Spondyloarthropathies: what radiologists should know.

Poster No.: C-0478
Congress: ECR 2013
Type: Educational Exhibit
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Keywords: Musculoskeletal system, Conventional radiography, MR, CT, Diagnostic procedure, Arthritides
DOI: 10.1594/ecr2013/C-0478

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Learning objectives

To examine the involvement of the spine and sacroiliac joints in spondyloarthropathies using a multimodal radiologic approach (radiography, CT, MRI), providing a practical guide for the differential diagnosis of these conditions.

Background

The inflammatory involvement of the spine and sacroiliac joints is the most peculiar feature of seronegative spondyloarthropathies (SpA), which include ankylosing spondylitis, psoriatic spondyloarthritis, reactive spondyloarthritis (Reiter’s syndrome), enteropathic spondyloarthritis (related to inflammatory bowel diseases such as Crohn’s disease and ulcerative colitis), undifferentiated spondyloarthropathies and SAPHO syndrome.

The main clinical manifestations of SpA include inflammatory back pain caused by sacroiliitis or inflammatory involvement of the lumbar and/or distal thoracic spine; peripheral arthritis (often oligoarticular and asymmetric); enthesitis and extraskeletal manifestations, such as uveitis.

In SpA, the most characteristic targets of the autoimmune process are entheses, anatomical structures made of fibrous or fibro-cartilaginous tissue, which provide anchorage of tendons and ligaments to the bone surface. Enthesitis is accompanied by the appearance of small erosions in the cortical bone, typically surrounded by subcortical reactive osteosclerosis (osteitis), which can often prevail over bone reabsorption; in the later stages osteoproliferation leads to the ossification of ligaments, tendons and joint capsules, and, eventually, to ankylosis.

Imaging, along with clinical and laboratoristic evaluation, is an important tool to reach a correct diagnosis and to provide a precise grading of disease progression, influencing both clinical management and therapy. Conventional radiography, which is often the first-step imaging modality in SpA, does not allow an early diagnosis. Computed Tomography (CT) demonstrates with a very high spatial resolution the tiny structural alterations of cortical and spongy bone before they become evident on plain film radiographs. Magnetic Resonance Imaging (MRI) is the only modality that provides demonstration of bone marrow oedema, which reflects vasodilatation and inflammatory hyperemia.

Imaging findings OR Procedure details
Ankylosing spondylitis

Sacroiliitis is the earliest alteration, followed by the involvement of the dorsal-lumbar spine. The involvement of the cervical spine is almost always late, and it can occur even 20 years or more after the disease's onset. Sacroiliitis affects both the synovial (antero-inferior) and the ligamentous (postero-superior) aspects of the joint, presenting, in most cases, a bilateral and symmetric distribution. In the early stages alterations are represented by juxta-articular osteoporosis, superficial erosions and progressive subchondral osteosclerosis, which is first focal, then more and more extended (Fig. 1A, B). The erosions tend to appear in the synovial portion of the joint on the iliac side, where the cartilage is thinner, but they are often masked by reactive subchondral osteosclerosis (Fig. 1C). As the disease progresses, erosions become more numerous and tend to coalescence, thus resulting in a diffuse bone resorption which creates the illusion of an expansion of the joint space. Subchondral osteosclerosis reduces in the following stages, which are characterized by an increase in the fatty content of cancellous bone (post-inflammatory fatty conversion of bone marrow). The osteo-proliferative stage is characterized by the development of irregular bony bridges that cross the joint space, reducing its width until complete ankylosis (Fig. 1D). The remnants of the joint space are sometimes visible as a thin sclerotic line on plain-film radiographs, which appears hyperdense on CT images.

Conventional radiography does not allow an early diagnosis, but it still represents the most frequently requested radiological investigation to confirm the clinical suspicion of ankylosing spondylitis. The modified New York criteria, proposed in 1984, still represent a largely diffuse radiographic scoring system, and they have also been applied to CT (Fig. 1). CT also represents the "reference standard" for detection of osteoproductive alterations.

MRI is the only imaging modality that may provide an early diagnosis, showing bone marrow oedema, which appears hypointense on T1-weighted images and hyperintense on fluid-sensitive ones (STIR or T2-weighted images with fat signal suppression).

The spinal involvement, which may be earlier, contemporary or subsequent to the onset of sacroiliitis, occurs with a greater frequency at disco-vertebral junctions and in correspondence to interapophyseal and costo-vertebral joints. It includes enthesitis with bone erosion, post-inflammatory fatty conversion of red bone marrow, osteosclerosis and osteoproliferation with ectopic bone formation. The enthesitis of the disco-vertebral junction, which occurs in correspondence to the anterior and posterior corners of vertebral bodies, is associated with erosions, resulting in the typical "lesions of Romanus". Osteosclerotic foci develop in correspondence to corner erosions ("shiny corners"); they progressively become larger, causing the "squaring" of the endplates of vertebral bodies, with loss of the normal concavity of the anterior vertebral wall ("square" vertebra or "squaring" ). "Shiny corners" are the expression of osteitis and appear hypointense on T1-weighted MR images and hyperintense on T2-weighted images. As the disease progresses the "shiny corners" become hyperintense on T1-weighted images due to the
post-inflammatory fatty degeneration of bone marrow (Fig. 2). The chronic inflammation at the discovertebral junction determines the onset of an osteo-proliferative process with formation of syndesmophytes (Fig. 3), which differ from osteophytes for their vertical course and the absence of associated disc degeneration. In advanced stages the ossification of vertebral (longitudinal, supra- and interspinous) ligaments may occur, leading to ankylosis.

The presence of symmetric syndesmophytes along the whole spine (cervical spine is the last rachidian region to be involved) leads to the characteristic "bamboo" spine appearance (Fig. 4).

An extensive inflammatory involvement of the intersomatic disc and adjacent vertebral endplates may occur, the so-called Andersson spondylodiscitis, which, on MRI examination, is characterized by a diffuse hypointense signal on T1-weighted images involving the intersomatic disc and adjacent vertebral endplates. It appears hyperintense on fluid-sensitive sequences and shows significant enhancement after intravenous administration of Gadolinium-based contrast agents.

Interapophyseal joints are not preserved and erosions, sclerosis and progressive ankylosis may develop at this level with formation of a continuous bonny pillar due to the fusion of the articular processes of adjacent upper and lower vertebrae. Although ectopic bone formation is a typical finding of ankylosing spondylitis, this pathological condition is also characterized by diffuse osteoporosis and low mineral density of bone, with an increased risk of vertebral fractures (Fig. 5).

**Psoriatic spondyloarthritis**

The spondylitis-like form of Psoriatic arthritis is characterized by sacroiliitis associated with spondylitis. The main features related to the axial involvement are: a) syndesmophytes that differ from those of ankylosing spondylitis (the so-called "non-marginal bulky syndesmophytes " or "para-syndesmophytes"); b) involvement of the sacroiliac joints, which may be bilateral and symmetrical, or unilateral (Fig. 6); c) sparing or modest involvement of interapophyseal joints.

Syndesmophytes of psoriatic spondyloarthritis are more frequent in the thoraco-lumbar spine and appear as radiopaque elements that are roughly linear or curvilinear, thick, fluffy and parallel to the lateral surface of vertebral bodies and intersomatic discs. They can also tend to coalescence, appearing as a massive osteophytic bone bridge joining two or more contiguous vertebrae, but they rarely lead to the "bamboo" spine, and remain isolated and asymmetric. Unilateral asymmetric distribution and separation from the lateral aspect of the vertebral bodies are the main radiological features which allow to distinguish psoriatic syndesmophytes from those of ankylosing spondylitis and spondylitis associated with inflammatory bowel diseases. The main radiological findings of psoriatic sacroiliitis, which may also occur in the absence of spondylitis are: erosions, which are more frequent on the iliac portion of the joint, osteosclerosis, joint space narrowing, and,
rarely, ankylosis. Interapophyseal joints of the cervical spine are frequently involved (in opposition to what happens in the thoracolumbar spine), and they may eventually become ankylosic, while anterior atlo-axial subluxation is much more rare.

**Reactive spondyloarthritis (Reiter's syndrome)**

The eponym Reiter’s syndrome indicates a clinical syndrome characterized by conjunctivitis, urethritis or gastroenteritis, followed by the onset of aseptic arthritis after an interval of 1-4 weeks. The term reactive arthritis is related to the pathogenetic theory of this SpA in which an infection of the conjunctival, intestinal or urethral-genital mucosa may represent the trigger for a systemic autoimmune reaction which determines an aseptic inflammatory process involving the axial skeleton or appendicular joints. The involvement of the appendicular skeleton is typically represented by asymmetrical oligoarthritis, often unilateral, which shows a predilection for the large synovial joints of the lower limbs. The involvement of the sacroiliac joints is frequent and has the same radiological features of psoriatic sacroiliitis. Also the spinal involvement, although rare, has features similar to those of psoriatic SpA. In fact, a typical early finding is represented by coarse syndesmophytes, which are not distinguishable from those of psoriasis and are located most frequently in correspondence to the lower three thoracic and the upper three lumbar vertebrae. The involvement of the interapophyseal joints is associated to erosions, osteosclerosis and ankylosis, but these findings are less frequent than those observed in ankylosing spondylitis.

**Enteropathic Spondyloarthritis (Enteroarthritis)**

Enteropathic SpA are related to ulcerative colitis and Crohn’s disease, of which are considered extraintestinal manifestations. Two types of arthritis have been described: the peripheral and the axial one. The peripheral arthritis is oligoarticular, asymmetrical, often transient and migratory; both large and small joints can be affected, most frequently in the lower limbs. With regard to the axial arthritis, the incidence of sacroiliitis varies from 10% to 20%, while that of spondylitis from 7% to 12%. It should be remembered that these values may underestimate the real incidence of the axial inflammatory involvement, which may have a subclinical course that eludes diagnosis, being masked by symptoms of bowel inflammation (Fig. 7). Radiological features of both spondylitis and sacroiliitis are closely similar to those of primitive ankylosing spondylitis.

**SAPHO Syndrome**

The acronym SAPHO was used to indicate the clinical association of synovitis, acne, pustulosis, hyperostosis and osteitis. According to the more widely accepted pathogenetic hypotheses, SAPHO syndrome has been considered a "reactive osteitis", which represents the consequence, in genetically predisposed individuals, of a nonspecific immune response, triggered by an infection. The bone involvement concerns
mainly the sterno-costo-clavicular region, the spine, and sacroiliac joints. In the early phase osteitis appears as focal osteosclerosis associated to erosive changes of the bone cortex and edematous thickening of the adjacent soft tissues. Subsequently, hyperostosis (diffuse osteosclerosis with increased bone volume) and synovitis may develop. The latter can be primary or secondary to the intra-articular extension of an adjacent osteitis. Synovitis appears more frequently in the sacroiliac joints, where the involvement is often unilateral, and in the sterno-cost-clavicular joints. It has been demonstrated a prevalent involvement of the anterior vertebral corners of the thoraco-lumbar spine (Fig. 8).

Images for this section:

**Fig. 1:** Radiographic and CT scoring of sacroiliitis by means of the New York modified criteria in four patients with ankylosing spondylitis. A AP radiograph of the sacroiliac joints presenting with typical definite bilateral sacroiliitis (grade 3) with diffuse subchondral sclerosis involving the iliac (antero-inferior) portion of both sacroiliac joints and widening of the joint space, which is particularly evident on the left side (arrows). B Axial CT scan shows bilateral sacroiliitis (grade 2) with gentle spongiosclerosis, which is more evident along the iliac side of sacroiliac joints (arrows). C Axial CT scan presenting with bilateral sacroiliitis (grade 3) with dense spongiosclerosis along the iliac side of sacroiliac joints (arrows) and some left-sided areas of erosions (arrowheads). D Axial CT scan
shows bilateral sacroiliitis (grade 4) which resulted in complete bony ankylosis and areas of sclerosis in region of merged sacroiliac joints.
Fig. 2: Sagittal T1-weighted fat-suppressed image of the lumbar spine in a 37-year-old man with primitive ankylosing spondylitis shows three signal alterations in correspondence to the anterosuperior corners of L4 and S1 vertebrae and at the posterosuperior corner of L5 vertebrae, which are called "shiny corners" (arrows). In this early stage conventional radiography appears usually normal. An older, inactive Romanus lesion is localized at the anterosuperior corner of L5 vertebra (arrowheads).
Fig. 3: Sagittal multiplanar reformatted CT image of the thoraco-lumbar spine in a 45-year-old patient with ankylosing spondylitis shows syndesmophytes and ossification of the anterior longitudinal ligament (arrows).
**Fig. 4:** Anteroposterior radiograph of the lumbar spine shows bridging syndesmophytes leads to the characteristic "bamboo" spine appearance (arrows).

![Anteroposterior radiograph of the lumbar spine](image1)

**Fig. 5:** Pathological vertebral fracture in a 56-year-old man with ankylosing spondylitis of 19-year duration after a minor trauma. A Sagittal multiplanar reformatted CT image and B corresponding coronal multiplanar reformatted CT image clearly define the through-and-through fractures (arrows) involving the anterior longitudinal ligament, the intervertebral space, the spinous processes, the inter- and sovraspinous ligaments. Note the ossification of interspinous and sovraspinous ligaments (arrowheads in A).
Fig. 6: Coronal multiplanar reformatted CT image of the lumbar spine in a 46-year-old woman with psoriatic spondyloarthritis shows non-marginal "bulky" syndesmophyte (parasyndesmophyte) which originates from the border of the vertebral body (arrowhead).
**Fig. 7:** A,B 50-year-old man with Crohn's disease and sacroiliitis. A axial CT image with bone window shows bilateral sacroiliitis (arrows), which is more evident at the right side. B Axial CT-enterography image shows thickening and mural stratification with mucosal enhancement of an ileal loop affected by Crohn's disease.

**Fig. 8:** A-E 23-year-old man with palmoplantar pustulosis and low-back pain. A Sagittal T1-weighted, B T2-weighted fat-suppressed, and C contrast-enhanced T1-weighted fat-suppressed MR images of the lumbar spine show signal alterations in correspondence to the anterosuperior corner of L4 and L5 vertebrae (arrows). The corner lesions are hypointense on the T1-weighted image, hyperintense on the T2-weighted fat-suppressed image, and show enhancement after the administration of contrast media. D Axial T2-weighted fat-suppressed MR image passing through L5 body confirms the corner lesion (arrowheads) and E the corresponding axial CT scan demonstrates the corner erosion of vertebral endplate surrounded by spongiosclerosis (arrowheads).
Conclusion

Bone marrow oedema, osteo-proliferative changes, erosions and osteo-sclerosis are the main radiological findings of SpA, and multimodal imaging allows a complete demonstration of the inflammatory lesions in their different stages of progression. The diagnosis of SpA and their treatment must be fast to avoid structural damage and functional impairment, and the role of MRI is particularly important for this purpose.

Radiologists, in order to have a correct diagnostic approach, have to know the patho-anatomical basis of radiological findings and the main systems of classification and scoring of musculoskeletal lesions.

References


Personal Information