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Evaluation through imaging of early rheumatoid arthritis☆

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ABSTRACT

Radiography is the most widely utilized imaging modality for measuring joint damage in early rheumatoid arthritis. Conventional radiography is, however, insensitive for showing bone erosions and is totally unsuitable for assessing synovial inflammation. The recognition of these limitations has led to intense interest in ultrasonography and magnetic resonance imaging for assessing synovitis and bone erosions. Magnetic resonance imaging allows detection of bone marrow edema, which is considered to be a very early marker of inflammation as well as a "forerunner" of erosions.

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Valoración por imagen de la artritis reumatoide precoz

Palabras clave:
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RESUMEN

Las radiografías continúan siendo la técnica más utilizada para evaluar el daño articular en la artritis reumatoide precoz. Sin embargo, su baja sensibilidad en la detección de erosiones y la imposibilidad de identificar la sinovitis ha propiciado la introducción de otras modalidades de diagnóstico por imagen, como la ecografía y la resonancia magnética (RM), que permiten la identificación directa de la inflamación sinovial y de las erosiones. La RM tiene la ventaja de permitir el diagnóstico del edema óseo, que se considera como un marcador precoz de inflamación activa y un precursor de la aparición de nuevas erosiones.

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Introduction

Imaging techniques play an increasingly important role in diagnosis at the initial stages of rheumatoid arthritis (RA), called early onset or recent onset RA, characterized by symptoms lasting less than 6 or 12 months, according to different authors.

The imaging techniques that are reviewed in this article are simple X-rays, ultrasound, computerized tomography (CT) and magnetic resonance imaging (MRI). While x-rays are only capable of detecting destructive joint changes produced by an inflammatory process, both ultrasound and MRI can identify not only destructive changes, but also inflammation starting at early stages of the disease. Special emphasis will be given to the advantages and disadvantages of MRI compared with other techniques, providing some guidance on possible indications in patients with early RA.

Radiographs

Radiographs are the gold standard in daily clinical practice for assessing joint damage caused by disease. Detection of erosions on radiographs is one of the classification criteria proposed by the American College of Rheumatology (ACR)[1] and is used in the diagnosis. H☆owever, the percentage of patients with early RA in which erosions are identified on radiographs ranges between 8% and 40% according to different series.[2-6] On the other hand, the assessment of inflammatory joint involvement is indirect and insufficient, detecting only periarticular soft tissue swelling. Its projectional imaging character, in which a three-dimensional structure is represented in two dimensions thus overlapping structures, as well as the use of ionizing radiation are other well-known disadvantages of radiographs.

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Despite its drawbacks, especially its low sensitivity in detecting early joint damage, radiographs represent a useful technique because of their low cost, easy availability and reliability.

Ultrasound

Ultrasound allows direct detection of synovial inflammation and bone erosion. The use of color Doppler and Power Doppler detects the increased vascularity of synovitis, which facilitates differentiation from effusion, and erosions, allowing differentiation from synovial cysts and subchondral geodes. A high correlation between Dopper ultrasound and MRI with intravenous contrast in the detection of synovitis in the wrist and joints of the finger has been described[7] (Figure).

Ultrasound has proven more sensitive than radiographs in detecting erosions in the fingers and metatarsal-phalangeal joints.[8,9] When compareing ultrasound with MRI for the detection of erosions, the sensitivity is very similar in accessible locations such as 2nd and 5th metacarpophalangeal, metatarso-phalangeal or interphalangeal joints and worse in the 3rd and 4th metacarpophalangeal or metatarso-phalangeal joints, that are only approachable from the dorsal and palmar sides but not the lateral, and much worse than MRI in complex anatomical areas such as the wrist.[7,9]

The disadvantages of ultrasound are the fact that it is of an explorer-dependent nature, the problems of reproducibility of results and the technical limitations of the test in the evaluation of deep joints.

Computed tomography

The introduction of the multidetector CT technology has represented a breakthrough in the study of osteoarticular pathology, allowing the obtention of very thin slices, thinner than 1 mm, and reconstructions in any plane of space with the same quality as the original slices obtained.

There is little experience with the CT evaluation of patients with early RA, and sensitivity to change in the soft tissue with this test is less than that of ultrasound and MRI. However, its multiplanar nature and the quality of bone imaging is useful when detecting bone erosions with great sensitivity. In fact, two series have been published, one which compares X-rays, ultrasound and MRI for the detection of erosions using multidetector CT as the technique of reference,[10] and a second in which a high correlation between the volume of bone erosions detected by MRI and multidetector CT was shown.[11]

MRI

The growing role of MRI in early diagnosis is owed to its ability to detect and characterize the involvement of the synovial membrane, and to identify erosions and changes of subchondral bone edema.

Diagnosis of synovitis by magnetic resonance

The diagnosis of synovitis by MRI is based on three criteria.[12]

1) the increasing size of the synovium
2) the increasing water content of the joint, and
3) the increasing signal of the synovium after intravenous contrast administration.

Given the small size of the normal synovium, MRI cannot identify it correctly in healthy individuals. On the contrary, the increasing size of the synovium that occurs in RA synovitis can be easily

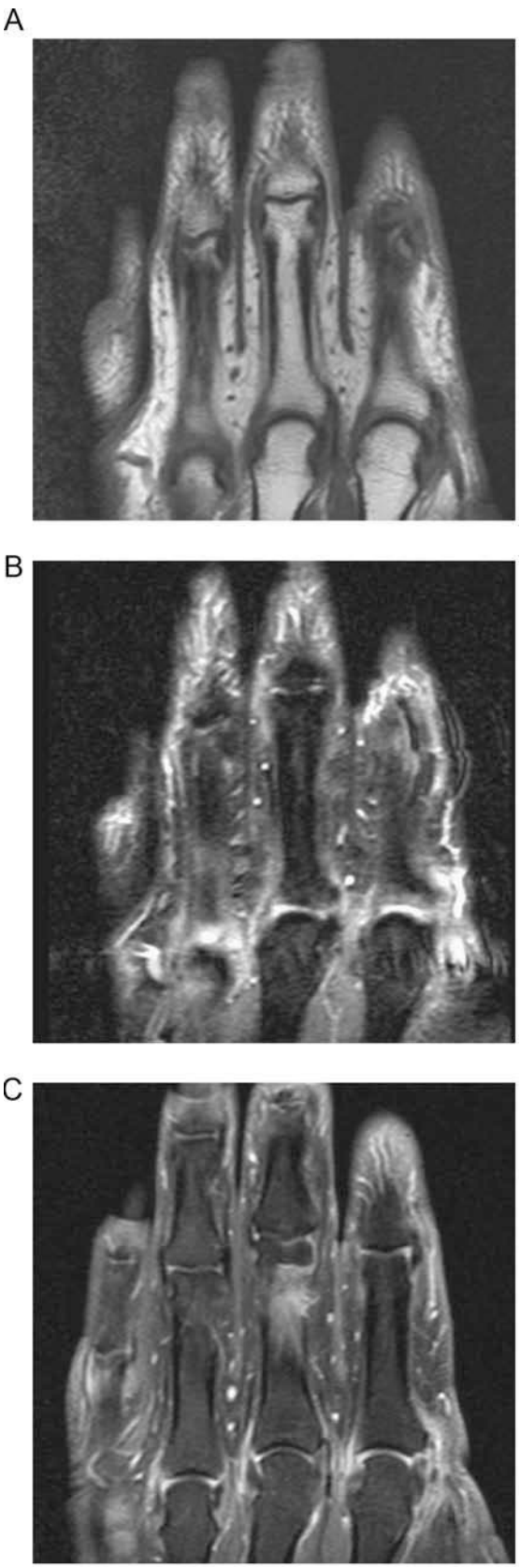

Figure. A) Coronal cuts on the MR in T sequences, B) Short Tau inversion recovery (STIR). C) T1 with fat suppression and, after administration of intravenous contrast, changes due to synovitis can be seen in the metacarpophalangeal joints, with a low T1 signal, high STIR signal and intense enhancement after administration of contrast.

identified on T1 sequences, with or without intravenous contrast administration, and to a lesser extent on T2.

The increased water content of the inflamed synovium is identified on T2, in which synovitis has a high signal. However, acute synovitis and joint effusion present a similar appearance in MR sequences with low signal on T1 and high on T2. Although effusion tends to have a homogeneous signal, lower in T1 sequences and higher on T2, than synovitis, differentiation of the two requires in most cases intravenous administration of contrast material.[13,14]

Compared with the normal synovial membrane, the inflamed synovium of RA has an increased capillary perfusion and capillary permeability,[12] so that intravenous contrast administration diffuses quickly through the synovium and leads to intense synovial signal enhancement. The assessment of contrast enhancement is performed on T1 sequences, in which fat tissue has a high signal, so it is useful to use sequences with fat suppression, which cancel it, better identifying areas of synovial uptake.

The intense enhancement of synovitis after intravenous contrast administration allows the differentiation from joint effusion, which shows no significant enhancement over a period of between 5 and 15 minutes after injection.

Chronic synovitis presents fibrotic changes that are reflected in a reduction of signal on T2 and a reduction in contrast enhancement.[14,15]

MRI has proven to be more sensitive than physical examination in detecting synovitis, even in small joints of the hands and feet, and can also detect active synovitis in patients without any analytical alteration,[16] which would allow for the diagnosis of atypical or inconclusive arthritis situations or clinical presentations.

Edema of the bone marrow or bone edema

MRI is very sensitive in detecting bone marrow edema or bone edema, a relatively nonspecific finding also seen in tumors, infections, trauma and ischemia, but that is characteristic of joint involvement in RA, not only in its early stage. On the one hand, it is considered an early marker of inflammation, given the correlation between detection by MRI and increased acute phase reactants and the values of the clinical scales for assessing disease activity.[6,16-18] Lee et al demonstrated a reduction of bone edema in RA patients in clinical remission, suggesting a link with disease activity.[19]

Moreover, in RA, bone edema is closely correlated with the presence of synovitis, and is considered a precursor of the appearance of erosions during follow-up[6,16,20-22] and therefore can be used as a prognostic marker of joint destruction. In some series, bone edema been has shown to be rare in the absence of synovitis in patients with early rheumatoid arthritis.[6,16-22] Bone edema can be isolated or associated with erosions and most authors consider that while bone edema represents a potentially reversible stage of bone inflammation[23,24] and of osteitis, erosions represent permanent structural damage, with little capacity for regeneration. In this regard, a recent preliminary study correlated the detection of changes of bone edema on MRI and histology of resected surgical specimens of metacarpophalangeal joints and interphalangeal of patients with RA, showing that bone edema is caused by an inflammatory infiltrate of the bone marrow.[25]

Bone marrow edema correctly differentiates erosions in RA, on the basis of their morphological characteristics and the behavior of their signal: ill-defined edges, diffuse decreased signal on T1 sequences, increases on T2 and enhancement after contrast administration.[20,21,23,26]

Erosions

MRI is more sensitive than X-rays, and has a similar or much higher sensitivity than ultrasound, according to studies regarding the diagnosis of joint erosions. In series of patients with an early onset RA, erosions in MRI show percentages reaching over 70%.

Detection of erosions in early rheumatoid arthritis, with radiographs and/or MRI has a predictive value on the appearance of new erosions in radiographs during monitoring.[27] Moreover, McQueen et al demonstrated that 82% of cases of early onset RA without erosions on MRI studies at baseline, had no erosions on radiographs after 2 years of follow up, allowing the identification of non progressive forms with little destructive activity.[6]

Erosions were defined as juxtaarticular bone defects in the MR, to be seen in two different planes, with an interrupted cortex identified in at least one level.[26] Erosions have the same signal and contrast enhancement than synovitis.[26] To avoid overestimation of joint damage, it is essential to be strict in the use of this definition.

Rating scales joint lesions detected by magnetic resonance

Although there are qualitative, quantitative and semiquantitative methods for assessment of articular lesions detected by MRI in RA, the most widespread method is called RAMRIS (Rheumatoid Arthritis, Magnetic Resonance Imaging Score) developed by an interdisciplinary task force of OMERACT (International Consensus Conference on Outcome Measures in Rheumatology).[26]

Clinical indications

Clinical situations in which MRI may be indicated[28] are the following: 1) clinical suspicion of arthritis with inconclusive examination and/or analytical, 2) early unclassified arthritis, lasting less than 6 or 12 months, to assist in differential diagnosis, and 3) new onset RA, especially without erosions on x-rays to establish the prognosis and the baseline level of bone destruction. In our experience, in patients with clinically suspected early seronegative RA and without erosions on x-rays, MRI used in the diagnosis has a specificity of 78% and a sensitivity of 100%, whereas anti-CCP antibodies have a specificity of 100% and a sensitivity of 23%.[29]

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