

SACROILIITIS: IMAGING EVALUATION*

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Abstract Sacroiliitis is a non-infectious inflammatory process involving the sacroiliac joint, and is a diagnostic criterion for seronegative spondyloarthropathies. Imaging methods are of great value for confirming the diagnosis of this condition. The present study is a review of cases included in didactic files and in the literature to illustrate the anatomy, techniques, and main imaging findings in x-ray, computed tomography and magnetic resonance imaging for determining the diagnosis of sacroiliitis, also approaching main differential diagnoses. *Keywords:* Sacroiliitis; Spondyloarthropathy; X-ray; Computed tomography; Magnetic resonance imaging.

Resumo *Sacroilite: avaliação por imagem.*

Sacroilite é o processo inflamatório não-infeccioso das articulações sacroilíacas, sendo critério diagnóstico das espondiloartropatias soronegativas. O diagnóstico desta enfermidade requer confirmação pelos métodos de imagem. O presente trabalho faz um revisão de casos do arquivo didático e de artigos da literatura para ilustrar a anatomia, a técnica e os principais achados de imagem na radiografia, tomografia computadorizada e ressonância magnética, na determinação do diagnóstico de sacroilite, abordando inclusive os seus principais diagnóstico diferenciais.

Unitermos: Sacroilite; Espondiloartropatia; Raio-X; Tomografia computadorizada; Ressonância magnética.

INTRODUCTION

The sacroiliac joints are frequent sites of lumbar pain or lumbosciatalgia commonly seen in the clinical daily practice, a non-infectious inflammatory process — sacroiliitis — being the most frequent cause of disease in this topography⁽¹⁾.

Seronegative spondyloarthropathies are basically subdivided and differentiated by their clinical features, and are classified into five different entities: ankylosing spondylitis, reactive arthritis, psoriatic arthritis, arthritis related with chronic inflammatory disease and undifferentiated spondyloarthropathy. The inflammatory involvement of sacroiliac joints is a criterion for diagnosis of these diseases⁽¹⁻³⁾.

Most frequently, spondyloarthropathies occur in young patients, the early diagnosis being critical for establishment of an appropriate therapy aiming at improving prognosis and working capacity of the patients⁽³⁾.

Most of times, the clinical diagnosis of sacroiliitis is difficult, depending substantially on the confirmation of radiological findings, where conventional x-ray, and currently, computerized tomography (CT) and magnetic resonance imaging (MRI) assume an essential role⁽⁴⁻⁶⁾.

The objective of the present study was to review and demonstrate the main aspects in sacroiliac joints imaging evaluation, especially on CT and MRI.

MATERIALS AND METHODS

Twenty-five cases with different imaging studies for sacroiliac joints evaluation have been retrospectively selected from the files of Clínicas da Imagem e Multimagem, Goiânia, GO, Brazil, aiming at didactically illustrating the anatomy, technique and findings of the main conditions affecting these joints. The studies were performed in equipment of different brands.

X-rays images were obtained in antero-posterior views with caudal and oblique inclinations. The current protocol for CT

studies consists of axial and coronal oblique images acquisition in 3.0 mm-thick slices, guided by digital radiography, without contrast agent injection (Figure 1).

The protocol for MRI also consists of axial and coronal oblique views in 4.0 mm-thick slices, with narrow view field (20–24 cm) and 256 × 512 matrix, in T1, T2-weighted and STIR sequences. Later, T1-weighted sequences with fat saturation are performed, before and after gadolinium injection (Figure 2).

It was not a purpose of this study a systematic analysis of each case separately.

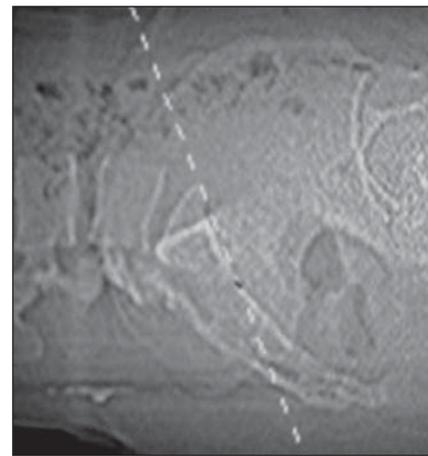


Figure 1. Digital radiography: lateral view demonstrating the ideal plane for coronal-oblique slices on CT.

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Received March 4, 2005. Accepted after revision May 2, 2005.

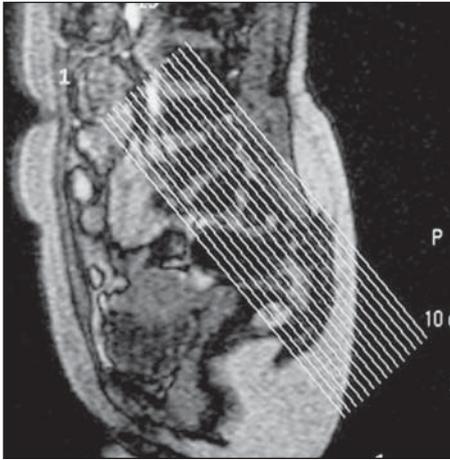


Figure 2

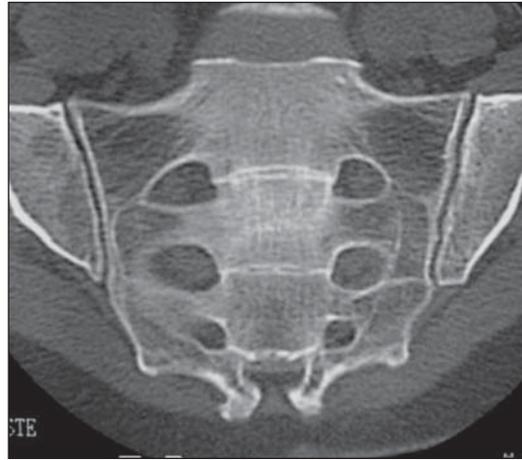


Figure 3

Figure 2. Survey on sagittal plane showing the schedule for MRI coronal oblique plane views.

Figure 3. CT coronal oblique view showing preserved and symmetrical joint spaces, with regular surfaces. The joint space is considered as normal between 2.0 and 4.0 mm.

DISCUSSION

The sacroiliac joint presents a complex two-compartment anatomy. The synovial portion of the sacroiliac joint is vertically oriented, while the ligamentous portion presents horizontal-oblique orientation^(4,5). Puhakka et al. have demonstrated that, histologically, the synovial portion is a symphysis with some characteristics of a synovial joint being confined to the distal cartilaginous portion at the iliac side⁽⁷⁾.

Several studies indicate that the vertical synovial tissue is better demonstrated by coronal, oblique views^(1,4-6). Puhakka et al. have demonstrated that axial, oblique views provide a better visualization of the two-compartment anatomy of this joint, as well as of some anatomic variations, facilitating the interpretation of imaging findings⁽⁷⁾.

The normal joint space of the sacroiliac joint measures 2.5–4.0 mm (mean = 3.0 mm)^(4,5) (Figure 3).

Conventional x-ray still remains as the imaging method most utilized in the clinical practice. An international consensus still remains to be reached regarding the best technique and view for radiographic evaluation of the sacroiliac joint. Anteroposterior views with 25–30° caudal angulation of the x-ray tube, and oblique views are the most utilized in our practice, in an attempt to minimize structures overlapping, so facilitating the study interpretation^(1,6).

The main limitation of the x-ray film is the low sensitivity for detecting abnormalities in the early stages of the disease. Radiographic signs in sacroiliitis appear only

three to seven years after the initial symptoms onset, presenting with alterations only in the chronic phase of the disease^(1,2,8).

The main radiographic signs are: bone erosions, joint space alterations, subchondral sclerosis and ankylosis^(6,8-11).

Assessing a patient with suspected sacroiliitis, we may classify the sacroiliac joint into five radiographic grades (modified New York criterion): 0 – normal; 1 – suspect, although unclear alterations; 2 – minimal erosions and sclerosis, but without joint space alteration; 3 – erosions and sclerosis, with widening or narrowing of the joint space; 4 – ankylosis^(1,6,9,10) (Figure 4).

Scintigraphy presents high sensitivity for sacroiliitis, but specificity is low. This study must be interpreted in combination with other radiological study, and is of higher value in cases of unilateral alterations. The most significant indication would be for localizing another disease as a cause of lumbar pain^(1,6,8).

Imaging methods like CT and MRI are extremely useful, especially in the absence of alterations, or when they are minimal on plain x-ray (grades 0 to 2)⁽¹⁾.

The evaluation of sacroiliitis by CT, in comparison with the conventional x-ray, has shown to be more sensitive, with a better and earlier detection of bone alterations, principally because of its capability to perform sequential slices, so avoiding structures overlapping^(6,7,9,10,12).

The CT shows higher sensitivity for detecting minimal bone erosions and joint space narrowing, however presents the same diagnostic capacity of plain x-rays in

cases of ankylosis⁽²⁾. Lawson et al. have not found any abnormality on x-ray films that were not defined by CT⁽⁵⁾.

The most frequent findings of sacroiliitis on CT are: joint space narrowing, subchondral sclerosis, bone erosions and ankylosis. Joint space narrowing is characterized by a thickness of less than 2.0 mm in synovial tissues (Figure 5). Subchondral sclerosis is found in the presence of an asymmetrical or focal area with increased density (> 5.0 mm on the iliac side, and > 3.0 mm on the sacral side) (Figure 6). Bone erosions are small cortical defects on the synovial portion of the joint (Figure 7). These two latter findings can be seen in both sides of the joint, however, they are frequently seen at the iliac side because this side presents lower thickness and some cartilaginous clefts. The focal or complete fusion of the joint characterizes ankylosis observed in more advanced stages of the disease^(4,5) (Figure 8).

Alterations in the ligamentous portion are rare, when compared with the synovial portions. CT is better than MRI for detecting bone formation in the entheses of this topography⁽³⁾.

CT is comparable to MRI for detecting bone erosion, but is superior for evaluating bone sclerosis and ankylosis, and is indicated especially for detecting chronic alterations⁽¹⁾.

CT is a method of excellence in demonstrating bone details, besides serving as a guidance tool in percutaneous biopsies, arthrocentesis, and for intra-articular injection of steroids^(6,11,12).

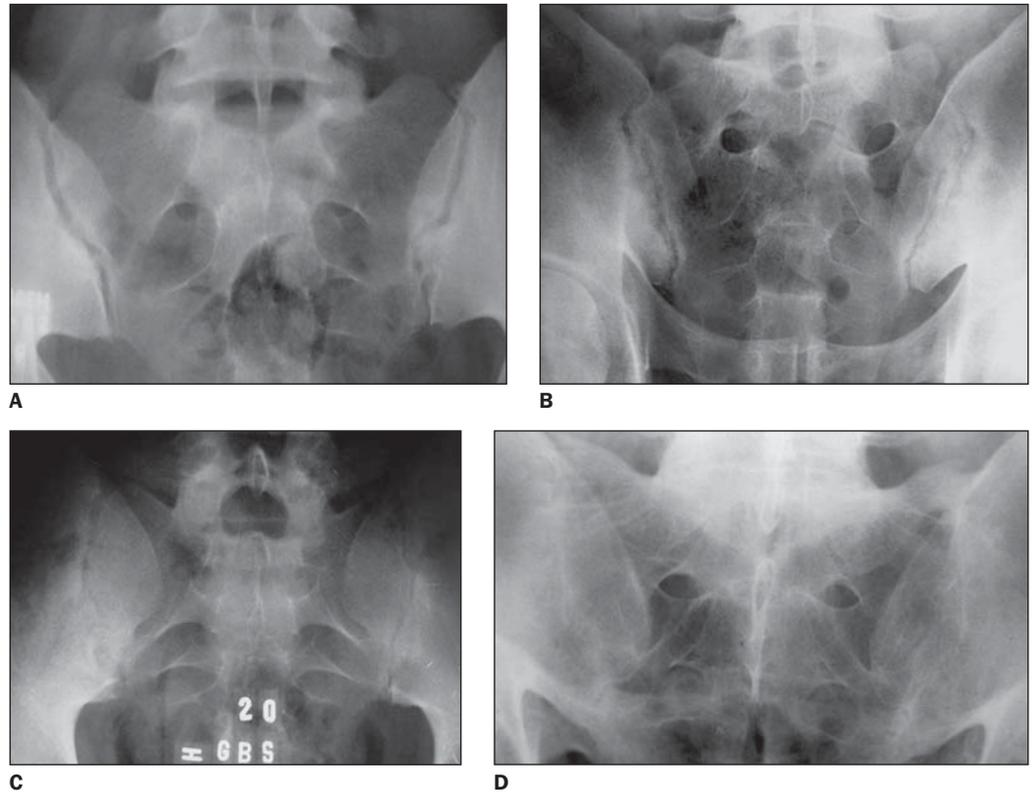


Figure 4. Radiographic classification in the evaluation of sacroiliac joints. Grade 0 – normal (A); grade I – suspicious; grade II – mild irregularity and sclerosis of articular surfaces, with preserved joint space (B); grade III – joint space narrowing, besides intense irregularity and subchondral sclerosis (C); grade IV – bilateral ankylosis (D).

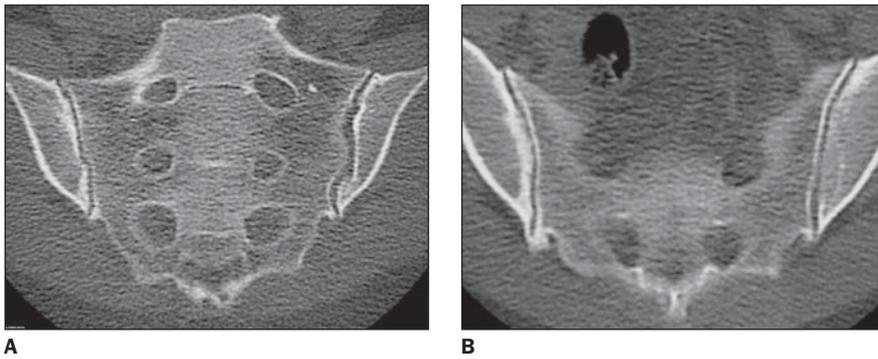


Figure 5. Tomographic cuts – coronal oblique plane demonstrating joint space narrowing at right, and preserve at left. Also, subchondral sclerosis is observed at right, more evident in the iliac portion.



Figure 6. Tomographic cuts – coronal oblique plane demonstrating irregularity and sclerosis of articular surfaces, predominating in the iliac bone.

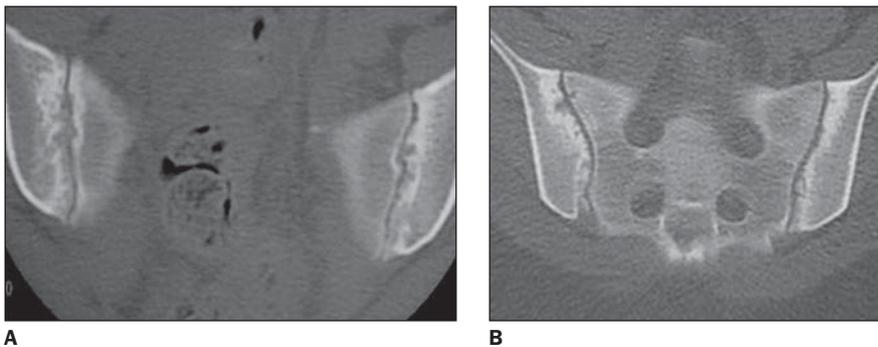


Figure 7. Tomographic cuts – axial view (A) and coronal view (B) showing marginal, bilateral erosions and subchondral sclerosis.



Figure 8. Tomographic cuts – coronal oblique plane demonstrating bilateral, partial fusion.

On the other hand, sacroiliac evaluations by CT presents some inconveniences like radiation exposure, and incapacity to show alterations in the acute phase, identifying especially the inflammation consequences rather than the inflammatory process activity^(2,6,8-10).

Elgafy et al. have demonstrated lower sensitivity and specificity of CT in the evaluation of patients with suspected pain in the sacroiliac joint, since asymptomatic patients, especially the oldest ones, present some findings similar to those of sacroiliitis, like marginal osteophytes and subchondral sclerosis⁽⁴⁾ (Figure 9).

MRI has been suggested as a method of choice in the evaluation of sacroiliitis, because of the higher quality of the images, absence of ionizing radiation, and mainly the capacity of detecting and differentiating acute and chronic alterations^(2,6,8-11).

Structures comprising the sacroiliac joint are better demonstrated by MRI, and

are seen as follows: 1) cartilage – a thin zone of intermediary signal on T1- and low signal on T2-weighted sequences, with high signal on T1-weighted, fat-saturated sequences; 2) subchondral cortex – linear zone with signal void on T1- and T2-weighted sequences, is better seen on T1-weighted, fat saturated sequences; 3) subchondral medullary – homogeneous, intermediary signal on T1- and T2-weighted, and low signal on fat-saturated and STIR sequences; 4) absence of bone marrow uptake after intravenous contrast injection (gadolinium)^(2,4,7) (Figure 10).

Main alterations seen on MRI of patients with sacroiliitis are^(2,6,8-11) (Table 1):

a) Interarticular fluid collection – is better seen on T2, mainly on T2-weighted, fat-saturated and STIR sequences (Figure 11);

b) replacement of articular cartilage by pannus (synovial proliferation), resulting in heterogeneous signal, with areas of focal thickening with hypersignal on T2-

Table 1 Findings of sacroiliitis on MRI.

<i>Acute phase</i>
– Intra-articular fluid
– Subchondral bone marrow edema
– Articular and periarticular post-gadolinium enhancement
– Soft tissues edema
<i>Chronic phase</i>
– Periarticular bone marrow reconversion
– Replacement of articular cartilage by <i>pannus</i>
– Bone erosion
– Subchondral sclerosis
– Joint space widening or narrowing
– Ankylosis

weighted sequences and contrast uptake (Figure 12);

c) cortical bone erosions represented by foci with high intensity or intermediary signal on T1- and T2-weighted sequences in sacral or iliac cortical bones, with marginal irregularity and deeper defects, also affecting the adjacent bone marrow. These erosions are better demonstrated on T1-weighted fat-saturated sequences;

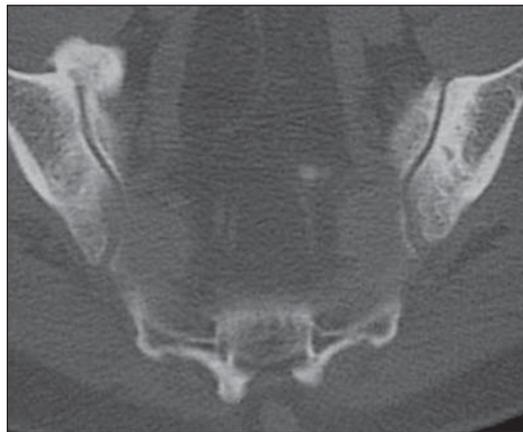


Figure 9. Tomographic cuts – coronal oblique plane demonstrating anterior marginal osteophytes, predominating at right, besides subchondral sclerosis at left. Frequent findings in asymptomatic elders.



Figure 10. MRI coronal oblique views, T2- and T1-weighted, fat-saturated sequences after contrast injection. Normal aspect – absence of paramagnetic contrast enhancement.

Figure 11. MRI coronal oblique views, STIR sequence showing intense bilateral subchondral edema (hypersignal).

d) subchondral sclerosis characterized by zones with low-intensity signal on T1- and T2-weighted images;

e) subchondral bone marrow edema characterized by low-intensity signal on T1- and high-intensity signal on T2-, especially the T2-weighted fat-saturated and STIR sequences. On T1-weighted fat-saturated sequences, after intravenous gadolinium injection, a significant enhancement of sacroiliac joint and surrounding bone marrow can be observed, and this finding is highly suggestive of an active disease (Figure 12);

f) signs of focal or diffuse, periarticular in chronic phases, bone marrow reconversion (fat collection) (Figure 13);

g) bone ankylosis represented by low-intensity signal through the sacroiliac joint, permeated by areas of intermediary sign representing bone marrow.

In 1990, Ahlström et al.⁽¹³⁾ described two types of lesions identified by MRI.

Type I lesions were characterized by low-intensity on T1-weighted, and high-intensity signals on T2-weighted sequences and on images acquired after gadolinium injection. Type II lesions were characterized by low-intensity signal in all of the sequences. This observation has suggested that MRI is able to differentiate lesions with high hydric contents (inflammatory edema) from those with fibrous tissue or sclerosis, i.e., differentiating acute from chronic alterations. Type II lesions are associated with fat collections⁽¹³⁾.

The study developed by Hanly et al.⁽⁹⁾ has proposed that subchondral bone marrow edema is the earliest manifestation of the acute sacroiliitis, since 57% of their patients with subchondral bone edema did not present any sign of articular cartilaginous alteration. This theory is histopathologically corroborated by another study, by means of open biopsy in patients with initial stage of disease, where the earliest find-

ing was subchondral inflammation. The sequence with highest sensitivity and specificity in detecting periarticular bone marrow edema is the STIR sequence, since, differently from the conventional T2-weighted spin-echo sequence, it saturates de fat, differentiating it from fluid^(6,8,12).

The limitation of this finding — subchondral bone marrow edema — is that it also occurs in early phases of the degenerative process resulting from vascularization of fibrous tissue. For differentiating them, it is important to observe the site of the edema, i.e., hypersignal on the synovial portion of the sacroiliac joint indicates inflammatory disease, and, on the ligamentous portion, indicates degenerative disease⁽⁸⁾.

The use of dynamic post-contrast sequence in the evaluation of inflammatory processes has been reported in several studies, but this has not been easily done in the daily practice⁽³⁾.

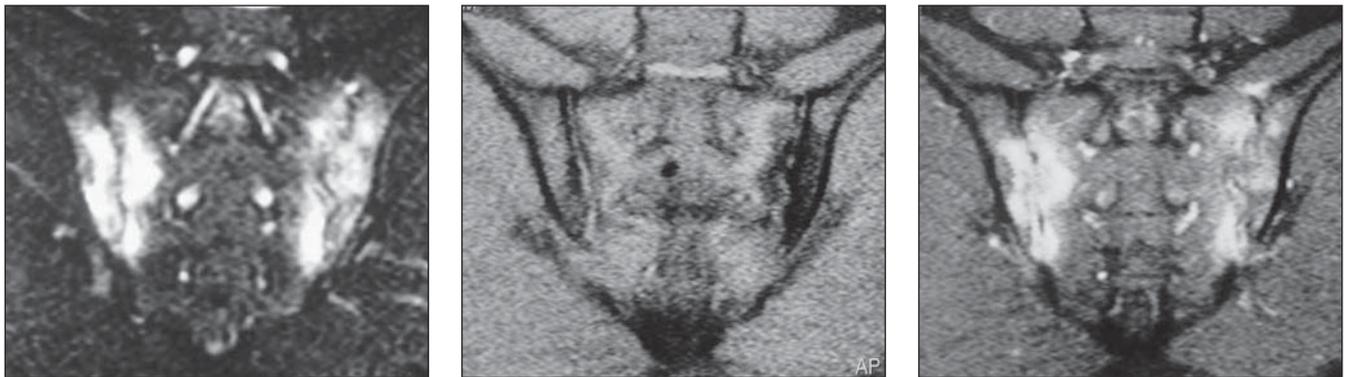


Figure 12. MRI coronal oblique views STIR (A) and T1-weighted fat-saturated sequences, before and after gadolinium injection (B,C) showing intense subchondral edema (hypersignal on STIR), as well as accentuated contrast enhancement. Also, joint space narrowing, contours irregularities and marginal erosions are observed.



Figure 13. MRI coronal oblique views T1-weighted (A) and T1-weighted fat-saturated sequences (B) demonstrating yellow bone marrow collection (fat) in subchondral bone, more evident at left (hypersignal on T1), with signal loss in the fat-saturated sequence.

Puhakka et al. have demonstrated some anatomical variations, like synovial recesses, bony and cartilage clefts, situated in the transition between the two proximal one-thirds and the distal one-third of the dorsal aspect of the iliac side of the joint that may mimic bone erosion, contrast-enhancement on the ligamentous portions as a result of the intense vascularization, and fat infiltration of the sacral bone marrow without pathological significance⁽⁷⁾.

Oostveen et al. have demonstrated a 60% positive predictive value of MRI for sacroiliitis development after three years, with 85% sensitivity and 47% specificity⁽¹⁴⁾. On the other hand, Battafarano et al. have demonstrated high MRI sensitivity and specificity (100%) for type I alterations, and, respectively 69% and 46%, in the evaluation of type II alterations.

The main disadvantages of MRI are: high cost, low availability, and long duration of examination (30 minutes), although the latter is well tolerated by the majority

of patients, in pediatric examinations included^(1,2,6,11).

DIFFERENTIAL DIAGNOSES

The main differential radiographic diagnosis of sacroiliitis is condensing iliac osteitis, that usually presents bilaterally and symmetrically in female, asymptomatic patients, manifesting on images as sclerosis of the ventro-caudal portions of the sacroiliac joint⁽¹⁴⁾ (Figure 14).

Other relevant differential radiographic diagnoses include metabolic diseases like hyperparathyroidism and gout. Usually, in cases of hyperparathyroidism the condition manifests bilaterally and symmetrically, either in its primary form or in its secondary forma (renal osteodystrophy), characterized by subchondral bone reabsorption with irregularity on the bone surface, sometimes with adjacent sclerosis and widening of the joint space. In cases of chronic tophaceous gout, the condition may mani-

fest symmetrically or asymmetrically, sometimes unilateral, characterized by large, destructive erosion with a sclerotic halo, but with preserved joint space⁽¹⁵⁾.

In the evaluation of the sacroiliac joint, the patient's age should be taken into consideration, since osteoarthritis is frequent in elder, asymptomatic patients. These alterations are characterized by marginal osteophytes, subchondral sclerosis, and eventually articular fusion^(1,3) (Figure 15). Erosion, subchondral cysts and ankylosis are rarely seen in the degenerative process⁽⁴⁾. Early in the initial phase of the process, periarticular subchondral bone marrow edema can be seen representing fibrous, vascularized tissue⁽⁸⁾. Fat deposition also may be seen in normal elder individuals, and in patients with degenerative disease⁽¹⁶⁾ (Figure 16).

Other important differential diagnosis is infectious sacroiliitis, particularly the pyogenic type. Infectious sacroiliitis is quite rare, prevailing in injectable drugs users and in individuals with skin, pulmonary and genitourinary infections, and have as its most frequent etiologic agent the *Staphylococcus aureus*. The diagnosis of infectious sacroiliitis is difficult, many times delayed because of its insidious clinical presentation with non-specific and poorly localized signs, frequently simulating abdominal syndromes, lumbar discopathies or lumbosciatalgia. CT and MRI allow an earlier diagnosis, but are not able to define the etiologic agent. Generally, radiographic alterations can be observed only two or three weeks after the first symptoms onset, while on contrast-enhanced MRI, alterations can be observed

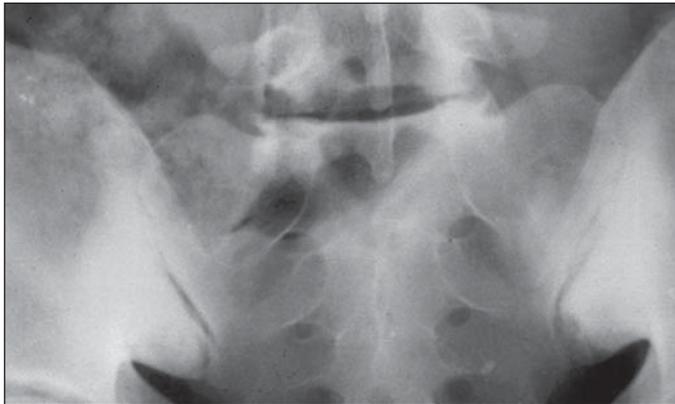


Figure 14. X-ray film showing sclerosis in the ventro-caudal portions of iliac bones in female, asymptomatic patient, characterizing condensing iliac osteitis. Note that joint spaces are normal.

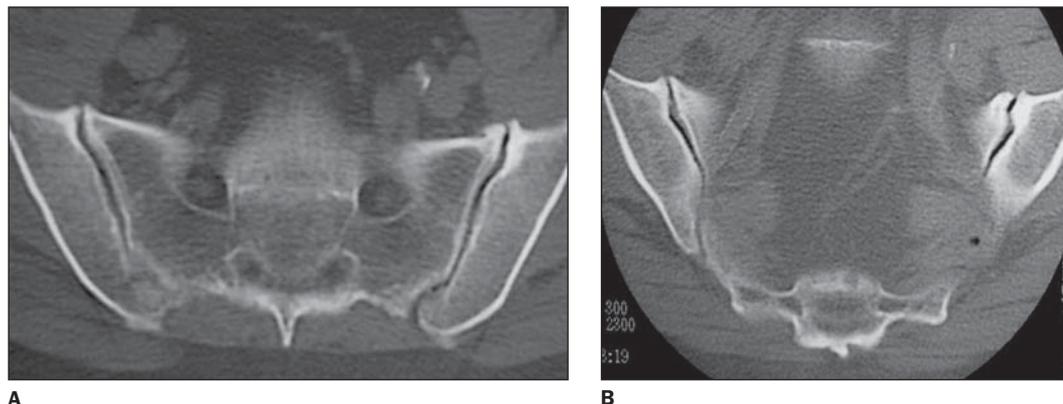


Figure 15. Tomographic cuts – axial and coronal planes. Osteoarthritis – anterior osteophytes with mild subchondral sclerosis. Also, note bilateral vacuum phenomenon.

Figure 16. Elder patient with back pain. MRI coronal oblique views, T1 (A) and T1-weighted, fat-saturated sequences (B) showing diffuse bone marrow reconversion (hypersignal on T1), with signal loss in the fat-saturated sequence.

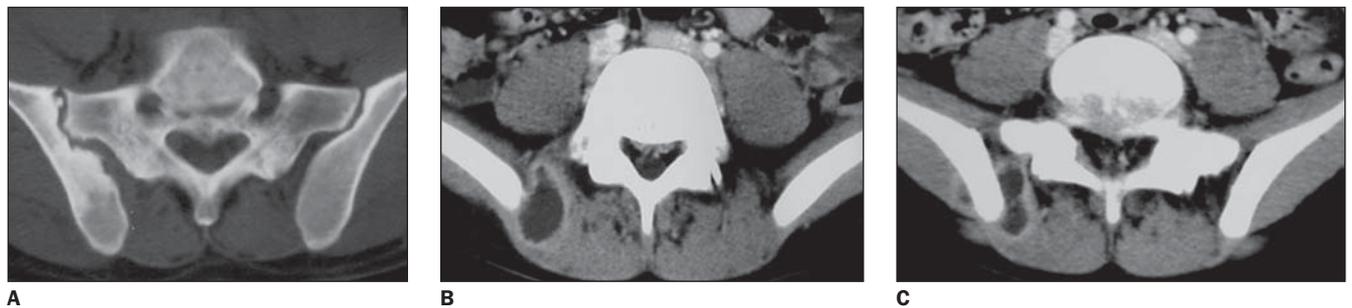
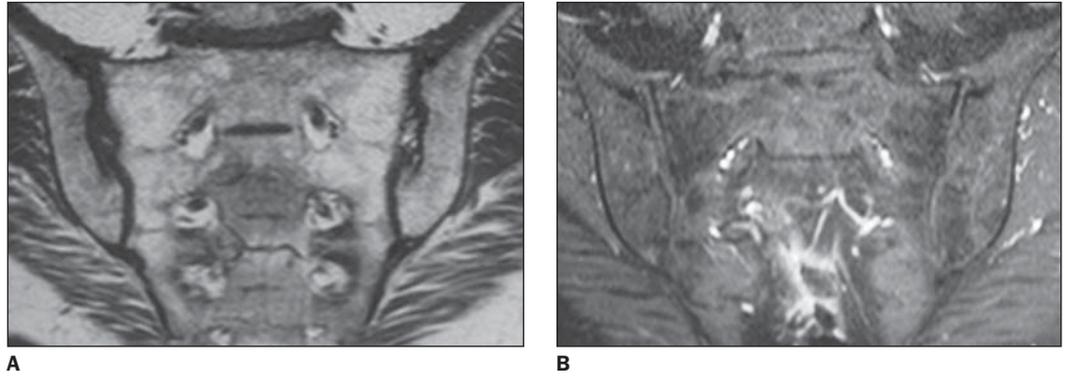


Figure 17. Tomographic cuts – Axial view, non-contrast enhanced on the bone window (A) and after contrast agent injection, on the soft tissue window (B,C). Infectious sacroiliitis – unilateral lesion characterized by accentuated irregularity and sclerosis of articular surfaces, besides periarticular abscess.

within up to three days, showing MRI higher sensitivity^(2,6,15).

CT findings in the infectious process are the same of those observed in the sacroiliitis of spondyloarthropathies, except for the juxtarticular bone demineralization, considered as the earliest finding, besides signs suggestive of soft tissues involvement and unilaterality of the process⁽¹²⁾. MRI, besides determining alterations in the affected sacroiliac joint and in the contiguous bone, also clearly demonstrates the involvement of adjacent soft tissues or collections, frequently posteriorly to the iliopsoas muscle, these findings being highly suggestive of infectious involvement, and not seen in spondyloarthropathies^(6,12,13,15,16). The intravenous gadolinium injection can more accurately define these soft tissues involvement^(12,13,16) (Figures 17 and 18).

CONCLUSION

The conventional x-ray remains as the method of choice in the primary evaluation and follow-up of patients with sacroiliitis. The MRI plays an essential role in better

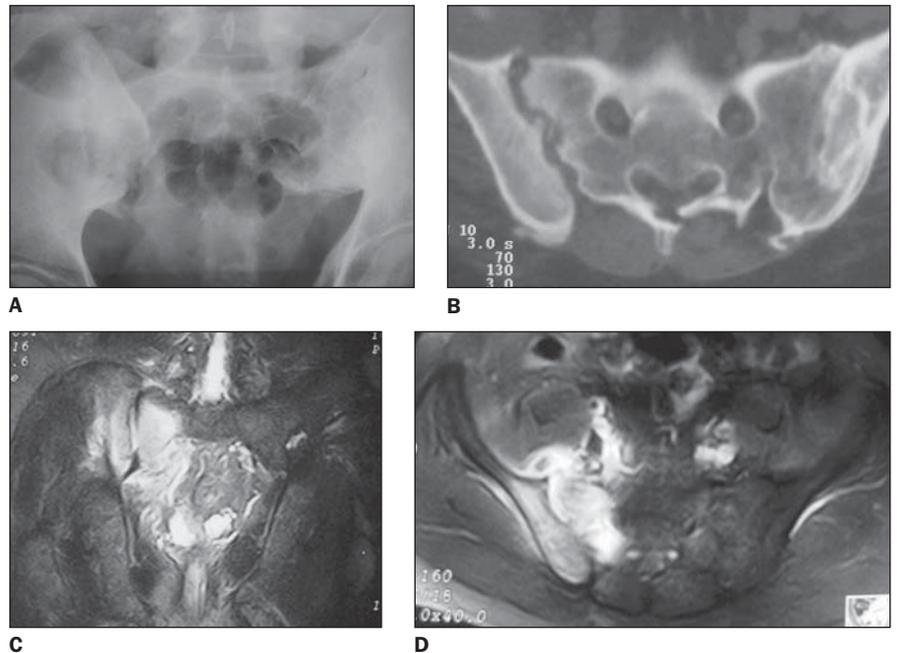


Figure 18. Plain x-ray (A), axial CT view (B), coronal MRI view, STIR (C) and axial MRI view, T1-weighted, fat-saturated sequence after contrast injection (D). Right infectious sacroiliitis – accentuated irregularity of articular surfaces, joint space widening, intense subchondral edema (hypersignal on STIR) and accentuated contrast-enhancement including adjacent soft tissues. Signs of traumatic at left.

demonstrating early alterations and inflammatory activity of this process. On the other hand, CT is superior in quantifying chronic alterations.

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