Seminars in ULTRASOUND CT and MRI

# Cross-Sectional Imaging for Inflammatory Arthropathy of the Pelvis

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**Inflammatory arthropathy predominantly affecting the axial skeleton can cause pain, stiffness, disability, and ankylosis. This article discusses the use of cross-sectional imaging in the domain of inflammatory pelvic and axial arthropathy highlighting the key distinguishing features of common known diseases and their differential diagnoses.**
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## Introduction

Inflammatory arthropathy of the axial skeleton occurs in a variety of disorders, including rheumatoid arthritis (RA) and seronegative spondyloarthropathies. Axial spondyloarthropathy refers to a specific group of chronic inflammatory rheumatic diseases that predominantly affect the axial skeleton and are seronegative for rheumatoid factor. According to the European criteria, its subtypes include ankylosing spondylitis (AS), psoriatic arthritis, reactive arthritis, enteropathic arthritis, and undifferentiated spondyloarthritis.[1] These are characterized by inflammation and osteoproliferative changes, classically involving the spine and the sacroiliac joints (SI), leading to symptoms of inflammatory back pain and stiffness. Sacroiliitis, spondylitis, spondylodiscitis, and spondyloarthritis are the main inflammatory manifestations, whereas syndesmophytes and ankylosis of the vertebral column are related to new bone formation.[2] These diseases can lead to pain, dysfunction, and disability and constitute an important group in the differential diagnosis of chronic pelvic pain disorder.

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Imaging of the spine, pelvis, and hips plays an important role in the early diagnosis, classification, and monitoring of inflammatory axial arthropathy. The imaging modalities employed depend on clinical findings, disease duration, and suspicion for inflammatory vs infectious process as well as patient's age. When supporting clinical and laboratory findings are present, generally, positive findings on conventional radiographs are sufficient for identifying and quantifying structural changes in axial arthropathy.[3] These include blurring of the articular margins, subchondral sclerosis or erosions on one or both sides of the joint, and finally, ankylosis (Table 1). Early inflammation, however, is not well elucidated by radiographic methods. Magnetic resonance imaging (MRI), with this superb contrast resolution of soft tissues, is an effective modality for identifying and quantifying active inflammatory disease.[4,5] The emergence of anti-inflammatory biologics for the treatment of RA and seronegative spondyloarthropathies further highlights the importance of monitoring active inflammation.[6] Given the lack of reliable clinical and laboratory biomarkers, magnetic resonance (MR) has a pivotal role in early detection and monitoring of inflammation and aiding in guidance of treatment for the affected patients.[2] Recently, Xu et al showed than one-half to two-thirds of patients considered being in remission following treatment based on patient scores and laboratory parameters show subclinical inflammation on MRI.[7] Computed tomography (CT) is generally reserved for equivocal cases or in the postoperative setting. Ultrasound (US) is cheaper but operator-dependent modality. It is difficult to interrogate deep tissues using US; however, superficial enthesopathy sites can be assessed for active inflammation using color or power Doppler imaging.

The purpose of this article is to review the use of cross-sectional imaging of inflammatory arthropathy of the pelvis highlighting the key imaging findings. In addition, related differential diagnoses will be discussed.

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**Table 1** Diagnosis and Grading Sacroiliitis on Plain Radiographs According to the New York Criteria[3]

| Grade | Feature |
|---|---|
| 0 | Normal |
| I | Suspicious: joint margin blurring |
| II | Minimal sclerosis with some erosion |
| III | Definitive sclerosis on both sides of the joint. Severe erosions with widening of joint space ± ankylosis |
| IV | Complete ankylosis |

## Technical Considerations

CT and MRI are the most common cross-sectional modalities that are employed to evaluate spondyloarthropathies. However, unlike conventional radiographic survey, the examination is focused to a specific area of abnormality in the axial skeleton, for example, spine, SI joints, pelvis, or hips, due to limitations such as radiation, scan time, and costs. Benefits of cross-sectional imaging techniques over radiography include superior soft tissue contrast, improved spatial resolution, and assessment of vascularity and synovitis, the latter being a significant advantage over conventional radiographs given its ability to identify radiologically occult active disease process.

CT can also facilitate detection of incipient erosions, calcification, joint space loss, or intra-articular ankyloses. With contrast administration, CT can also help identify active inflammation or infection, especially in postoperative patients or when MR is contraindicated. CT imaging is currently acquired on multislice scanners with thin (0.5-0.65 mm) collimation and multiplanar reconstructions. If performed with contrast, the imaging is obtained in approximately 45-60 seconds delay to capture tissue enhancement. Dual-energy or spectral CT can be helpful in identifying mineral deposition, with different mono-energy settings able to assess mineral types for definitive diagnosis. In addition, improved image quality can be obtained in areas of beam hardening or metallic implants.[8]

MRI is the optimal technique for evaluation of soft tissues, bone marrow edema, synovitis, and vascularity. T1-weighted (T1W) images are useful for assessing bone erosions, sclerosis, osteophytes, avascular necrosis, and infection. Fat-suppressed fluid-sensitive sequences, such as short-tau inversion recovery or fat-saturated T2-weighted (FST2W), are useful for detection of bone marrow edema, fluid collections, synovitis, and intra-articular loose bodies. Noncontrast MRI is generally sufficient to identify bone marrow edema, erosion, and enthesitis. However, precontrast and postcontrast FST1W sequences help evaluate hyperemia, synovitis, periostitis, and aid in characterization of fluid collection and ganglia. 2D FST1W is adequate to demonstrate synovitis on 1.5 T imaging; however, multiplanar demonstration of enhancement increases the confidence and specificity. Therefore, 3D isotropic imaging is becoming more popular. On 3 T scanners, it is more time efficient to obtain isotropic 3D imaging and reconstruct the volume into thinner 2D slices. The latter avoids slice cross-talk and magnetization transfer effects. Diffusion-weighted imaging has been reported to detect active inflammation with similar sensitivity to postcontrast T1W images, with alteration of apparent diffusion coefficient values observed in active cellular hyperemia.[9,10] Simple edema or joint effusion without synovitis does not restrict diffusion to a significant degree. Active inflammation or bursitis restricts diffusion with increased signal on Diffusion-weighted imaging and correspondingly decreased apparent diffusion coefficient value. The chemical-shift–based modified Dixon sequences provide fat, water, in-phase and out-phase maps, with potential to provide information about hemosiderin (decreased signal on in-phase images) and fat deposition (decreased signal on out-of-phase images) in chronic inflammatory arthropathies.[11] High-field scanners (3.0 T) allow faster imaging in a large field of view while maintaining superior resolution. On these scanners, three-dimensional isotropic inversion recovery turbo spin echo imaging of the whole abdomen and pelvis can be performed in 7 minutes. This allows multiplanar imaging and excellent assessment of the lumbosacral and pelvic joints and related enthesopathy sites. Speed can also be traded for increased resolution in cases where detailed imaging of the joints is needed based on clinical suspicion. Hence, 3 T scanners are preferred for the evaluation of spondyloarthropathies.

## Imaging Considerations

Conventional radiographs of the SI joints and the spine are routine for screening and evaluating structural changes associated with axial spondyloarthropathy, and in combination with clinical findings, they are part of historical diagnostic and classification criteria.[3] Grading schemes for sacroiliitis range from 0-4 based on sclerosis, erosions, and ankyloses (Table 1). Owing to the anatomy of the SI joint, two-dimensional imaging may present difficulty in differentiation of ambiguous cases from degenerative changes. With multiplanar capability, CT is the gold standard for assessing structural changes in SI joints. Osteoproliferative changes including syndesmophytes, ligamentous ossification, and periarticular and intra-articular ankylosis are very well visualized owing to increased spatial resolution. MR may be of benefit when the diagnosis is in doubt, in particular, when structural damage is not apparent. MR findings of the SI joint arthritis (Table 2) and spondyloarthritis (Table 3) are important to know. As such, MR findings of active inflammation are now an integral component to the Assessment of Spondyloarthropathy International Society (ASAS) guidelines (Table 4).[6] These criteria are used in patients with back pain for greater than 3 months and age of onset less than 45 years, and have sensitivity and specificity of 83% and 84%, respectively.[6] A "positive MRI" for active sacroiliitis is defined by the presence of periarticular and subarticular bone marrow edema (Table 5).[5] These can be applied to any of the axial spondyloarthropathies.

## Spectrum of Axial Inflammatory Arthropathies

Further discussion will focus on the key clinical and imaging features of various axial inflammatory arthropathies involving pelvis and their related differential diagnoses.