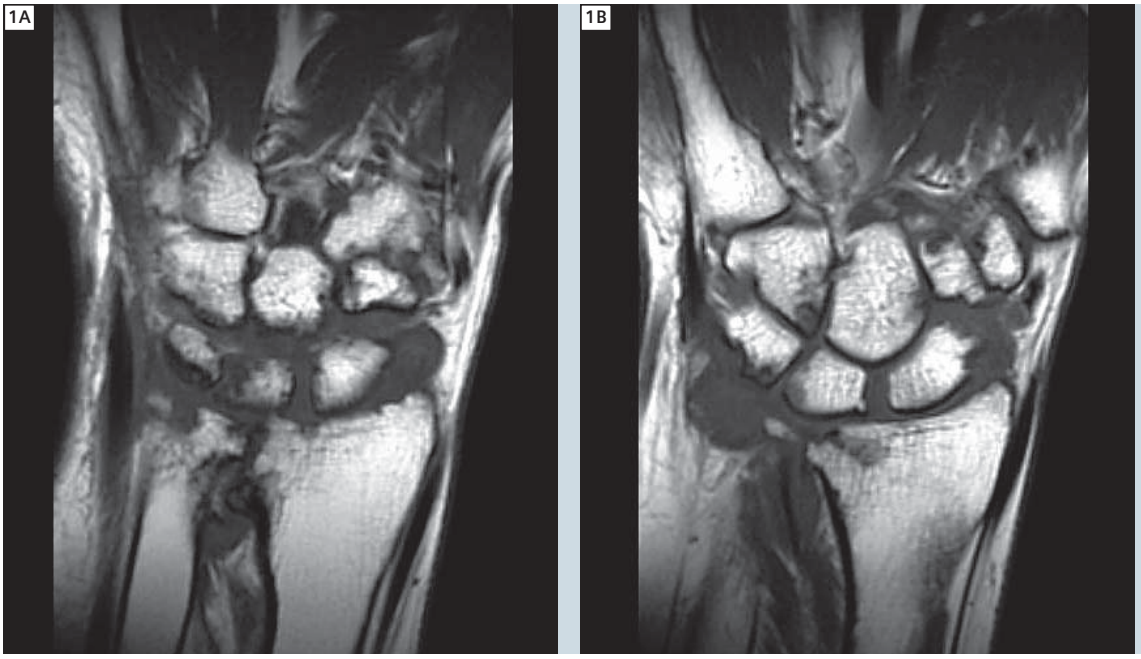

1 Coronal T1w TSE of the wrist in case of advanced rheumatoid arthritis. Multiple erosions of the bones and resulting severe destruction of the joints is shown.

The Importance of MRI of the Wrist in Patients with Rheumatoid Arthritis

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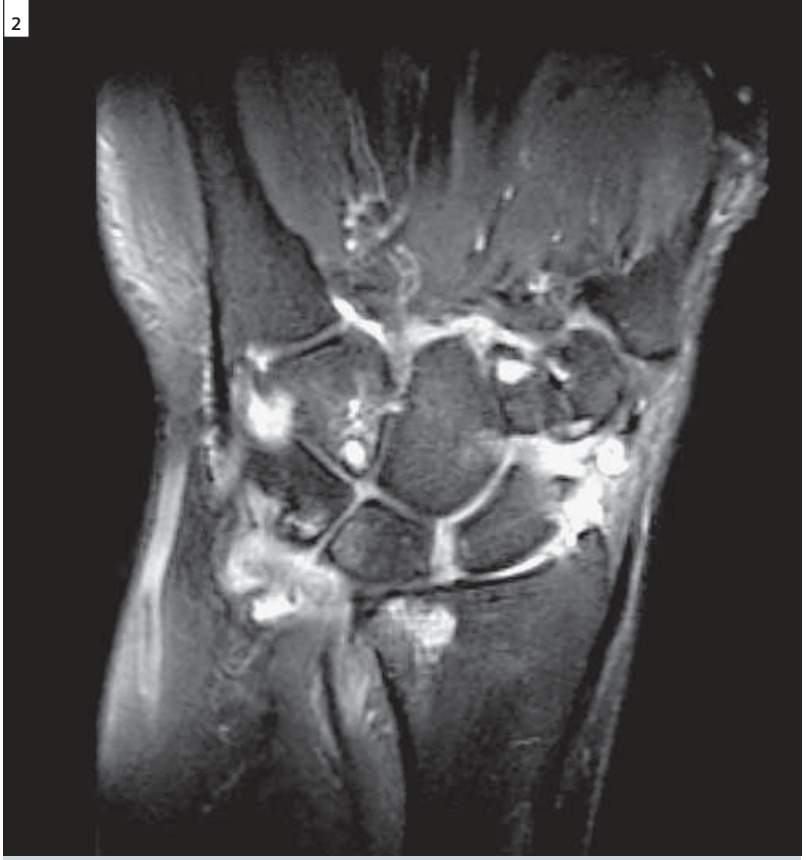
Introduction

Rheumatoid arthritis (RA) is a chronic inflammatory disease affecting the joints, mainly the metacarpo-phalangeal joints (MCP) and the carpal joints.
MR imaging (MRI) is the only imaging modality that can directly detect the early findings of the disease such as bone marrow edema (BME) and synovitis [1]. Moreover MRI can detect tendosynovitis and bone erosions with greater sensitivity than in standard radiography.
The treatments with anti-tumor necrosis factor (TNF) drugs are very expensive and carry potential severe infectious adverse effects. Therefore it is very important to have an early and accurate diagnose of RA which is possible with MRI associated with clinical and laboratory findings. Moreover an early treatment with anti-rheumatic drugs seems to have a better disease outcome at 2 years [2].
We will review the MRI signs of RA such as BME, synovitis/tendosynovitis and bone erosions. The first three manifestation of the disease are included in the rheumatoid arthritis MRI scoring system (RAMRI) of the outcome measurement in Rheumatology clinical trials (OMERACT) [3]. We will not treat cartilage loss that should be treated separately, due to its complexity and the presence of different promising emerging techniques.

MRI in patients with Rheumatoid arthritis

Bone marrow edema is a sign of early manifestation of RA and it shows low signal intensity ill defined areas on T1-weighted sequences and high signal intensity in fluid sensitive sequences such as STIR or T2 fat sat. Several interesting considerations are important regarding BME. First, BME follows the same pattern than bone erosions



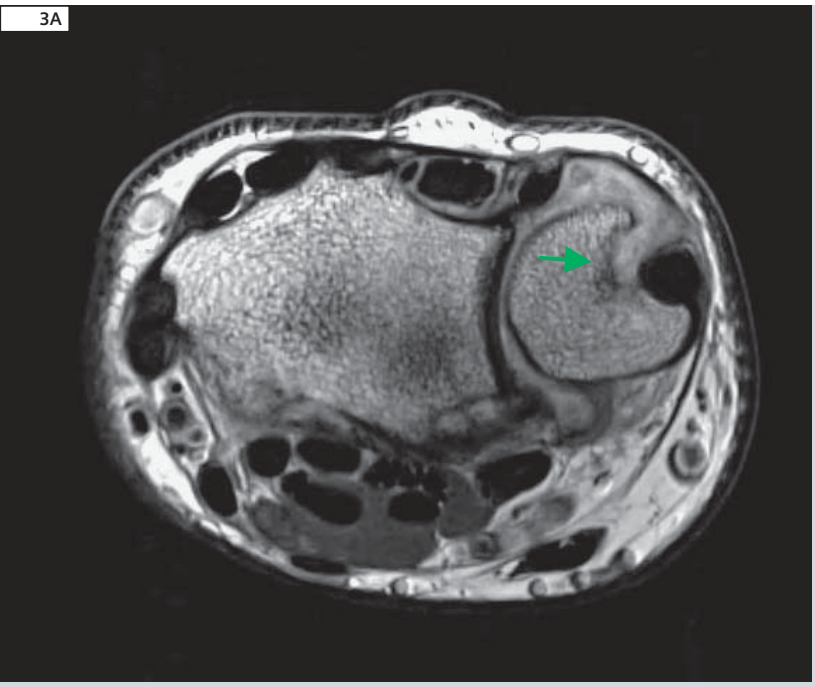
2 Corresponding T1w contrast-media enhanced image to figure 1 is shown. Synovial enhancement as a consequence of acute inflammatory process is present in this case.

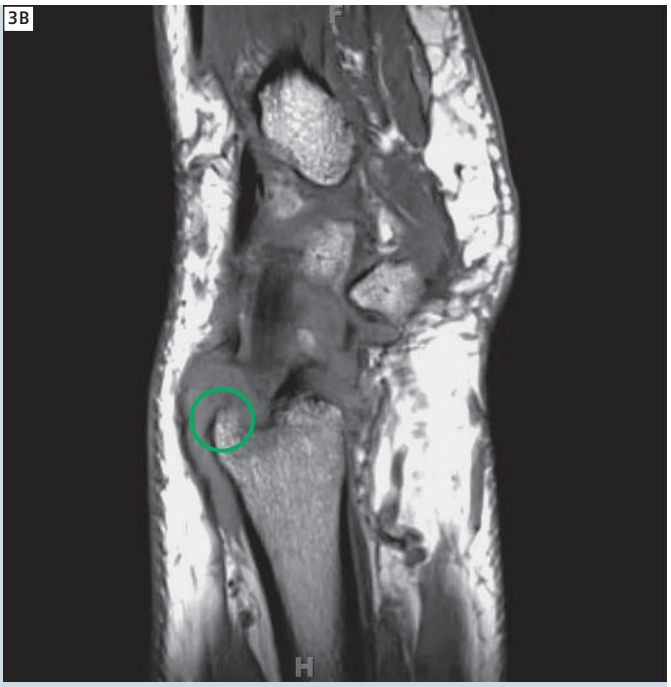
suggesting that bone marrow edema is the precursor of bone erosions [4]. Second, BME is the most important prognostic factor for progression of the disease. The authors of one study [5] were able to correctly detect the disease progression in 82% of the cases with a sensitivity of 81% and a specificity of 82% using clinical (hand arthritis, morning stiffness) laboratory (positivity for RF) and imaging criteria (bone marrow edema score in MCP and carpal joints). Another 2-years randomized controlled trial [6] concluded that MRI bone marrow edema is the strongest predictor of progression of the disease in hand, wrist and foot. Third, according to Olech et al. [7] bone marrow edema is the most specific sign (among bone marrow edema, synovitis and bone erosions) for RA. The study [7] showed that BME was 65% sensitive and 82.5% specific for RA and, if the lunatum was not included in the scoring system, the sensitivity decrease to 62.5% but the specificity increase to 87.5%. BME was present in 15% of the control group subjects and, if the lunatum was excluded, in 12.5% of the subjects. Interestingly no one healthy subject presented bone marrow edema in the MCP joint.

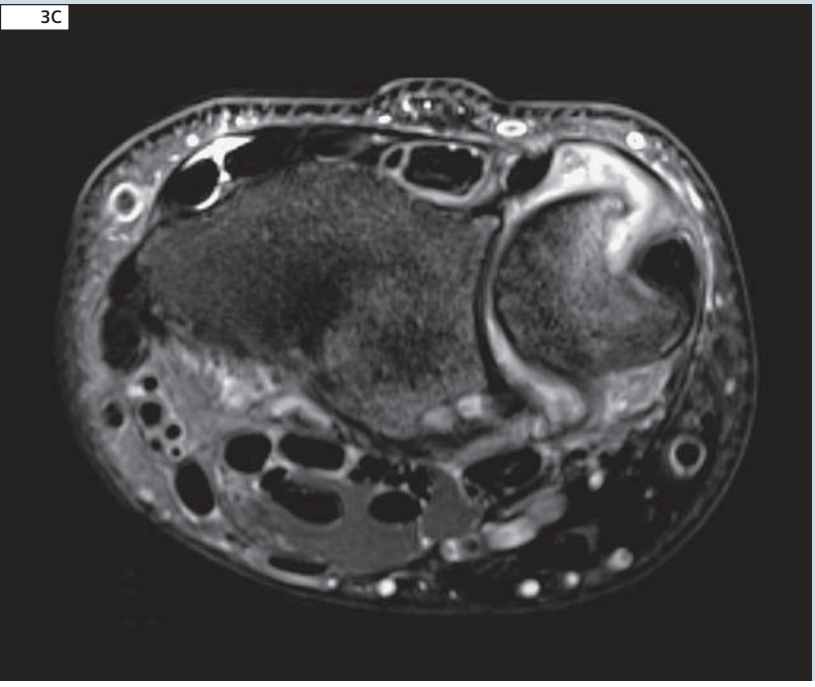
Bone erosions represent "the focal loss of cortical and/or underlying trabecular bone" [8] and are better visualized in T1-weighted sequence as interruption of the cortical and trabecular bone. According to the RAMRI criterion bone erosions are defined as follows: "a sharply marginated bone lesion, with correct juxta-articular localization and typical signal characteristics, which is visible in two planes with a cortical break seen in at least one plane" [3]. MRI has a moderate sensitivity (61%) and a good specificity (93%) to detect bone erosions compared to CT as a gold standard whereas standard radiography has a sensitivity of 24% and a specificity of 99% [9]. In order to effectively diagnose bone erosions it is mandatory to run MRI protocols with thin slices (ideally 1 mm), high spatial resolution in two planes according to RAMRI score criteria [10]. Here 3 Tesla MRI could play an important role in the near future, due to its higher signal-to-noise ration (SNR) and the potential to obtain high resolution isotropic 3D sequences.

The starting point of the disease process of RA seems to be the inflammation of the synovium which leads to high cellular inflammatory tissue, the pannus, which in turn is responsible for the cartilage and the bone destruction (bone erosion) [1, 11]. Synovium presents on MRI with low signal intensity on T1-weighted sequences and with high signal intensity on fluid sensitive sequences. Compared to free fluid the intensity signal of synovium is slightly higher on T1-weighted sequences and slightly lower on T2 fat set sequences.

Contrast-enhanced MRI is mandatory in RA patients in order to detect and quantify the inflammation synovium enhancement following the RAMRIS score whereas detection and quantification of BME and bone erosion don't need the administration of Gadolinium. One interesting study of Agarwal et al. [12] used diffusion tensor imaging (DTI) in order to test an alternative method to evaluate the inflammation of the synovium in 18 patients and 6 volunteers. The principle of DTI is based on the isotropic or anisotropic movement of water molecules. The molecules are moving isotropic if they can move freely in all direction like in fluid whereas they are moving anisotropic if they are limited in the movement due to other components like in tissues. The degree and direction of diffusion can be described in a scale value from 0 to 1 [8]. In patients with RA the water molecules present a restricted motion due to the fractional anisotropy of the inflammatory fluid (effusion). According to the study these







3 Synovial reaction and early signs of bone errosion of the ulnar styloid processus. **3C**: Corresponding T2w image with fat saturation showing oedema within the bone and fluid collection as well as thickening of the synovia.

values are significantly altered in patients with RA compared to healthy individuals. DTI is by no doubt an interesting and promising technique to study the synovial inflammation with the great advantage of the absence of contrast media and the risks that are connected such as nephrogenic systemic fibrosis [13], acute adverse reactions and other, less important but common adverse events, such as extravasations. Moreover, according to the study, DTI has a similar sensitivity in detection synovial inflammation compared to conventional T1-weighted fast SE fat sat sequences. According to one recent study [14] even flexor tendosynovitis, that can be detected with MRI or sonography, has a strong predictive value for RA. The study analyzed 99 patients with unspecific arthritis or suspected RA and negative standard X-rays. Moreover by adding RF or anti-cyclic citrullinated peptides (anti-CCP) the predictor was stronger with a sensitivity of 83% and a specificity of 63% [14].

Conclusion

MRI is an imaging modality that can detect RA in the early stadium. This information is mandatory to start appropriate therapies that are very expensive and that carry potential severe adverse reactions. Due to its higher SNR and the potential increase in spatial resolution, 3 Tesla MRI will probably play an important role to improve the detection of bone erosions and to implement new technique in the near future without the need of gadolinium administration.

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