Reiter syndrome), arthritis or spondylitis associated with inflammatory bowel disease, psoriatic arthritis and undifferentiated spondyloarthritis (3,6). Sacroiliitis can occur in other rheumatic diseases, such as the SAPHO syndrome (synovitis, acne, pustolosis, hypertention, osteitis), occasionally in rheumatoid arthritis, systemic lupus erythematous, Sjogren’s syndrome and sarcoidosis, in metabolic disorders such as gout and hyperparathyroidism, in infectious diseases and, rarely, in malignancy (6).

Images for this section:

Fig. 1: Normal Sacroiliac Joints - Coronal Oblique images showing the lower and ventral part of the sacroiliac joints A. RM T1-weighted image and B. CT

Fig. 2: Normal Sacroiliac Joints - Superior and dorsal part of the sacroiliac joints in A. Coronal Oblique T1-weighted images and B. Axial CT
Fig. 3: Accessory Sacroiliac Joint - Axial CT showing a left Accessory Sacroiliac Joint (arrow) in a 60 years old woman and lower back pain. The sacroiliac joints only had mild degenerative changes.
Findings and procedure details

The diagnosis of Sacroiliitis in clinical practice relies heavily on imaging techniques (6). Some of the most important clinical indications for imaging the sacroiliac joints are clarify the diagnosis in a patient with inflammatory back pain, make a diagnosis of ankylosing spondylitis, determine the amount of inflammation, determine the amount of chronic changes and exclude septic Sacroiliitis (6). The imaging methods most used for this purpose are conventional radiography, computed tomography (CT) and magnetic resonance imaging (MRI).

Conventional Radiography

Radiography is still an accepted imaging method and frequently the initial diagnostic tool for Sacroiliitis. Plain radiographs are readily available, quick and easy to generate, relatively inexpensive and very helpful when have positive findings (3,6,7). The main limitations reported are the difficulty in interpreting plain radiographs, the inter and intraobserver interpretation variations, the poor sensitivity in the early stages of the disease and the inability to detect active inflammation (3,6,7). A frontal projection with the patient in a supine position with the tube angulated 20-30° in the cephalic direction or a PA projection with 25-30° caudal angulation allows a good visualization of the sacroiliac joints (fig. 4) (7). The diagnostic value of the oblique views is minimal (7). It is important to visualize the hip joints, since they are affected in 25% of patients with spondyloarthropathy (3).

The earliest changes of Sacroiliitis are erosions of the iliac side (where the cartilage is thinner); with their progression there could be an apparent widening of the joint space (caused by the confluence of the erosions) (7). After that, reparative changes start, with apposition of new bone behind the erosions, that appear in the radiographs as sclerosis (fig. 5). Narrowing of the joint space and ankylosis could happen later in the course of the disease (fig. 6) (7). The modified New York criteria classify the radiographic changes of sacroiliitis in 5 stages: Grade 0 - normal sacroiliac joints with well-defined margins; grade 1 - incipient sclerosis and decreased focal thickness of the articular space; grade 2 - loss of definition of the articular margins, subchondral osteoporosis and areas of reactive sclerosis; grade 3 - subchondral sclerosis of both sacral and iliac articular margins (predominantly on the iliac side), erosions, reduced articular space, widening of the joint space, and incipient ankylosis; and grade 4 - complete ankylosis with residual sclerosis (tends to decrease over time) (8). Bilateral changes corresponding to grade 2 or higher, or unilateral changes corresponding to grade 3 or higher, must be detected to diagnose sacroiliitis radiographically (8).

Computed Tomography
Computed Tomography (CT) is superior to conventional radiography for the detection of Sacroiliitis (7). It allows a better assessment of the sacroiliac joints (fig.7), a better definition of bone detail, presence or absence of air, fluid and/or abscesses and assessment of the surrounding soft tissue. Also, the interobserver variability is lower than conventional radiography. The main limitations are the incapacity to assess for the presence of active inflammation and the radiation exposure (3,7).

The CT findings of Sacroiliitis are similar to those seen at radiography, namely, contour irregularities, joint space alterations, joint erosions, subchondral bone changes (osteoporosis or sclerosis) (figs. 8 and 9), enthesitis and ankylosis (fig. 10) (3,7).

**Magnetic Resonance Imaging**

Magnetic Resonance Imaging (MRI) is an extremely useful method for assessment of Sacroiliitis. MRI should be used when possible to evaluate Sacroiliitis (7). The basic protocol should have coronal and axial oblique fast spin-echo T1-weighted sequences (to detect structural changes), coronal and axial oblique short inversion time inversion-recovery (STIR) or fat-saturated fast spin-echo T2-weighted sequences (to detect acute inflammatory changes) (3). Fat-saturated fast spin-echo T1-weighted sequences after the administration of gadolinium-based contrast material can show active inflammatory changes and may differentiate synovitis from joint effusion (3). Fat-saturated T1-weighted or gradient-echo T2-weighted sequence provides good contrast between cartilage and subchondral bone and is very sensitive for the detection of erosions (9).

MRI estimates the degree of disease activity and is extremely useful for monitoring the disease course, including the effect of pharmacological treatment (7). Allows an early diagnosis of Sacroiliitis (before cortical erosions and subchondral sclerosis appears) because it can detect inflammatory changes that are the hallmark of early disease (10,11). Disadvantages are long examination times, relative high cost, requirement for skilled staff, and specific contraindications, like ferromagnetic implants, cardiac pacemakers, and claustrophobia (3,7).

MRI can depict active inflammatory lesions and structural damage lesions (12). Active inflammatory lesions (bone marrow edema, synovitis, capsulitis, and enthesitis) are visualized on STIR, fat-suppressed T2-weighted, and contrast-enhanced fat-suppressed T1-weighted images (3).

**Bone marrow edema** appears as a hyperintense signal on STIR images (fig. 11) or fat-saturated fast spin-echo T2-weighted and usually as a hypointense signal on T1 images (fig. 8). Typically the subchondral bone marrow is affected (marrow with periarticular localization). Sacral interforaminal bone marrow signal is the reference for normal bone marrow signal. A hyperintense signal on T1 fat-saturated images post-Gd reflects increased vascularization and is considered osteitis. Bone marrow edema is an indicator of active sacroiliitis but may be found in other diseases; may be associated with signs of structural damage such as sclerosis or erosions. **Synovitis** can be differentiated from joint
fluid only after the administration of paramagnetic contrast medium, therefore is detected as a hyperintense signal on contrast-enhanced, T1-weighted fat-saturated images in the synovial part of the SI joints (intensity similar to blood vessels). Synovitis, as a single feature (without bone marrow edema), is very rare and does not suffice for making a diagnosis of Sacroiliitis. Enthesitis appears as a hyperintense signal on STIR images (or fat-suppressed T2-weighted images) and/or on contrast-enhanced, T1-weighted, fat saturated images at sites where ligaments and tendons attach to bone, including the interosseous ligaments. The signal may extend to bone marrow and soft tissue. Capsulitis may involve the anterior and posterior capsule and has similar signal characteristics to those of synovitis. Can be detected on contrast-enhanced fat-suppressed T1-weighted images and on STIR or fat-suppressed T2-weighted images (12,13).

Structural or chronic lesions of the SI joints are better visualized on T1-weighted sequences; erosions are best visualized on T1-weighted sequences with fat saturation or T2-weighted gradient echo sequences. The lesions can appear as subchondral sclerosis, erosions, fat deposits and ankylosis. Subchondral sclerosis manifests as low-signal-intensity or signal-free bands by all sequences (T1, STIR, T1 post-Gd) and don't enhance after contrast medium administration. The sclerosis typically extends at least 5 mm from the sacroiliac joint space, since small areas of periarticular sclerosis can be observed in healthy subjects (fig. 12). Erosions are bone defects at the joint margin of the cartilaginous compartment. Erosions initially appear as single lesions, their confluence can cause a pseudo-widening of the SI joints. On MRI they appear as hypointense foci on T1-weighted images and as hyperintense foci on STIR images, if active (fig 13). Gradient-echo T2-weighted or fat-suppressed T1-weighted sequences can be more useful in detecting erosions. Periarticular fat deposition is a non-specific finding (probably indicates areas of previous inflammation). On MRI periarticular fat deposition is characterized by an increased signal on non-fat-suppressed T1-weighted images. Bone bridges or ankylosis are the result from the fusion of bone buds that have formed during the course of inflammation and face each other. Appears as a low intensity signal on all MRI sequences, sometimes surrounded by high-intensity signal on T1 (fat deposition of bone marrow) (fig. 14). When several bony bridges are present, the joint cavity becomes increasingly blurred (12,13).

According to the new ASAS (Assessment of SpondyloArthritis international Society) criteria for axial spondyloarthropathy (SpA), active inflammatory lesions of the sacroiliac joints (reflecting active Sacroiliitis) are required for the fulfillment of the imaging criterion "Sacroiliitis on MRI". Bone marrow edema (on STIR) or osteitis (on T1 post-Gd) are highly suggestive of SpA but must be clearly present and located in the typical anatomical areas (subchondral or periarticular bone marrow). The sole presence of other active inflammatory lesions such as synovitis, enthesitis or capsulitis is not sufficient for the definition of Sacroiliitis on MRI. Structural lesions such as fat deposition, sclerosis, erosions or bony ankylosis are likely to reflect previous inflammation; however, the sole presence of structural lesions does not suffice for the definition of a positive MRI. If there is only one lesion, it should be present on at least two sections; if there is more than one lesion on a single section, that section is sufficient for making the diagnosis (12,13).
Comparison of Radiography, CT and MRI

Radiographs are frequently normal in early Sacroiliitis and their characteristic features only appear 3 to 12 years after the onset of low back pain. CT is more sensitive and accurate than plain radiographs in the evaluation of sacroiliac joints and is superior for the detection of erosions and sclerosis (figs. 5 and 8) (14,15). However radiographs and CT represent static images and only show chronic changes of the sacroiliac joints (14,15). On the other hand MRI is extremely sensitive in detecting articular and bone marrow changes of early Sacroiliitis (inflammatory changes). Early active inflammatory changes (bone marrow edema and enhancement in the joint space) are detectable by MRI making it possible to diagnose Sacroiliitis before definite joint destruction, detectable by CT and radiography (fig. 11) (16). MR imaging can also reveal the changes of cartilage abnormalities and bone marrow edema which could not be found by CT (15). There are some conflicting data regarding the detection of subcondral sclerosis, but, in all, CT was equal or better imaging method than MRI for that purpose (9,14,15,16). CT is also better than MRI in the identification of bone production, like in the ligamentous portion (enthesopathy) (8).

Differential Diagnosis

It is important to know that there are some diseases that may mimic inflammatory lesions seen in Sacroiliitis. In the differential diagnosis should be considered degenerative changes, osteitis condensans illii, insufficiency sacral fractures, infectious sacroiliitis, hyperparathyroidism and bone tumors (17,18).

Degenerative changes are a common finding in the elderly and typically involve the anterior and middle half of the Sacroiliac joint. It can cause unilateral or bilateral, symmetrical or asymmetrical joint involvement. It is associated with marginal (anterior) osteophytes, periartricular joint space narrowing, and subchondral cysts, however small areas of bone marrow edema along the sacroiliac joint can be present (fig. 15) (13,17,18). Osteitis condensans illii is characteristically seen in middle age woman (more frequently multiparous) and has a typical location and configuration: triangular area of subchondral sclerosis at the anterior inferior iliac margin, wider at its inferior region (fig. 16) (13,18). Insufficiency sacral fractures can cause unilateral or bilateral sacral bone alterations of signal that might be compatible with marrow edema or osteitis. The noninvolvement of iliac surface and visualization of the distinct fracture line helps in differentiation (18). Infectious Sacroiliitis should be considered in the presence of unilateral joint involvement and disproportionate bone marrow edema. The presence of large bone erosion, thick capsulitis, extracapsular fluid collection, and periartricular muscle edema on MRI suggest infectious Sacroiliitis (fig. 17) (18,19).

Images for this section:
Fig. 4: Anteroposterior Radiography showing normal Sacroiliac Joints with smooth articular contours and normal joint space

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Fig. 5: Sacroiliitis. Anteroposterior Radiography of a 52 years old woman. Subchondral sclerosis on the iliac side and irregular articular contours, more prominent on the left

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**Fig. 6:** Chronic Sacroiliitis. Subchondral sclerosis, predominantly on the iliac side with ankylosis (arrows) of the ventral and lower part of both sacroiliac joints.

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Fig. 7: Normal Sacroiliac Joints on Axial CT. The articular surfaces are smooth and the joint space is normal

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Fig. 8: Sacroiliitis. Axial (A) and Coronal Oblique (B) CT showing subchondral sclerosis (arrowheads) and erosions (small arrows) affecting the iliac side with bilateral and symmetric distribution (same patient picture 5)

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**Fig. 9:** Sacroiliitis. Axial (A) and Coronal Oblique (B) CT of a 31 years old woman showing evident bilateral and symmetric subchondral sclerosis (arrowheads) and erosions (arrows) in the iliac margin.

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**Fig. 10:** Chronic Sacroiliitis. Axial (A) and Coronal Oblique (B) CT showing ankylosis (arrows) of both Sacroiliac Joints. (Same patient picture 6)

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Fig. 11: Active Sacroiliitis. MR STIR image showing a hiperintense foci in the left sacrum (arrow), representing bone marrow edema, a signal of active sacroiliitis on a 28 years old woman.

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Fig. 12: Sacroiliitis of a 27 years old man. MR Axial T1-weighted images (A) and T2-weighted images (B) showing bilateral subchondral sclerosis (hypointense bands) (large arrows) and irregular articular surfaces (thin arrows) that are better depicted on B.

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Fig. 13: Sacroiliitis in a 24 years old woman. MR Axial T2-weighted images showing erosions affecting the iliac side of the right sacroiliac joint (arrow). Bilateral subchondral sclerosis is also present.

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**Fig. 14:** Chronic Sacroiliitis of a 28 years old woman. MR Axial T1-weighted images (A) and T2-weighted images (B) showing bilateral subchondral sclerosis and ankylosis of the right sacroiliac joint (large arrows). Subarticular foci of hiperintense signal on A (thin arrow) represents periarticular fat deposition.

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**Fig. 15:** Axial CT of a 78 years old woman. Bilateral periarticular joint space narrowing, marginal osteophytes (thin arrows) and vacumm phenomenon (large arrows) are present, typical findings of degenerative Sacroiliac Joints.

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Fig. 16: Osteitis Condensans illii. MR Axial T1-weighted images showing a triangular area of subchondral sclerosis (arrows) at the anterior inferior iliac margin, with smooth articular surfaces.

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**Fig. 17:** Infectious Sacroiliitis of the right sacroiliac joint of a 26 years old man that suffered a penetrating trauma with a firegun. Axial CT showing a fluid collection next to the right sacroiliac joint.

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Conclusion

Sacroiliac joints have a complex anatomy. Radiography, CT and MRI are useful for the diagnosis of Sacroiliitis. CT is superior to MRI in the detection of bony changes, but MRI is better for detection of early disease and the effect of pharmacological treatment.

Personal information

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