

Synovial membrane disease and imaging approach to inflammatory arthropathies: a literature review

La enfermedad de la membrana sinovial y el enfoque imagenológico de las artropatías inflamatorias: una revisión de la literatura

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Summary

Introduction: One of the crucial aspects for the appropriate management of patients with inflammatory arthropathies is early diagnosis, since, accompanied by effective and timely treatment, it can lead to remission of the disease. However, this is not an easy task, and even clinical information and biomarker-based approaches may be insufficient. Therefore, this article aims to describe the imaging findings associated with inflammatory arthropathies. ***Methods:*** A literature review was conducted using controlled vocabulary and free terms in PubMed, Embase, SciELO, and Google Scholar. Original and secondary studies in English or Spanish were included. ***Results:*** Initially, a general approach based on the ABCDEs for inflammatory arthropathies can be employed. Subsequently, focus should be directed towards specific radiological findings based on etiology and its characteristic features, the type of diagnostic imaging employed, and the affected joints. ***Conclusion:*** Diagnostic imaging plays a pivotal role in the diagnostic process, in addition to aiding in disease severity classification. It is considered an essential tool for evaluating patients with suspected or diagnosed inflammatory arthropathy.

Resumen

Introducción: Uno de los puntos críticos para el adecuado manejo del paciente con artropatías inflamatorias es el diagnóstico precoz, debido a que, acompañado de un tratamiento temprano efectivo, puede llevar a la enfermedad a un estado de remisión. Sin embargo, no es una tarea fácil, e incluso la información clínica y basada en biomarcadores puede ser insuficiente, por lo que este artículo busca describir los hallazgos imagenológicos de dichas entidades. ***Métodos:*** Revisión de la literatura. Para la búsqueda se usó vocabulario controlado y términos libres en PubMed, Embase, SciELO y Google Scholar. Se incluyeron estudios originales y secundarios en inglés o en español. ***Resultados:*** Inicialmente, se puede realizar un enfoque general basado en el ABCDE para artropatías inflamatorias. Posteriormente, se debe enfocar el hallazgo con base en la etiología y sus manifestaciones características, el tipo de imagen diagnóstica empleada y la articulación comprometida. ***Conclusión:*** Las imágenes diagnósticas permiten apoyar el proceso diagnóstico, además de clasificar la severidad se la enfermedad. Se considera una herramienta esencial para la evaluación del paciente con sospecha o diagnóstico de artropatía inflamatoria.

Introduction

Inflammatory arthropathies are a heterogeneous group of diseases that share the common characteristic of inflammation of the synovial membrane. Among them, the most common is rheumatoid arthritis (RA) (1), which has a reported prevalence of 0.52% in Colombia (2). Additionally, there are other etiologies that can be included in the term seronegative arthropathies (3, 4). Among the critical points for the proper management of patients with these pathologies is early diagnosis, in order to administer effective early treatment and even achieve remission of the disease (5). Furthermore, it is important to differentiate RA from other diseases, due to the implications this may have for prognosis, choice of management, and the variety of systemic involvement. However, this is not an easy task, and even clinical and biomarker-based information is limited (6).

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Accordingly, radiology and other diagnostic imaging techniques are important tools for obtaining an early and accurate diagnosis. Therefore, the expertise of the radiologist is important when interpreting diagnostic images that evaluate joint involvement (7). Thus, the objective of this article is to describe the imaging findings of inflammatory arthropathies.

Methods

Study design and objective

A narrative review of the literature was conducted that complies with the SANRA checklist (8). The objective of the study is to describe the imaging findings of inflammatory arthropathies based on their clinical manifestations and pathophysiology.

Article search and selection criteria

Controlled vocabulary terms such as MeSH and free terms were used for the search. We searched for inflammatory arthropathies and diagnostic imaging using terms such as "arthritis," "rheumatoid arthritis," "psoriatic arthritis," "spondylitis," "ankylosing arthritis," "reactive arthritis," "radiography," "ultrasonography," "Doppler," and "magnetic resonance imaging." The search engines used were PubMed, EMBASE, SciELO, and Google Scholar. Original and secondary studies in English or Spanish were included.

Results

Anatomy and pathophysiology of the synovial membrane

Diarthrodial joints allow the greatest range of motion, which is why they are covered by the synovial membrane. This membrane provides stability and lubrication to reduce friction and wear on the joint surfaces. It also covers other structures such as bursae and some tendons (e.g., Achilles tendon, subacromial subdeltoid bursa), performing the same function (9).

The synovial membrane has been described as a highly vascularized structure consisting of two main components: the outer fibrous layer and the inner or intimal layer. The former is responsible for stabilizing the joints and is predominantly composed of dense fibrous and connective tissue. The latter produces synovial fluid and is predominantly composed of synoviocytes and phagocytic B cells. However, neither of these two components is visible on imaging in non-pathological conditions (10) (Figure 1).

There are five main pathological manifestations of the synovial membrane. First, synovial thickening has been defined as a measurement greater than 3 mm, which makes the affected synovial membrane visible. Second, an increase in intra-articular fluid may be found, but this finding is usually nonspecific, so other signs such as membrane thickening should be sought (11). Hemarthrosis per se can guide an etiological diagnosis, considering trauma, although when it appears with chronic progression it is associated with hemophilia (12). Thirdly, there is a reduction in joint space, which is caused by cartilage damage. Thus, uniform loss is associated with symmetrical destruction, typical of inflammatory arthropathies, while uneven or asymmetrical destruction is more common in degenerative arthropathies (11).

Fourthly, prolonged synovitis causes proliferation of the intimal membrane, with secondary cellular imbalance. This can be caused by synovitis in the context of a cellular imbalance that mainly affects the bare area, causing osteitis and bone edema, as well as juxta-articular osteopenia secondary to the activation of osteoclasts by the inflammatory process. The persistence of this pathology over time can lead to marginal erosions in this case or subchondral erosions in cases of irregular cartilage loss (osteoarthritis). In advanced cases, inflammatory arthropathies can present both types of erosions. Additionally, another effect of synovial proliferation is fat proliferation, especially in a rare form called arborescent lipoma (13). Fifth, there are intra-articular bodies, another pathological manifestation of the synovial membrane. These are abnormal formations within the joints that can be calcifications (as in primary or secondary osteochondromatosis) or papillary protections due to necrosis of the thickened and proliferated synovial membrane (11). Imaging-wise, these projections can be described as the "rice grain" sign, and they are more commonly found in RA (14) (Figures 2 and 3).



Figure 1. Anatomy of the synovial membrane: diagram of the outer and inner layers of the synovial membrane. Own elaboration.



Figure 2. Axial MRI slice. Thickening of the synovial membrane: patient with chronic synovitis and right glenohumeral joint effusion.

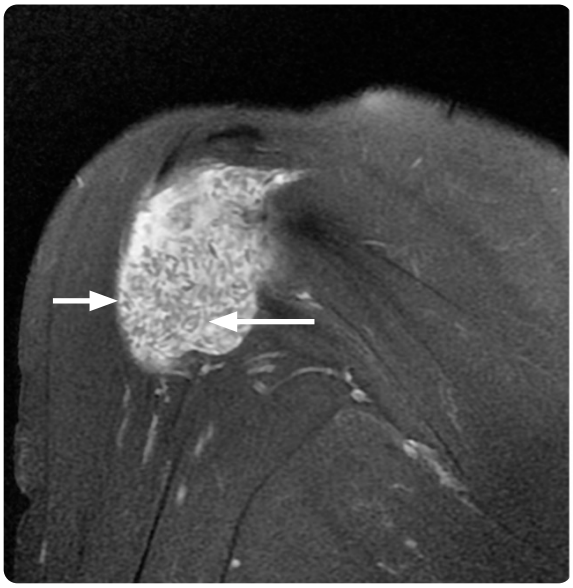


Figure 3. Axial MRI slice. Intra-articular bodies resembling "rice grains": same patient with chronic synovitis of the glenohumeral joint, with a "rice grain" sign due to multiple intra-articular bodies resulting from necrosis of the thickened synovium.

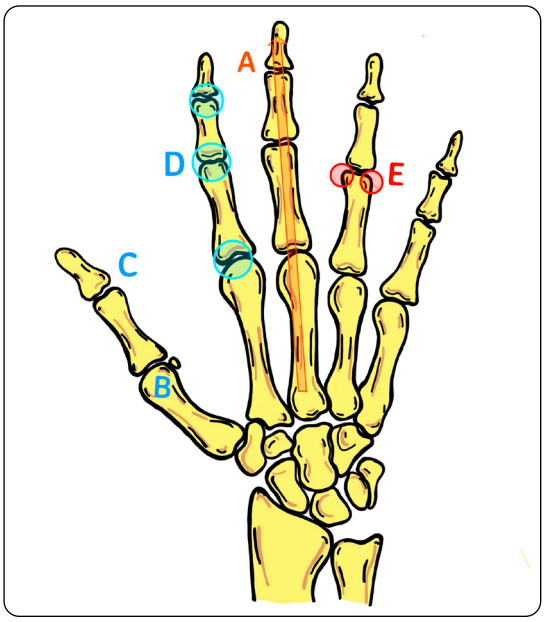


Figure 4. Initial approach to arthropathies: ABCDE scheme for arthropathies. Own elaboration.

Diagnostic imaging approach

For the initial approach to arthropathies, the acronym ABCDE'S (Table 1, Figure 4) can be used to search for and identify the main findings (11, 15, 16).

Table 1. ABCDE'S approach to inflammatory arthropathies

A	Alignment and joint space	Alignment: ligament and tendon hyperlaxity (SLE and Jaccoud's arthropathy), varus or valgus deviations due to wear (OA), erosions, pannus and tendon fibrosis such as volar subluxation, ulnar deviation of the MCP joints, as well as other more specific deformities such as swan neck or buttonhole finger, typical of RA, or "pencil-in-cup" deformity (characteristic of, but not exclusive to, psoriatic arthritis). Joint space: preserved, symmetrically decreased (erosive or inflammatory arthritis such as RA), asymmetrically decreased (degenerative arthropathies such as OA).
B	Bone	Preserved bone density (early stage or in psoriatic arthritis), osteopenia (juxtarticular suggestive of RA due to inflammation, hyperemia, and inflammatory granulation tissue, pannus), and bone proliferation due to reparative response (in OA, sclerosis of the joint surface and formation of osteophytes with the "gull wing" sign are common; also seen in seronegative arthropathies). Calcification of the bone insertion of tendons and ligaments (characteristic of seronegative arthropathies) or the formation of syndesmophytes at the insertion of the fibrous rings of the intervertebral discs, specifically in Sharpey's fibers (in AS), may be found in the enthesis.
C	Cartilage	A symmetrical decrease can be seen in RA and other inflammatory arthropathies due to proteolytic enzymes that alter the balance of the synovial membrane and intra-articular space, with impaired diffusion of nutrients to the hyaline cartilage and uniform loss of cartilage. On the other hand, there may be an asymmetric decrease due to asymmetric cartilage wear and loss of uniformity in the distribution of forces (OA)
D	Distribution (quantity or location)	Quantity: monoarticular (septic arthritis), oligoarticular (seronegative arthropathies), polyarticular (generalized involvement with RA as the first possibility). Location: symmetrical (RA), asymmetrical (OA, seronegative arthritis, especially psoriatic arthritis, and in deposit diseases such as gout), distal (hands and feet, DIP and PIP in seronegative arthropathies), proximal (IFP, MCF, intercarpal and radiocarpal-ulnar, mainly RA), axial or appendicular skeleton; axial involvement leads to suspicion of AS, especially with symmetrical involvement of the sacroiliac joint; psoriatic and reactive arthritis can involve the sacroiliac joint symmetrically or asymmetrically.
E	Erosions (focal loss of cortical and subcortical bone)	Marginal (affecting the bare area of the epiphysis, intrasynovial but not covered by cartilage, visible in most inflammatory arthropathies), non-marginal (further from the joint margin, without particular involvement of the bare area of cartilage, associated with sclerosis and seen in deposit diseases such as gout) and subchondral (common in degenerative arthropathies due to asymmetric loss of hyaline cartilage, not to be confused with subchondral cysts in inflammatory arthropathies, in which pannus infiltrates and destroys the bone in this location).
S	Soft tissue (soft tissue)	Focalized periarticular edema may be the initial manifestation of RA, and if it is fusiform in appearance, it represents pannus formation and extensive edema. In cases of diffuse inflammation, it represents an inflammatory process beyond the joint. A clear example is dactylitis due to psoriatic arthritis, known as "sausage finger".

Abbreviations: RA (rheumatoid arthritis), OA (osteoarthritis), SLE (systemic lupus erythematosus), MCP (metacarpophalangeal), AS (ankylosing spondylitis), DIP (distal interphalangeal), PIP (proximal interphalangeal).

Seropositive arthropathies

RA is characterized by persistent synovitis, systemic inflammation, and autoantibody production (17). The term "seropositive" refers to the detection of elevated rheumatoid factor (RF) in the blood, although this is not exclusive to this disease (18). It affects approximately 1% of the adult population, most commonly people between the ages of 45 and 65, and is more prevalent in women (1). The cause of this disease has not yet been fully clarified. Genetic predisposition is believed to contribute to 50% of cases; similarly, environmental factors such as smoking, periodontal disease, and alterations in the gut microbiota play a significant role (19).

Clinical, serological, and radiological criteria are considered in the diagnosis. In 2010 (20), the American College of Rheumatology, in conjunction with the European League Against Rheumatism, updated the diagnostic criteria established in 1987 (21), which included radiography as a primary criterion in the diagnostic approach. The aim of this new classification is to make an early diagnosis of the disease in order to determine which patients could benefit from early management with new therapies-predominantly biological at present-(22), with the aim of preventing the disease from progressing to its chronic erosive phase, when changes become irreversible.

Beyond the diagnostic process, imaging has become increasingly important in classifying the severity of the disease (23). Radiographic examination of RA is based mainly on comparative radiographs of the hands (24). RA involvement has been described mainly by synovitis and symmetrical joint space narrowing, symmetrical and proximal distribution-proximal interphalangeal, metacarpophalangeal, intercarpal, and radioulnocarpal joints- edema of the periarticular soft tissues, bone edema preceding erosions, absence of reparative response and bone formation, marginal erosions that can progress to subchondral erosions in severe involvement, formation of synovial cysts, and deformities—volar subluxation, ulnar deviation of the MCP joint, swan neck deformity, or buttonhole finger. Depending on the joints affected, different guiding or characteristic findings will be found (Table 2, Figure 5) (7, 25).

However, there is evidence suggesting that magnetic resonance imaging (MRI) and ultrasound (US) have greater sensitivity and specificity in assessing synovial involvement (26) and erosions compared to radiography. Because of this, the OMERACT group standardized and classified MRI and US findings (Table 3). Each of these findings is characterized by a numerical value which, taken together, determines the extent of involvement and severity of the disease, predicting the outcome for each patient with a significant degree of certainty. However, the details of this classification are beyond the scope of this review, and a detailed description can be found in other references (27, 28). Another tool described is the Sharp classification, modified by van der Heijde, which is a scale based on erosions visualized in 16 areas of the hand and 6 areas of the foot (29) (Figures 6 and 7).

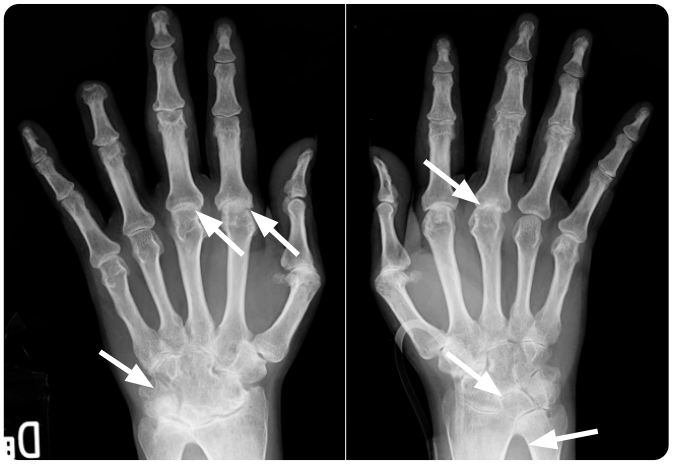


Figure 5. Comparative hand X-ray, with predominantly juxtarticular osteopenia, decreased joint space, and marginal erosions. There is severe intercarpal and radioulnacarpal involvement, with incipient ankylosis.



Figure 6. Coronal MRI. STIR sequence showing decreased joint space on the PIP, MCP, carpal, and radioulnocarpal planes, with osteitis and marginal erosions on the metacarpal heads and carpal bones.

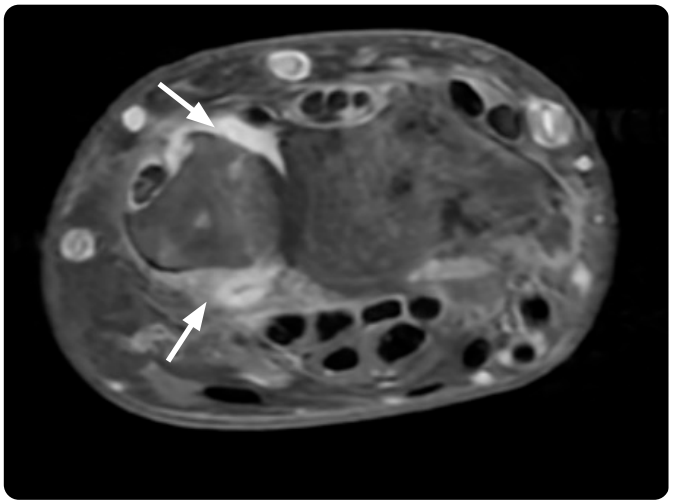


Figure 7. Axial MRI. T1 with gadolinium shows synovial thickening and enhancement with signs of tenosynovitis. There is associated bone edema on the articular surface of the carpus and ulna.

Table 2. Guiding or characteristic findings based on the joint affected in rheumatoid arthritis

Anatomical region	Description
Hands and wrists	Periarticular edema and juxtarticular osteopenia. Also, symmetrical joint space narrowing and marginal erosions, where one may precede the other, with no apparent predilection in the order of presentation. Assess the distal epiphyses of the metacarpals and the radial side of the proximal epiphyses of the proximal phalanges. Erosions may also be found in the wrist, occurring primarily in the scaphoid waist, the large bone, the joint of the fifth metacarpal with the hamate, the joint of the first metacarpal with the trapezium, and the radial and ulnar styloids. Other findings include progression to subchondral erosions, the joint deformity described, synovial proliferation and rice bodies, soft tissue atrophy or nodular formations, pannus, and ankylosis, predominantly in the carpus.
Foot	Juxta-articular osteopenia. Another finding is marginal erosion of the distal epiphyses of the metatarsals, which usually begins on the lateral side of the fifth metatarsal, with the others being affected first on their medial margin and then on the lateral margin. A decrease in joint space can also be observed, predominantly in the MTF joints, fibular deviation of the proximal phalanges, plantar subluxation of the metatarsal heads, hallux valgus, erosions at the insertion of the plantar fascia or Achilles tendon in the calcaneus, and tarsal ankylosis.
Knee	Symmetrical cartilage destruction in the medial, lateral, and patellofemoral compartments, with poor or absent reparative response; frequent synovial cysts, which may increase in size to form geodes, or Baker's cysts.
Hip	Less common than the knee. Loss of joint space, with axial migration of the femoral head and acetabular erosion with secondary acetabular protrusion.
Atlanto-odontoid joint and cervical spine	Main involvement of the axial skeleton, with respect to the other vertebral segments. There is laxity of the transverse ligament, which increases the atlanto-odontoid space in dynamic projections (flexion). In severe cases, basilar impression and craniocervical settling occur. Erosions can be identified in the facet joints, with secondary subluxations.
Ankle	Uncommon. It shares the decrease in joint space, but erosions are not frequent. The periosteal reaction of the posterior margin of the tibia is characteristic.
Shoulder	There is loss of glenohumeral, acromioclavicular, and acromioclavicular space. Rotator cuff rupture is common. Erosion of the greater trochanter and distal osteolysis of the clavicle.

Table 3. Findings on magnetic resonance imaging and ultrasound to determine joint involvement according to OMERACT

Finding	Description
Synovitis	Hyperechoic/hyperintense thickening of the synovium, with or without joint effusion. It is graded from 0 to 3, with 0 being normal appearance and 3 being synovial proliferation. It may also show increased flow on color Doppler examination.
Enthesitis	Hyperechoic thickening of the bone insertion of tendons and ligaments, ≤ 2 mm from the bone cortex. It may be associated with erosions or calcifications.
Tenosynovitis	This occurs due to the synovial covering of tendon structures, with findings similar to synovitis. There is similar involvement in the bursae. Increased Doppler flow should be considered if it is visualized in the sagittal and axial planes.
Tendon rupture	Assessed in two planes and resulting from persistent inflammation. It is only assessed in the ultrasound score.
Joint space narrowing	Assessed in 17 different locations in the wrist, carpus, and phalanges. Only taken into account in MRI.
Erosions/bone edema	Cortical discontinuity seen in two planes. Bone edema is evident in fluid-sensitive sequences such as STIR. In MRI, they are scored separately.

Seronegative arthritis

Also known as seronegative spondyloarthropathies, their main characteristic is RF negativity. Historically, the *HLAB27* gene has been linked to their development and is a marker for some of these diseases (30). In addition, synovitis has been described as a pillar in the diagnosis and monitoring of some of these diseases, and in general they share similar clinical characteristics. Among them, imaging manifestations may also be similar, with, for example, involvement of the enthesis, predominantly of the Achilles tendon.

Regarding diagnostic criteria and classification, the ASAS (Assessment of Spondylo-Arthritis International Society) group divided the diseases into two groups: those with primary involvement of the axial skeleton (2009), of which ankylosing spondylitis (AS) is the most common (4); and those predominantly affecting the appendicular skeleton (2011) (3), with psoriatic and reactive arthritis mainly in this group. Notably, this group also included MRI findings to increase the sensitivity of imaging diagnosis before the manifestation of irreversible findings. In this context, bone edema in sacroiliitis has been described as the main assessment item for the early diagnosis of AS. However, despite improving the diagnostic performance of the criteria that preceded them (31), they are not yet globally accepted. Therefore, an individualized approach to each patient is essential in the diagnosis of each of these pathologies, in addition to imaging criteria for both diagnosis and follow-up, contrary to what has occurred with advances in RA.

Ankylosing spondylitis (AS)

It is the most common seronegative arthropathy. Its pathophysiology is unknown, but it is associated in 90% of cases with *HLAB27* positivity, with a peak incidence between the ages of 1 and 40 and

a slight predilection for males (60% of cases). It is the arthropathy with the highest proliferative predominance and the least erosive involvement of bone structures (32).

X-ray is the main imaging modality for evaluating these arthropathies, based mainly on enthesitis involvement and vertebral and sacroiliac joint bone edema. MRI has been described as important in cases of equivocal spondyloarthropathy or with non-definitive findings on plain radiography. The findings are: ascending and non-saltatory involvement of the axial skeleton (initially in the lumbar spine, then the thoracic and cervical spine); symmetrical distribution with frequent involvement of the sacroiliac joint (initially with bone edema and ending in ankylosis, less frequently affecting the hip joints, shoulders, knees, hands, and feet, in descending order of frequency); normal bone density before ankylosis and osteopenia after ankylosis; subchondral bone formation preceding ankylosis; small, usually vertebral, and not very extensive erosions; absence of subluxations or synovial cysts.

Specific findings can be found in the spine (33). Bone edema due to enthesitis can begin at T12-L1 or in the lower lumbar region, and is ascending and non-saltarory. Initially, there is enthesitis of the anterior longitudinal ligament insertion with bone edema identified in fluid-sensitive MRI sequences such as STIR (34), progressing to erosions of the anterior margin of the vertebral endplates, known as Romanus lesion (35). Subsequently, and in this same location, sclerosis and bone proliferation occur, known as the "bright corner" sign. On the other hand, it is also possible to observe ossification of the insertion of Sharpey's fibers at the anterior margin of the fibrous rings of the vertebral discs, forming syndesmophytes that generate vertebral ankylosis, producing the classic appearance of a "bamboo spine." An important complication of this is pseudoarthrosis, which will lead to complete disc degeneration in the most severe cases. Also, ossification of the interspinous and spinolaminar ligaments can be observed, forming the "dagger" sign on the AP radiograph (36). If facet ankylosis also occurs, the "tram track" sign can be identified.

Bilateral and symmetrical involvement can be identified in the sacroiliac joints, beginning with small iliac erosions and then sacral erosions, with a reparative response. Ankylosis has also been described as occurring in both the synovial and fibrous components of the joint (37). The modified New York scale grades the findings in this joint from 0 to 4, where 0 is normal and 4 is complete ankylosis of the joint (38). Additionally, enthesitis can manifest with bone proliferation in other parts of the pelvis, such as the iliac spines and ischial tuberosities.

In the case of the hip joints, appendicular involvement is the most common. The involvement is symmetrical and divided into two types. First, non-destructive, in which ankylosis and uniform loss of joint space are the prominent findings (ring osteophytes). Second, destructive, which is usually not symmetrical and involves destruction of the femoral head, which appears irregular and precedes ankylosis.

Finally, there is the glenohumeral joint, which is characterized by the second most common appendicular condition. Non-destructive involvement occurs due to ankylosis with calcification of the coracoclavicular ligament, preserving the morphology of the humeral head. On the other hand, destructive involvement occurs due to erosion of the humeral head at the insertion of the rotator cuff, forming the "hatchet" sign, which precedes ankylosis (Figures 8 and 9).



Figure 8. AS in the spine: syndesmophytes and ossification of the anterior longitudinal ligament, with fusion of the vertebral levels. Incipient sign of "bamboo spine."

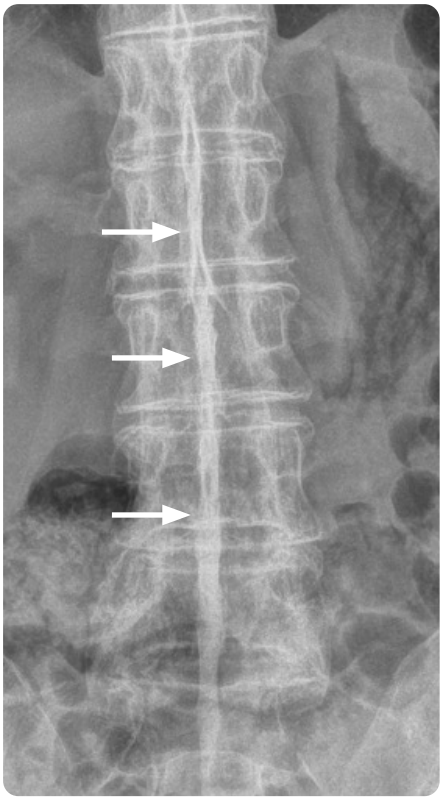


Figure 9. AS in the spine: "dagger" sign due to calcification of the interspinous ligament.

Psoriatic arthritis

Historically, this condition was considered part of the RA spectrum as an atypical variant or manifestation (39). However, it was later classified among seronegative arthropathies. In this group, it is the most common arthropathy of the appendicular skeleton and occurs in 5-15% of patients with cutaneous psoriasis, especially in the context of prolonged and severe dermatological disease (40).

As in ankylosing spondylitis, radiography is the main imaging modality for evaluation. However, follow-up with MRI and ultrasound is also possible (41). The involvement is usually bilateral and asymmetrical, mainly distal, involving the distal and proximal interphalangeal joints, but with relative sparing of the carpus and wrist. Bone density is preserved; however, there is bone proliferation secondary to periostitis due to enthesopathy (42). There is also dramatic loss of joint space, marginal erosions, and "pencil-in-cup" deformity and fusiform soft tissue edema (dactylitis with "sausage" finger) (43).

Specifically, the findings described above are present in the hands, but there are also others such as erosions that are initially marginal and then subchondral (a characteristic "pencil-in-cup" deformity, although this is not exclusive to this pathology). Bone proliferation occurs in four different areas, starting adjacent to the erosions, diaphyseal, articular, and in the entheses (42). In the diaphysis, the "ivory phalanx" sign can be seen, which presents a periosteal reaction and symmetrical cortical thickening. Ankylosis of the distal interphalangeal joints is not uncommon. The classic distribution pattern is distal, involving the proximal and distal interphalangeal joints. The second type is radial, with involvement of all joints of 1 to 3 fingers, sparing the others. The least common is the RA like distribution, so the analysis should focus on the other findings to achieve differentiation.

The feet are affected in a similar way to the hands. Dactylitis can be observed, as well as erosions and "pencil-in-cup" deformity. The most common finding is destruction of the interphalangeal joint of the first toe. Three patterns can be observed, which in order of decreasing frequency are: distal in the distal and proximal interphalangeal joints, metatarsophalangeal involvement (more common than in the hands), and finally radial involvement similar to that of the hand. Calcaneal enthesitis can be seen at the insertion of the plantar fascia and Achilles tendon, with erosions followed by bone proliferation (42).

With regard to the sacroiliac joints, a bilateral but usually asymmetrical distribution can be observed. There is erosion on the iliac side of the synovial part of the joint, with subsequent involvement of the sacral side and bone proliferation. In advanced stages, ankylosis may occur, but it is less common than in ankylosing spondylitis (42) (Figures 10 and 11).

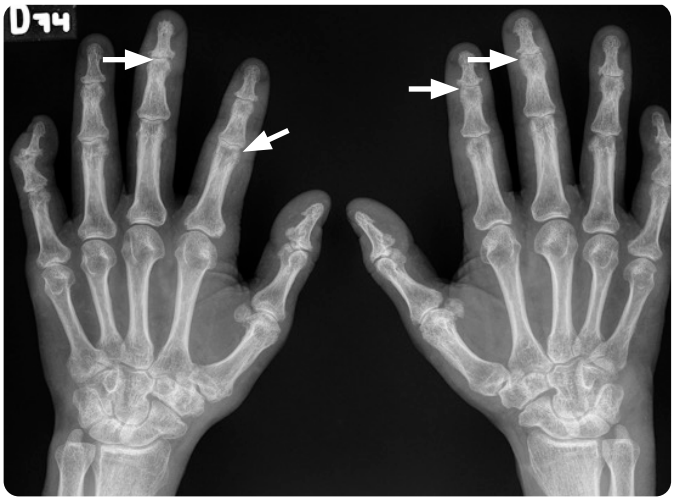


Figure 10. Psoriatic arthritis. Comparative X-ray of hands with more or less preserved bone density, decreased joint space predominantly in the distal interphalangeal joint (DIP) and proximal interphalangeal joint (PIP), with marginal erosions and cottony-appearing bone proliferation.



Figure 11. Psoriatic arthritis. Comparative X-ray of feet with decreased joint space in DIP and PIP joints, with marginal erosions and bone proliferation, with bone density more or less preserved.

Reactive arthritis

Previously known as Reiter's syndrome, it is characterized by the triad of conjunctivitis, urethritis (cervicitis in women), and arthritis, which is only present in approximately 30% of cases. It is much more common in men and peaks between the ages of 15 and 35. Its cause remains unknown, but it is believed to be secondary to a systemic response following a genitourinary (Chlamydia trachomatis) or gastrointestinal (Salmonella, Yersinia, Shigella, or Campylobacter) infection. It has also been associated with HIV (44).

From an imaging perspective, it has a similar presentation to psoriatic arthritis: it can present with juxtarticular osteopenia or normal bone density, bone proliferation, uniform and slight loss of joint space, poorly defined marginal erosions, fusiform edema of the soft tissues, and bilateral and asymmetric distribution. Regarding the latter, the manifestations are mainly in the first interphalangeal joint and in the metacarpophalangeal joint, with greater involvement of the lower limbs, mainly in the feet and less frequently in the ankles and knees, where there is a decrease in joint space, joint effusion, and periostitis with varying degrees of bone proliferation.

Specifically in the feet, the main structures affected are the distal and proximal interphalangeal joints, as well as the calcaneus (heel bone). Dactylitis may be observed, although it usually only appears as fusiform edema. Another finding is juxtarticular osteopenia with subsequent normalization of bone mineralization. An important aspect is that it can be monoarticular and confused with septic arthritis. There may be predominantly diaphyseal periostitis, decreased joint space with marginal erosions, and bone mineralization indistinguishable from psoriatic arthritis.

Erosive arthritis

It is a variant of osteoarthritis that commonly occurs in middle-aged women who experience episodic symptoms of inflammatory arthritis similar to those of RA (45).

Imaging studies show that it differs from osteoarthritis due to the concomitant presence of edema in the periarticular soft tissues. Centrally predominant erosions (cartilage loss), bone proliferation (sclerosis and marginal osteophytes with the "gull wing" sign), bilateral, asymmetric, and distal distribution (mainly in the distal and proximal interphalangeal joints) can also be seen. The differential diagnosis is psoriatic arthritis, and a clue to distinguishing between them is to look at the carpometacarpal joints of the first finger and the scaphoid joints with the trapezium and trapezoid, which will show degenerative changes in the osteoarthritis spectrum (Figure 12).

Enteropathic arthritis

It is a spondyloarthropathy that predominantly affects the axial skeleton and is related to inflammatory bowel diseases, as between 17% and 39% of these patients develop chronic arthropathy (46).

The images show a predominant distribution in the axial skeleton that is difficult to distinguish from spondyloarthritis, as there may be similar findings in the spine, such as syndesmophytes and ankylosis, although it has more erosive changes than spondyloarthritis. Therefore, the clinical context is key. The three possible presentations are spondylitis (very similar and almost indistinguishable from spondyloarthritis), sacroiliitis, and peripheral arthritis (rare) (47).

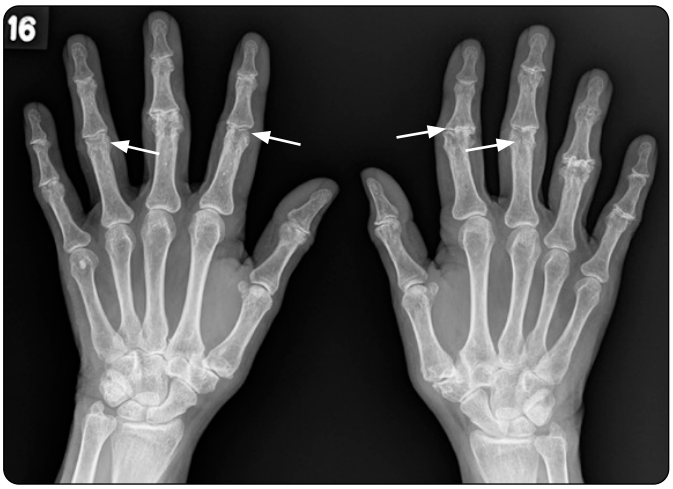


Figure 12. Erosive arthritis. Comparative X-ray of hands showing joint space narrowing, erosions, and bone proliferation with sclerosis of the joint surface with "seagull wing" sign. Mild periarticular edema of the soft tissues.

Undifferentiated spondyloarthropathy

This term refers to patients who have findings consistent with inflammatory arthropathy but who do not have the typical characteristics of any other condition or cannot be grouped within the other pathologies described (48). They are usually associated with *HLAB27* positive arthropathies and are considered a diagnosis of exclusion.

With regard to imaging findings, these patients may take various paths or manifest varied joint involvement. There may be manifestations in the axial skeleton similar to those of spondyloarthritis, but of lesser severity. On the other hand, there may be manifestations in the appendicular skeleton similar to psoriatic arthritis and RA, although these are equivocal. In the natural history of the disease, the findings of one of these pathologies can be established, and the patient will ultimately be classified into one of the aforementioned groups. This usually occurs months after the onset of manifestations (Figure 13).



Figure 13. Undifferentiated spondyloarthropathy. Nonspecific joint manifestations, proximal, asymmetric involvement, with juxtarticular erosions and progressive joint space narrowing. During the progression of the disease, ankylosis of the carpus is predominantly seen on the right side.

Juvenile idiopathic arthritis

This term encompasses multiple joint disorders in the pediatric population (49). Although each disorder has different presentations and findings, they often overlap in the natural course of the disease, making differentiation difficult. This spectrum includes juvenile ankylosing spondylitis, psoriatic arthritis, enteropathic arthritis, seropositive juvenile RA, which differs from the adult form in that it involves periostitis and bone proliferation, as well as erosions without significant loss of joint space -and Still's disease- seronegative chronic arthritis. The juvenile counterparts of adult pathologies occur in older children and behave similarly, with greater bone proliferation given the greater adaptability of bone structures to joint damage.

Still's disease accounts for approximately 70% of cases of juvenile idiopathic arthritis. Three different forms have been described. The first, the classic form, has systemic manifestations with little or no joint involvement and accounts for 10% of cases. It appears between the ages of 3 and 15. Patients present with fever, anemia, polymorphonuclear leukocytosis, hepatosplenomegaly, lymphadenopathy, and polyarthritis. The second, polyarticular, is a disease more focused on the joints, with fewer systemic manifestations. The third, pauciarticular, is divided into oligoarticular (4 or fewer) or monoarticular. It is the most common manifestation and accounts for 50% of cases (50). It is usually associated with iridocyclitis (51).

In general, imaging findings of Still's disease include edema of the periarticular soft tissues, osteopenia -juxtarticular, radiolucent metaphyseal bands, or, in more severe cases, diffuse- periostitis, and epiphyseal overgrowth or bulging. Advanced or premature skeletal maturation due to early closure of the physis and arrest of long bone growth in the context of bone proliferation and inflammatory changes may also be found. Some late findings include loss of joint space, erosions, and ankylosis. Additionally, in polyarticular disease, the distribution is usually bilateral and symmetrical, the pauciarticular variant is sporadic, asymmetrical, and mainly affects the knee, followed by the ankle, elbow, and wrist; and the polyarticular variant mainly affects the hands, wrists, feet, and knees. Other less common sites include the hip, cervical spine, and jaw (50).

Specifically, in the hands and wrists, Still's disease mainly manifests bilaterally and asymmetrically in the wrist. The involvement is distal and proximal, affecting the distal and proximal interphalangeal joints and the metacarpophalangeal joint. Periarticular edema, juxtarticular osteopenia, and periostitis can be found in the metaphysis and diaphysis of the phalanges and metacarpals, bulging of the epiphyses. There is enlargement and deformity of the carpal bones with premature maturation and erosions, ankylosis of the wrist that usually spares the radiocarpal joint, brachydactyly due to premature fusion of the physis, and compression fractures caused by flattening of the heads of the metacarpals and proximal epiphyses in the "cup" of the proximal phalanges.

Findings similar to those in the hand and wrist are evident in the feet and ankles. Thus, distribution may be distal and proximal in the interphalangeal, metatarsophalangeal, and tarsal joints. There may be similar metaphyseal and diaphyseal periostitis, as well as tarsal involvement and ankylosis. On the other hand, the knee is most frequently affected in the pauciarticular variant. Periarticular edema and juxtarticular osteopenia with radiolucent metaphyseal bands are seen. Other findings include epiphyseal bulging with overgrowth of the femoral condyles and enlargement of the intercondylar groove, as well as patellar overgrowth with an elongated or square configuration, similar to that seen in hemophilia. Additionally, flattening of the condyles and shortening of the bodies with an antegnathic notch immediately distal to the mandibular angle can be seen in the mandible. Finally, involvement of the cervical spine is variable. In juvenile RA, the atlanto-odontoid junction is usually affected in the same way as in its adult counterpart. However, this is rare in Still's disease, where facet ankylosis is more common, predominantly in C2-C3 (Figures 14 and 15).



Figure 14. Juvenile idiopathic arthritis. A 33-year-old patient with long-standing disease, showing severe involvement of the ankle and tarsus, with diffuse osteopenia, tarsal ankylosis with slight involvement of the tarsometatarsal joint. Epiphyseal bulging of the distal tibia.

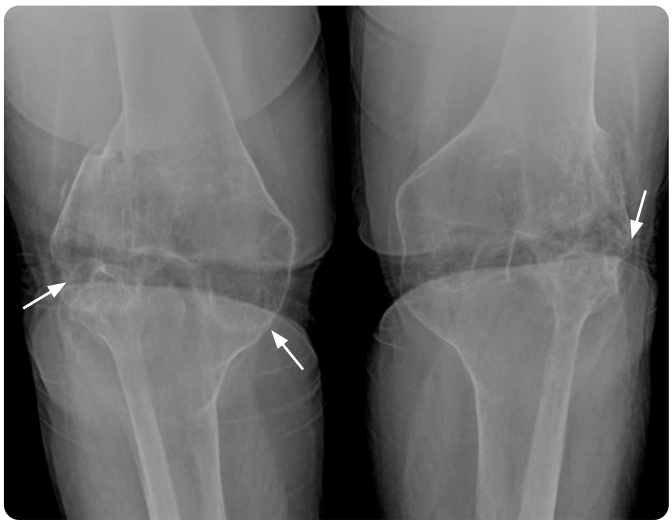


Figure 15. Same patient as in Figure 14, with evidence of ankylosis of the three compartments of the knee, with epiphyseal bulging and severe osteopenia predominantly in the periarticular region. Deformity of the right femoral metaphysis due to an old fracture.

Conclusion

There are different imaging modalities for addressing inflammatory arthropathies, from diagnosis and clinical follow-up to prognosis assessment. In this vein, the ABCDE'S approach to inflammatory arthropathies is offered as an initial approach; however, each pathology has specific characteristics to guide etiology, which in turn vary according to the imaging technique used.

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