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ANKYLOSING SPONDYLOARTHRITIS: REVIEW OF IMAGING FINDINGS IN THE SPINE

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Abstract

Introduction: Ankylosing spondyloarthritis (AS) is one of the most important of seronegative spondyloarthropathy, which has certain characteristics of chronic back pain due to chronic inflammation of the axial skeleton accompanied with progressive stiffness, these symptoms appear between 20 and 30 years of age in young patients, this disease linked to human leukocyte antigen B-27 (HLA B-27). for proper management of these cases it need current imaging techniques. To assess ankylosing spondylitis by radiologist, he needs to recognize classic imaging findings and its complications

Objectives: To present review of different findings of spinal imaging in patients with AS.

Methods and materials: An analysis will be made through different findings of conventional radiography, CT and MRI in multiple patients.

Results: different representative findings, complications, differential diagnoses, radiological key points will be shown. **Conclusion:** AS is characterized by typical MR manifestations, However, these are not specific and can be seen in multiple other spinal pathologies.

Keywords: Spondyloarthritis, Imaging, Spine.

Introduction

Ankylosing spondylitis (AS) is an arthropathy that is found within the group of seronegative arthropathies (with negative rheumatoid antigen), being the most common and representative entity of them. It is characterized by chronic inflammation of the axial skeleton, with back pain of the inflammatory and progressive stiffness, which may also involve hips, shoulders, peripheral joints, and entheses (corresponding to sites of attachment of ligaments, muscles, fasciae or capsules in a bone segment) Typically manifests in young patients who start their symptoms between the ages of 20 and 30, they generally have a good response to anti-inflammatory drugs, no steroids (1). Regarding the predilection for sexes, there is great disparity of data, however, an H: M ratio of 2:1 (2) is usually found.

The term spondylitis refers to inflammation of the vertebra or "spondyles" and ankylosing refers to compromise fibrotic or with ossifications that form joints between joints of the spine, both facet joints as intervertebral discs(3) . These unions in the beginning are affected by a subacute inflammatory process or chronic, with adjacent edema. Later, the injuries erosions become inactive and formation of bone tissue, which fills the eroded space and forms bridges between bones and towards the end of the affected ligament, creating a new enthesis.

These new entheses have a high metabolic activity, with abundant nerve endings and are responsible for characteristic symptoms inflammatory(4) . The disease is strongly linked to the leukocyte antigen human B-27 (HLA B-27), with a prevalence of 5-15% in patients with positive HLA B-27, who have a risk 20 times higher than population without this antigen. In Latin America the prevalence of AD

is close to 10 / 10,000 inhabitants(2,5) . Its diagnosis is based on the characteristic symptoms of inflammatory back pain, in younger patients age 40, ˜ detection of HLA B-27 and phase reactants elevated acute (CRP, HSV), associated with radiological findings of sacroiliitis and characteristic manifestations in spine.

The treatment of this pathology has been developing over time, with NSAIDs at maximum dose such as drugs first-line and physical therapy (initial therapy), and in if they do not respond, inhibitor drugs can be used TNF alpha, which have shown therapeutic success, especially in early stages, so the diagnosis early stage of these pathologies is imperative(6) . Many different inflammatory lesions on the spine vertebral can occur in AD.

Commitment can be bone, disc, synovial joints and / or entheses. Spinal injuries ultimately lead to to the formation of syndesmophytes and ankylosis. Current images play a fundamental role in the evaluation, both at the level of the sacroiliac joints, as in the spine1. A suitable protocol for its detection it is of utmost importance to differentiate these injuries and thus investigate this pathology in time. This manuscript focuses primarily on the findings imaging of AD in the spine.

Results: Imaging manifestations:

Radiography conventional, CT and MRI Anterior, posterior, and "square" spondylitis vertebral body The initial structural alterations of AD were described by Romanus and identified on radiographs those that consisted of erosions that involved the front and rear edges of the platforms vertebral bodies, known as Romanus lesions. The condition associated pathological is in relation to the epiphyseal ring in young patients (understood as the ridge or osseous labrum where the fibers of the fibrous ring are inserted) (9) that in adults is fused to the vertebral body. MRI allows detection of Romanus lesions in up to 67% of patients with spondyloarthritis, and its specificity and sensitivity increase in the absence of nodules Schmorl, osteophytes, and in patients under 40 years of age. (10) . These lesions can be detected both in the early stages as late. In the active stage, these lesions are seen as a lower signal focus ˜ at T1 at the edge of platforms vertebral bodies with increased signal ˜ in STIR and enhancement with intravenous contrast medium, representing in joint bone edema or osteitis (Fig. 1). It is called anterior or posterior depending on its location in the vertebral body, or marginal spondylitis. As already mentioned, these alterations occur exactly at the insertion site of the fibrous disc annulus in the vertebral platform, forming an enthesis, that is, union between ligament and bone, and therefore its inflammation will be called enthesitis. In late stages, the compromised edge presents a hyperintensity in T1, with areas of fatty degeneration of the bone marrow. Only at this stage the alteration known as shiny corners in conventional radiography (described below), after a chronic course of inflammation(1,5).

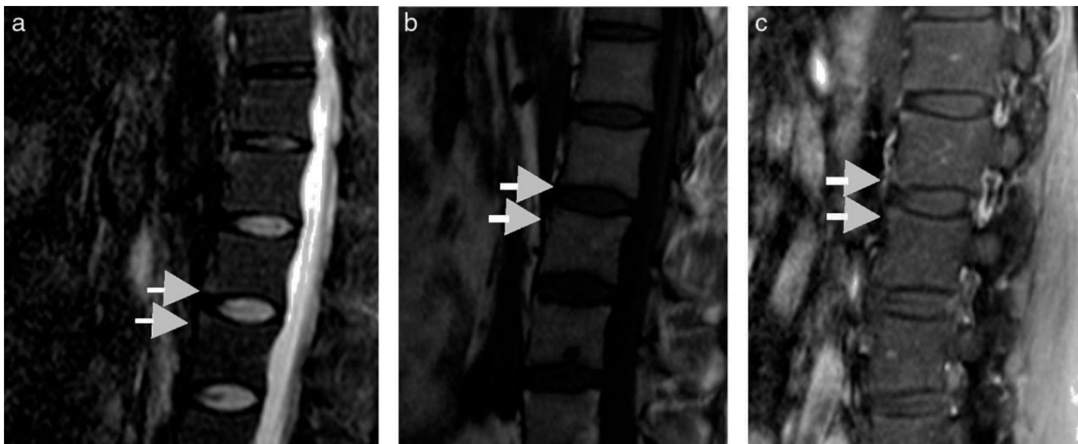

Figure 1 MRI. Very initial and subtle Romanus lesion on the anterior margins of the lumbar vertebral bodies. In the first image (a), indicated by white arrowheads, a STIR sequence is shown, small ˜ hyperintense borders, representing edema in anterior aspects of multiple lumbar vertebrae, which correspond to the images on the right: a T1 without contrast (b), where slight hypointensities are observed and enhancement with the use of contrast medium in T1 fat sat sequence (c)

In conventional radiology, AD in its earliest form It appears as a squaring of the bodies veins, which is evident in the lateral projection of column (fig. 2). This vertebral configuration is due to partly to the presence of syndesmophytes, which correspond to calcifications or heterotopic ossifications of ligaments or fibers from the annulus fibrosus that "fill in" the concavity normal anterior vertebral body. On the other hand, the presence of enthesitis and subsequent sclerosis is called a «sign from the shiny edge »or shiny corner sign or Romanus lesion; they also contribute to vertebral quadrature (Fig. 3). Fat infiltration at the edges of vertebral bodies indicates areas of previous inflammation. There are studies that suggest that these fatty deposits guide the diagnosis of spondyloarthritis when observe 5 or more of them(1)

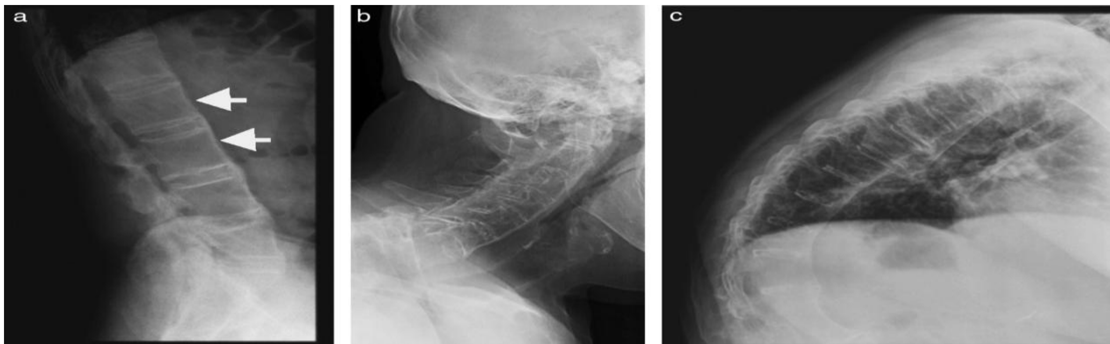

Figure 2 Lateral projections of spinal radiographs from the same patient. Left (a): quadrature of the vertebral bodies of the lumbar spine, with loss of its normal anterior concavity (arrows). On the right (b and c) the same phenomenon, determined by syndesmophytes.

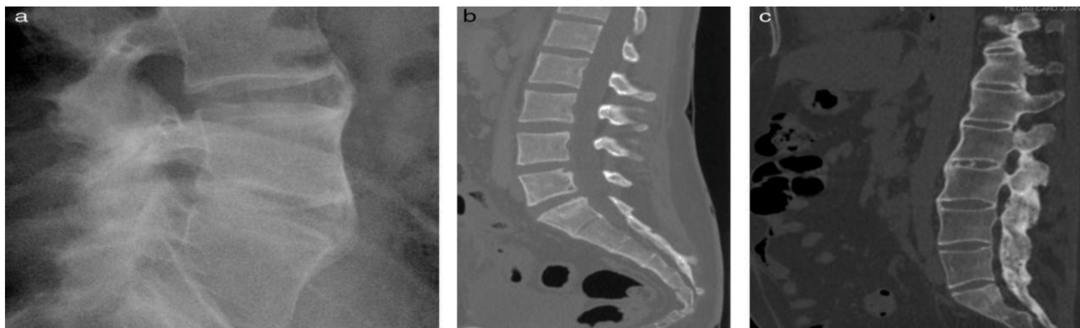

Figure 3 Lateral projection of the enlarged lumbar spine (a) and sagittal CT cuts in the bone window (b and c), where it is shown the sign of "shiny edges" or shiny corners

Spondylodiscitis

Inflammation of the intervertebral disc is known with Andersson's injury, who first described it in 1937. This aseptic inflammation occurs in approximately 8% of patients with AD detected by radiography. The MRI gives a much earlier and accurate view of these lesions, which are present in 33% of cases, possessing a specificity of 59% (10) . On MRI these lesions present alteration of the disc signal ˜ and decreased its height, in addition to signal alteration ˜ on one or 2 platforms vertebral bodies that make up the vertebral disc unit, appearing hyperintense in STIR and hypointense in T1, presenting a hemisphere shape (figs. 1 and 4). In phases early, hyperintense lines can be seen in sequential

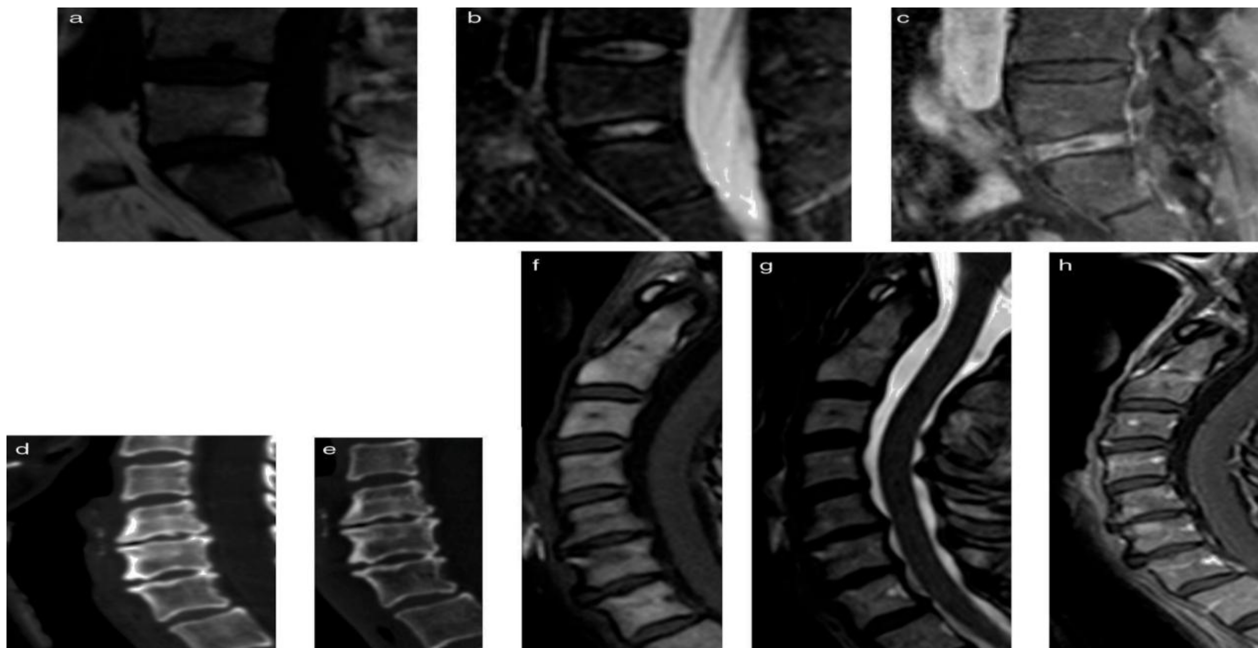

Figure 4 Andersson lesion at the lumbar and cervical level of 2 different patients. The images (a-c) are selected MRI slices of the lumbar spine showing signs of osteitis previously described in platforms adjacent to the disc L5-S1, in addition to peripheral disc enhancement, without soft tissue component or sequential collections with intravenous gadolinium. Note that the L4-L5 disc does not show the signs of osteitis or disc enhancement. Note that there is no commitment from other platforms contiguous discs. The images (d-h) are selected cervical spine MRI sections demonstrating the same phenomenon. Note increased bone density in cervical platforms adjacent to the affected disc and signs of osteitis on MRI, with decreased height of affected disc (second disc shown from top to bottom, level C5-C6).

Syndesmophytes

If inflammation progresses, bridging is observed between the vertebral bodies, on the periphery of the discs, characteristically thin, bilateral and symmetrical. In the case of being prominent, thick, irregular and asymmetrical tric, are called pseudosyndesmophytes, and frequently are associated with other forms of spondyloarthropathies, most commonly psoriatic arthritis(12) . By coexisting syndesmophytes with intervertebral ankylosis between joints interpophysial, what is called column in «bamboo cane» (fig. 5), where there is fusion between vertebral bodies and facet joints, with formation of bone marrow in ossified segments13,14 (fig. 6). Syndesmophytes associated with these pathologies are generally difficult to identify. They occur in approximately 15% of the vertebrae in a patient with these pathologies. Conventional radiography is superior in the detection of syndesmophytes. In both techniques the syndesmophytes look like anterior bony protrusions to the vertebral borders, having low or high signal ˜ in STIR depending on the inflammatory state of the pathology basic; this inflammatory compromise is better evaluated with MRI, as mentioned before, that is, detecting the Active Romanus lesions, a stage prior to the development of syndesmophytes.

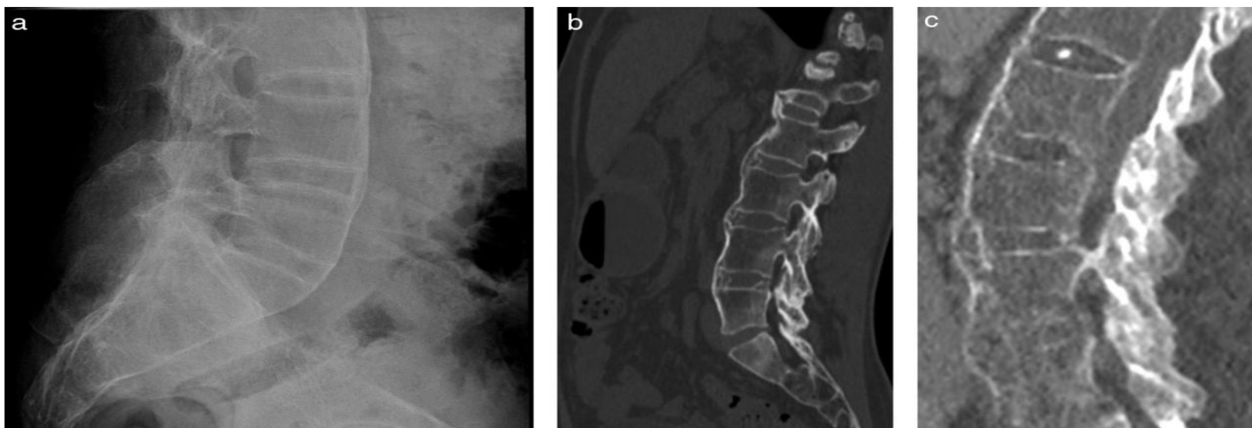

Figure 5 Lateral projection of conventional radiography (a) and selected bone window CT slices (b and c) showing lumbar columns in different patients, with ankylosis of the 3 pillars: anterior, middle and posterior, forming a structure continuous bone in «bamboo cane».

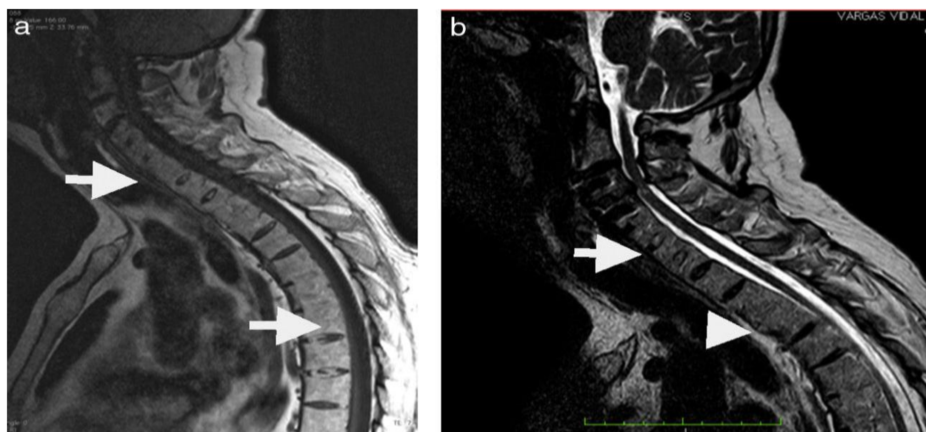

Figure 6 MRI showing signal ˜ similar to bone marrow in disc spaces. One image weighted at T1 (a) and another at T2 (b) show bone marrow signal in vertebral discs (arrows)

Ankylosis involves both edges and intervertebral disc, joining the center of the vertebral bodies, believed that by progression of anterior and posterior spondylitis and spondylodiscitis or Andersson's lesion. The bone formed has the same signal ˜ as normal bone in MRI (isointense to muscle on T1 and hypointense on STIR) and is very well demonstrated both in x-rays and in RM. Spinal ligament enthesitis Stabilization of the spine depends on a series of ligaments that may be involved in the process inflammatory spondyloarthritis. Your commitment is more prominent when interspinous ligaments are involved and supraspinatus, which may be associated with edema bone of the spinous processes. In T1 you usually see thickening of these structures, while in the conventional radiography rarely seen bone erosion of these elements (fig. 7). This finding has a specific 87% efficacy for spondyloarthritis(10) . In radiography and CT, when this inflammation is chronic, it produces ossification of interspinous ligaments, so that a continuous dense structure formed by this ossification contiguous ligament and spinous processes, what seen in PA x-ray or CT coronal slices looks like a dagger with the handle towards the lower end, called the «sign of the dagger '(fig. 8). The combination of fusion between these ligaments and facet joints produces the sign of the «line trolley »

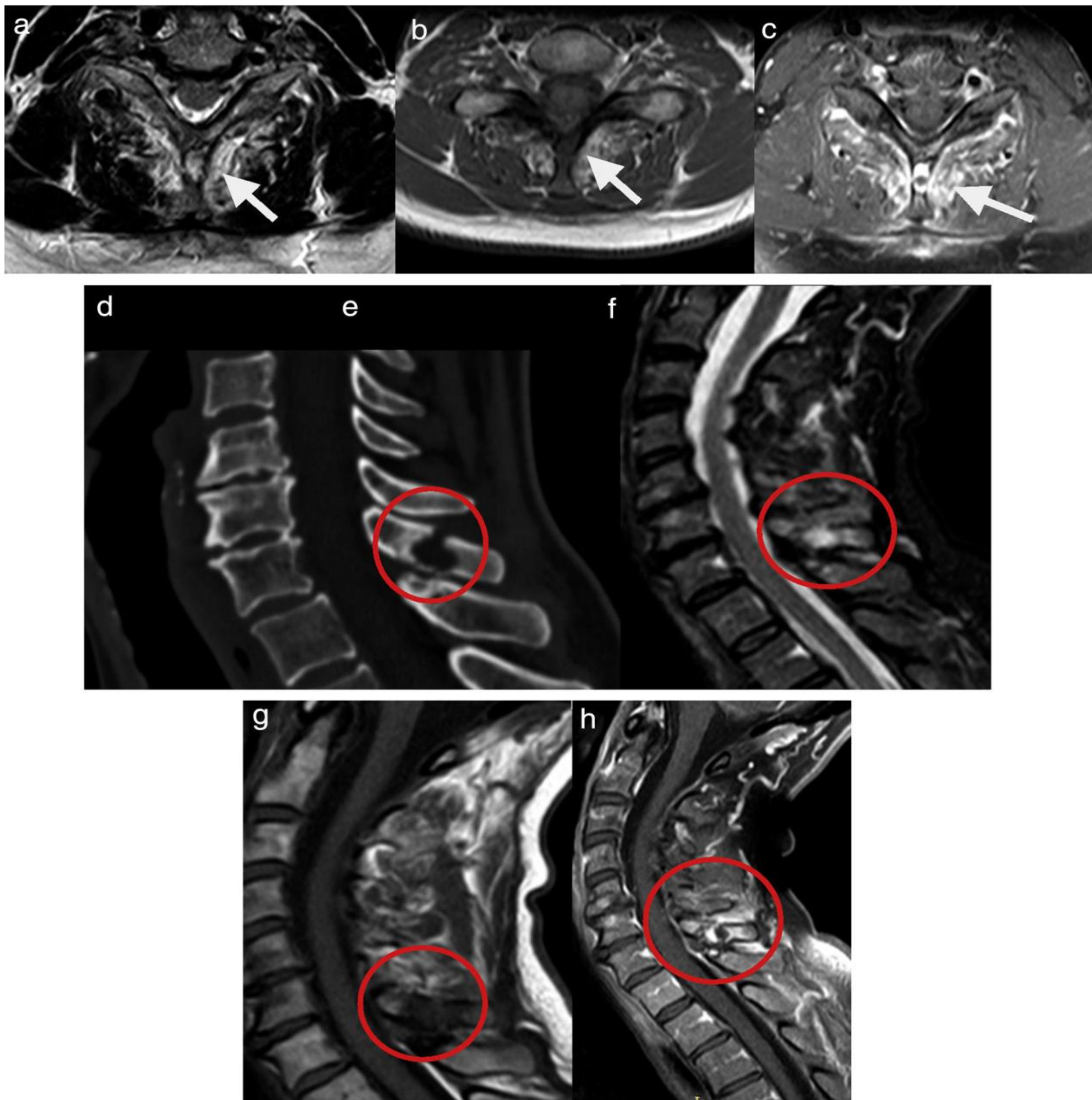

Figure 7 Axial and sagittal MRI and CT images, showing signs of interspinous and supraspinatus ligament enthesitis, marked by red circles in sagittal slices and arrows in axial slices. Note the marked enhancement with the use of gadolinium intravenous (c and g) of structures adjacent to a prominent rounded bone erosion focus in the spinous process of C7.

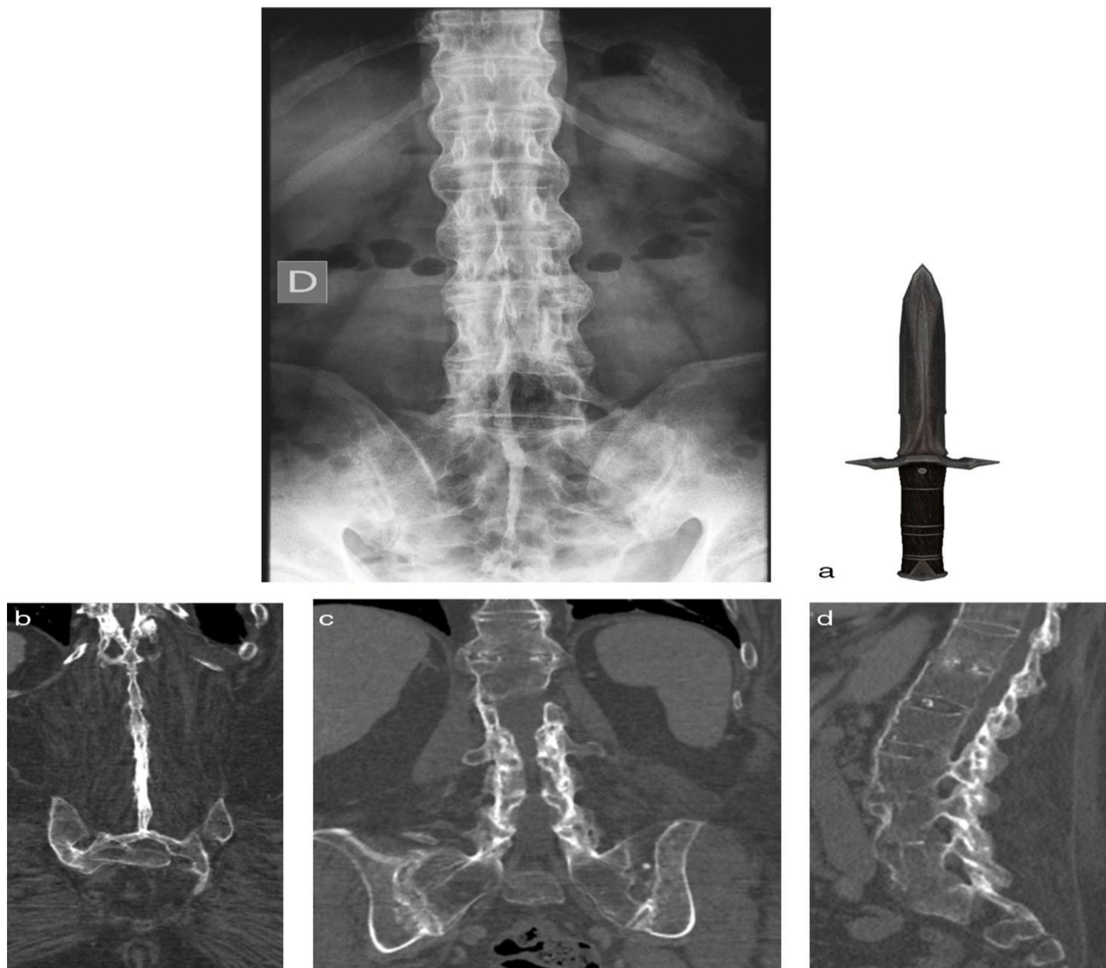

Figure 8 Dagger sign and trolley line sign: the upper image (a) shows a PA projection of the lumbar spine, with alteration of the bone configuration normally discontinuous in the midline. Normally this discontinuity is given by the interspinous and supraspinatus ligaments, which in this case are ossified, causing a continuous median line to be seen, which seen in conjunction with the sacrum and iliac crests make up an image similar to that of a dagger, with the handle facing the lower end (which would be the sacrum and part of the iliac wings) and the upper edge (ossification and spinous processes joined). Yes to this we add the facet joint ankylosis bilaterally, we find what is called the sign of the line trolley, with 3 vertical columns, also visible in this same PA radiograph. The images below show the same phenomenon in coronal CT slices (b-d), where continuity of spinous processes is shown, determined by ossification of interspinous and supraspinatus ligaments and ankylosis of the bilateral facet joints.

Synovitis and capsulitis

Arthritis of facet joints, costovertebral and transverse costs are comparable with those of peripheral joints in terms of their characteristics imaging, being very difficult to evaluate in the plane axial, therefore evaluation in other planes is recommended. Its inflammation is characterized by effusion, synovitis, erosions and bone edema, with joints that can reach to stagnate in late stages and therefore limit the thoracic excursion (figs. 9). Synovitis cannot be be differentiated from joint fluid in STIR sequences or T2, but with contrasted sequences(16) (Fig. 9). On conventional radiographs, blurring occurs of the interfacetary grooves, however, this finding only visible when the facet joints are affected lumbar or cervical, since at the thoracic level the ribs prevent adequate visualization (Fig. 10). No It should be forgotten that in projections of the lumbar spine, the sacroiliac joint involvement is also visible, bilateral and symmetrical, with erosions, sclerosis and finally ankylosis (Fig. 11). Costovertebral erosions Erosive lesions in the joints may also be evident costovertebral, with the same characteristics described in other synovial inflammatory lesions, which in late phases manifest as ankylosis(15) (Fig. 10).

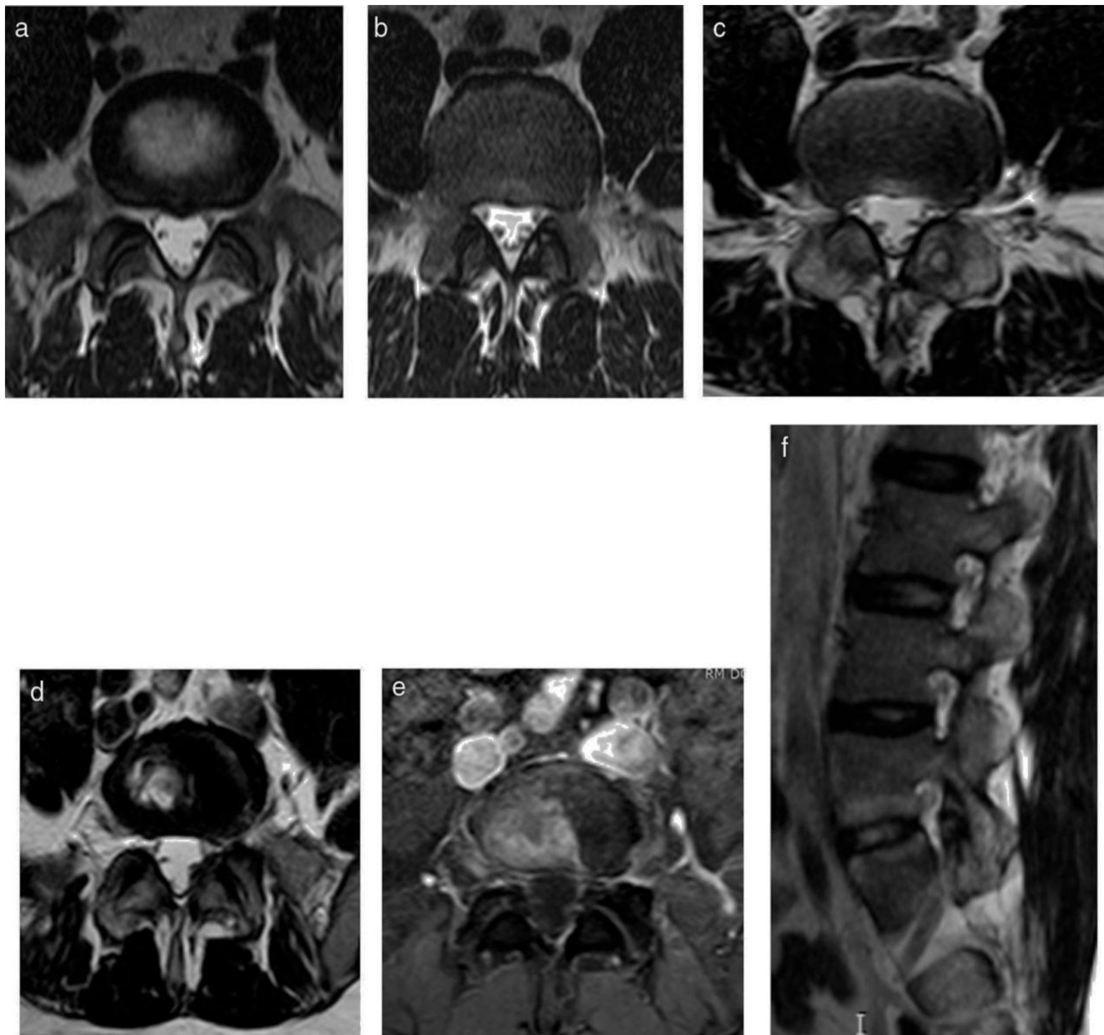

Figure 9 6-year evolution of a patient with currently symptomatic AD. Above (a and b) you can see T2 sequences that demonstrate mild bilateral degenerative changes of the facet joints at 2 different levels. Down, weighted cuts in T2 (c and d) and T1 (e and f) with contrast 6 years later. Note signs of facet joint ankylosis and disc enhancement L5-S1 intervertebral bone with enhancement of adjacent vertebral platforms, compatible with Andersson's lesion.

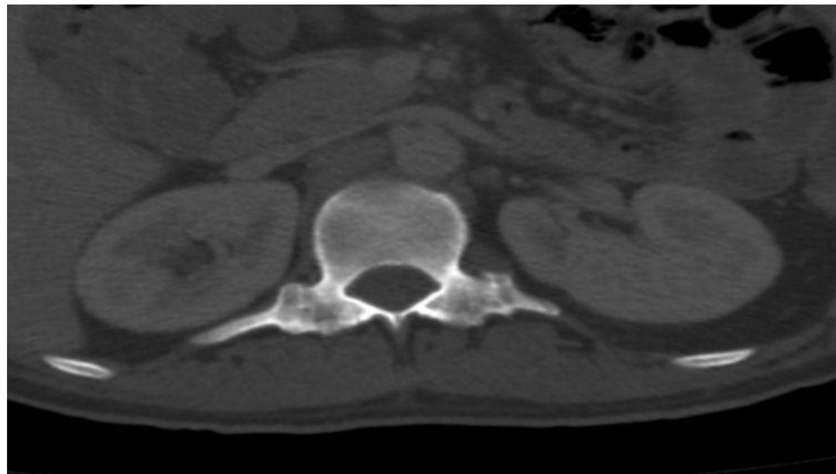

Figure 10 Axial CT section in bone window, where shows ankylosis of both costovertebral synovial joints in a patient with chronic back pain. Note the continuity of the costal articular facets with the corresponding costal tufts.

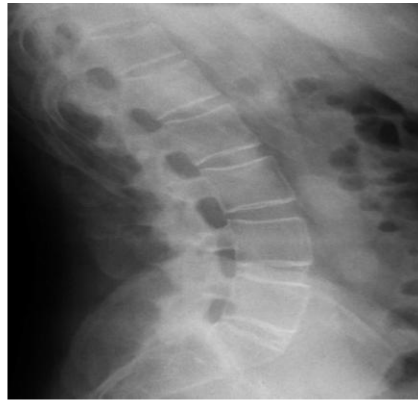

Figure 11 Lateral projection of the lumbar spine. Commitment of facet synovial joints, with respect to some discovertebral joints.

Complications The decrease in bone mineral density is a fact common in patients with AD(17) , especially in the spine vertebral(18) . Bone densitometry shows decrease of density in early stages of the disease, however, in late stages, this decline may being falsely normal, being masked by training syndesmophytes. Quantitative CT generally confirms this decrease in proportion to the duration of illness(18). In addition, the alterations in mineralization occur in patients with the persistently active disease, which plays a role important in bone mineralization disorders(19). Patients with AD are at increased risk of vertebral fractures(20) , given the fragility generated by aforementioned osteopenia and increased rigidity, occurring usually after minimal trauma(21) . Usually are at the disc level (transdiscal) or at the level of the vertebral body (transvertebral) and are typically diagnosed by conventional radiography. Insufficiency fractures old ones appear as hyperintense in T1, unlike of the recent ones that appear hypointense. When you are fractures heal and form a false joint, can simulate erosive osteochondrosis. Eventually may have pseudoarthrosis formation. Differential diagnosis Lumbar osteophytes in osteoarthritis they are generally confused with syndesmophytes. The osteophytes are characterized by their horizontal orientation extending from the intervertebral disc.

The presence of sclerosis and subchondral cysts and the absence of lesions inflammatory diseases such as erosions are suggestive of osteoarthritis5. The most objective way to differentiate syndesmophytes from osteophytes is to draw a line between the anterior edges of the vertebral bodies analyzed and another line at 45◦ in relation to the first: those bony prominences that exceed 45◦ would represent osteophytes, while than those that form a smaller angle would be syndesmophytes)(22) (fig. 12) Diffuse skeletal idiopathic hyperostosis (DISH) Characterized by exuberant ossifications with a thickness up to 2 cm in the anterolateral aspect of 4 or more vertebrae contiguous.

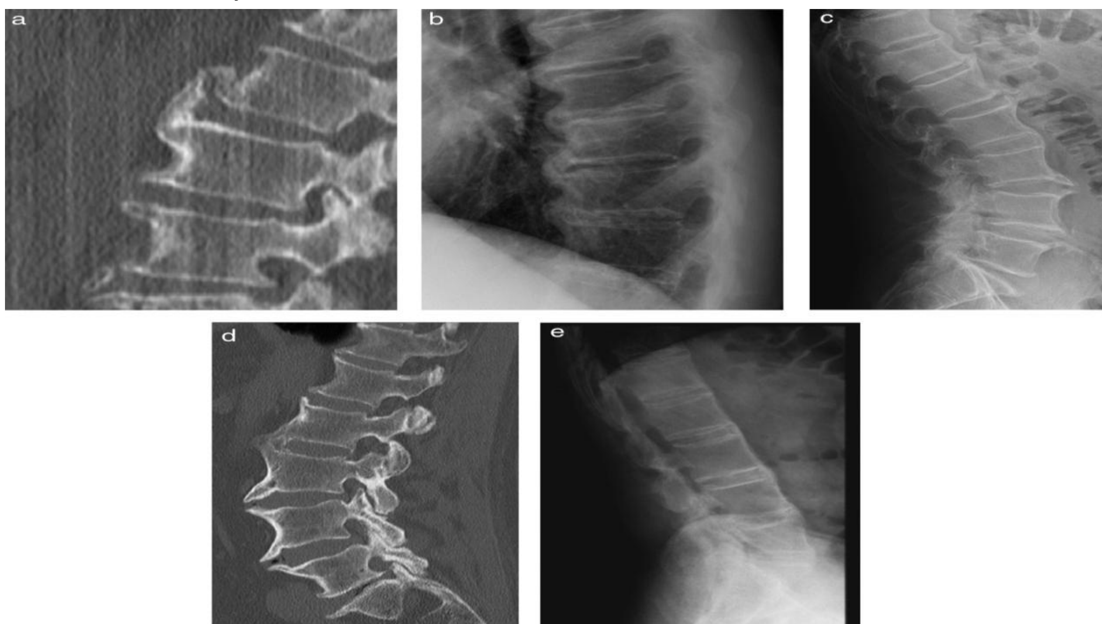

Figure 12 Differential diagnosis. CT views and lateral radiographs of different patients are shown to demonstrate differences between pathologies. The first 2 images on the left (a and b) are osteophytes from a patient with degenerative pathology disc. Note the decrease in intervertebral spaces and bony bridges anterior to the vertebral bodies, voluminous, with a Angle greater than 45◦ in relation to the anterior alignment of the vertebral bodies. The lumbarlateral radiograph (c) corresponds to a patient with DISH. Note the respect of the intervertebral spaces, with prominent osteophytes. Sagittal reconstruction of Lumbar CT (d) of the same patient shows prominent ossification of the anterior longitudinal ligament, with more protruding areas, extending at least anterior to 4 vertebral bodies. There is relative respect for the breadth of disc spaces and facet joints. Finally, image corresponding to a patient with AD (e). Note the syndesmophytes prior to vertebral bodies, which are thin and forming an angle of less than 45◦ with respect to the anterior border of the bodies vertebral.

They can also be found on the edge anterior of the sacroiliac joints. Not observed inflammatory involvement of any kind in facets, discs, or vertebral bodies, as well as in any ligament and generally this condition is asymptomatic (Fig. 13). Modic injury Degeneration of vertebral platforms with changes inflammatory (Modic I in the case of bone edema, Modic II in the case of fatty degeneration of the bone marrow or Modic III in the case of sclerosis) may be indistinguishable from a Andersson injury, however, the latter is usually associated with other findings of spondyloarthropathies (Fig. 13).

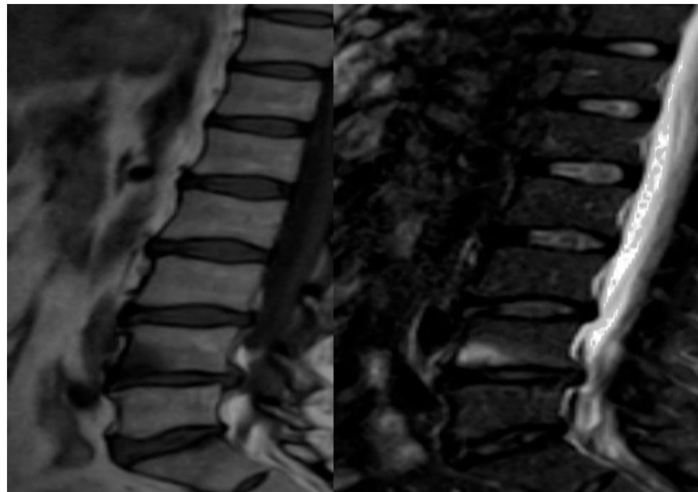

Figure 13 The image shows signal alteration ˜ of the bone marrow (Modic I changes) of the anterior aspect of the lower plateau of the vertebral body of L4, which is accompanied by of signs of L4-L5 disc degeneration. Note the indemnity of the rest of disc platforms.

However, these are often not present signs and you should turn to the clinic and laboratory. Infectious spondylodiscitis Differentiating it from an Andersson injury is difficult; infectious involvement generally extends to parts soft, with circumferential enhancement of the adjacent tissue, anterior to the vertebral body, collections and disruption of the border between the intervertebral disc and the vertebral body5 Tracing Methods have been developed to monitor acute injuries and chronicles of this pathology based on findings in MRI, both in the sacroiliac joints and in the spine.

The best known are: Spondyloarthritis Research Consortium of Canada MRI index for assessment of spinal inflammation in ankylosing spondylitis, the ankylosing spondylitis spine MRI score, and the Berlin method. The more used for having greater inter-observer congruence is the first of the 3. The effect of anti-TNF alpha is known on inflammatory changes in the spine after sixth week of treatment(23) .

Discussion

Some years ago, ˜ the imaging changes that guided the diagnosis of AD were based mainly on the simple radiography, however, these alterations take at least 5 years to appear once the first symptoms(7,8) .

They are currently recognized as the main imaging abnormalities anterior spondylitis Florida or Romanus injury, Discitis or Andersson injury, ankylosis, syndesmophytes, arthritis of apophyseal joints and costovertebral, enthesitis, ligament injuries interspinous and insufficiency fractures. Many entities can also compromise these elements, such as rheumatoid arthritis, degeneration disc, diffuse skeletal idiopathic hyperostosis (or DISH pyogenic spondylodiscitis, fractures vertebral,

Paget's disease, damaging the periosteum, discs, joints, capsules and ligaments. These conditions can be differentiated from spondyloarthropathies and specifically of the EA thanks to set between medical history, laboratory and images.

Within the imaging study with different techniques, It is important to mention that a specific protocol for spondyloarthropathies in the case of MRI, since it seeks to detect edema of affected structures, being a useful protocol in the evaluation of the spine vertebral sequence weighted in T1 TSE together with a short time inversion-recovery (STIR) sequence. A 512 pixel matrix must be used, with a thickness 3 to 4 mm cut-off, acquired with a resonator of 1.5 Tesla. Sequence-associated gadolinium administration with fat saturation T1 turbo spin eco are required for a better evaluation of some aspects, such as for example enthesitis, according to the experience of some authors(1) , to same as evaluation of abscesses associated with spondylodiscitis septic, for the evaluation of necrotic tissue, see soft tissue mass extension and disc enhancement. STIR sequences are also useful, particularly in the evaluation of costovertebral joints.

Ethical responsibilities

Protection of people and animals. The authors declare that no experiments have been carried out for this research in humans or animals. Confidentiality of the data. The authors declare that have followed the protocols of their workplace on the publication of patient data. Right to privacy and informed consent. The Authors declare that this article does not include data from patients.

Conclusions

AD is characterized by typical MR manifestations, However, these are not specific and can be seen in multiple other spinal pathologies. It is useful to have in note that inflammatory changes of the spine in pathologies inflammatory diseases do not occur in isolation and are mostly associated with sacroiliac joint disease, having key imaging characteristics in specific sites and a certain evolution over time. In patients with a history of pain referred to the spine nonspecific vertebral columns that are evaluated with images is important to correctly classify the findings, to start other corresponding diagnostic tests. Imaging monitoring of inflammatory changes provides the rheumatologist with an objective measure of treatment efficacy(24) .

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