Optimized, low-cost, low-field dedicated extremity MRI is highly specific and sensitive for synovitis and bone erosions in rheumatoid arthritis wrist and finger joints – a comparison with conventional high-field MRI and radiography

Bo Ejbjerg, Eva Narvestad, Søren Jacobsen, Henrik S. Thomsen, and Mikkel Østergaard

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Optimized, low-cost, low-field dedicated extremity MRI is highly specific and sensitive for synovitis and bone erosions in rheumatoid arthritis wrist and finger joints – a comparison with conventional high-field MRI and radiography

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Keywords:
Rheumatoid arthritis, high-field MRI, low-field MRI
Abstract:

Objective
To evaluate a low-field dedicated extremity MRI-unit for detection of bone erosions, synovitis and bone marrow edema in wrist and metacarpophalangeal (MCP) joints, with a high-field MRI-unit as the standard reference.

Methods
In 37 RA patients and 28 healthy controls MRI of the wrist and 2nd-5th MCP-joints was performed on a low-field MRI-unit (0.2 T Esaote Artoscan) and a high-field MRI-unit (1.0 T Siemens Impact) on 2 subsequent days. MRI was performed and evaluated according to OMERACT recommendations. Additionally, conventional X-ray, clinical and biochemical examinations were performed. In an initial low-field MRI “sequence-selection-phase”, based on a subset of 10 patients and 10 controls, the sequences for comparison with high-field MRI were selected.

Results
With high-field spin-echo MRI considered as the reference method, the sensitivity, specificity and accuracy of low-field 3D gradient-echo MRI for erosions were 94%, 93%, 94%, while the corresponding values for X-ray were 33%, 98% and 83%. The sensitivity, specificity and accuracy of low-field MRI for synovitis were 90%, 96% and 94%, while for bone marrow edema 39%, 99% and 95%. The intra-class correlation coefficients between low-field and high-field scores were 0.936 (p<0.005) for bone erosions and 0.923 (p<0.05) for synovitis.

Conclusion
Low-field MRI provided very high accuracy for detection and grading of erosions and synovitis, when high-field MRI was considered the standard reference. For bone marrow edema, the specificity was high, but the sensitivity only moderate. Low-cost, patient compliant, low-field dedicated extremity MRI can provide similar information on bone erosions and synovitis as expensive high-field MRI units.
The treatment strategy in rheumatoid arthritis (RA) has changed markedly during the last decade with emphasis on completely suppressing joint inflammation and preventing structural joint damage and functional disability as early as possible during the course of the disease (1-3). Due to this early and extensive treatment approach, there is a growing need for sensitive and specific tools for both early diagnosis and monitoring disease activity and joint damage. Furthermore, markers of prognostic significance are also called for.

The examination modalities currently used for assessment of disease activity and structural joint damage – clinical examination, composite disease activity scores, biochemical assessment and conventional radiography – are not sufficiently sensitive or specific, especially in early disease (4-6). In recent years new methods for diagnosing and monitoring RA have evolved. In particular, magnetic resonance imaging (MRI) is a promising tool as it offers the opportunity for an examination of all aspects of the rheumatoid joint disease, visualizing both destructive and inflammatory disease manifestations.

MRI performed on high-field units has in previous studies been more sensitive than conventional methods for detection of synovitis and bone changes in patients with RA (5, 7-10). Low-field dedicated extremity MRI units are more comfortable for the patients and less expensive, but largely unvalidated (11-14).

The objective of this study was to evaluate low-field dedicated extremity MRI unit with respect to detection and grading of synovitis, bone marrow edema and MRI erosions in wrist and metacarpophalangeal (MCP) joints, with high-field MRI unit as the standard reference, and to compare the MRI findings with the destructive joint changes on x-ray.

**Patients and methods**

Thirty-seven patients, 13 men and 24 women, with RA, fulfilling the ACR 1987 revised diagnostic criteria (15) and 28 healthy controls were enrolled in the study. All subjects were recruited from the Department of Rheumatology, Copenhagen University Hospital at Hvidovre. Local ethics committee approval was obtained prior to commencing the studies.

**Clinical and biochemical examination**

All clinical examinations were performed by the same rheumatologist. The examinations included assessment of joint swelling and joint tenderness as recommended by EULAR (16). Furthermore every person taking part in this study filled in a Health Assessment Questionnaire (17). The laboratory tests covered serum C-reactive protein (reflection photometry) and IgM rheumatoid factor (turbidimetry). Disease Activity Scores based on 28 joint assessments (DAS28) were computed for all patients (18).

**Conventional radiography**

X-ray of the wrists and hands were performed in the posterior-anterior and oblique projections (19). All radiographs were evaluated by the same radiologist who had no access to data and results of the MRI findings. Radiographic bone erosions were evaluated separately in each wrist bone and MCP bone quadrants.

**Magnetic resonance imaging**

MRI of the wrist and 2nd-5th MCP joints of the dominant hand was performed twice on two different MRI units, i.e. a 1.0 T Siemens Impact high-field MRI unit equipped with a circular polarized transmit-receive coil and a 0.2 T Artoscan (Esaote Biomedica) low-field dedicated extremity MRI unit equipped with a dual phased array coil.

The MRI scans were performed on two subsequent days to ensure complete clearance of the intravenously injected contrast agent (0.1 mmol gadolinium-DTPA-BMA/kg body weight – Omniscan (Amersham Health)) and still allowing only minimal time for biological variations.

**High-field MRI:** On the high-field MRI unit, the following procedures were performed: The sub-
jects were positioned prone with the hand fixed above the head in the centre of the coil (superman position). T1-weighted spin echo (T1-SE) sequences were obtained in the coronal and axial planes before and after intravenously injected contrast medium (Omniscan). In addition, a coronal short tau inversion recovery (STIR) and a coronal T2-weighted spin echo fat saturated (T2-SE-fs) sequence were obtained in the coronal plane before the contrast agent was administered. The imaging parameters for the different MRI sequences were as follows: T1-SE images: Repetition time (TR) 600 ms, echo time (TE) 15 ms, slice thickness 3 mm, field of view (FOV) 109 mm x 145 mm, matrix 192 x 256, number of acquisitions 2, number of repetitions 1. STIR sequence: TR 4500 ms, TE 30 ms, inversion time 150 ms, slice thickness 3 mm, FOV 109 mm x 145 mm, matrix 182 x 256, number of acquisitions 3, number of repetitions 1. T2-SE-fs sequence: TR 4500 ms, TE 96 ms, slice thickness 3 mm, FOV 109 mm x 145 mm, matrix 182 x 256, number of acquisitions 3, number of repetitions 1.

Low-field MRI: On the low-field MRI unit the following procedures were performed: The persons were seated in an adjustable chair with the dominant hand positioned in the centre of the coil in a neutral position. T1-weighted spin echo (T1-SE) sequences were obtained in the coronal and axial planes supplemented with a T1-weighted 3D Gradient Echo (T1-GE), with isometric voxels, before and after intravenously injected contrast medium (Omniscan). The gradient echo images were subsequently reconstructed with a slice thickness of 1 mm. A coronal short tau inversion recovery (STIR) sequence was obtained before the contrast agent was administered.

The imaging parameters for the different MRI sequences were as follows: T1-SE images: TR 550 ms, TE 18 ms, slice thickness 3 mm, FOV 200 mm x 200 mm, matrix 256 x 256, number of acquisitions 3. 3D-GE sequence: TR 30 ms, TE 12 ms, slice thickness 1 mm, FOV 140 mm x 140 mm x 80 mm, matrix 192 x 160 x 80, number of acquisitions 1, flip angle 65º. STIR: TR 1100 ms, TE 24 ms, inversion time 85 ms, slice thickness 3 mm, FOV 200 mm x 200 mm, matrix 192 x 160, number of acquisitions 3, interslice gap 0.3 mm.

MRI interpretation – preliminary evaluation: With the purpose to compare the sensitivity and specificity of the 3D gradient echo (recalled images) and the 2D spin echo sequence of the low-field MRI unit, we initially evaluated MR images from 10 patients and 10 healthy subjects. Conventional high-field MRI was considered the standard reference.

At the time of the preliminary MR image analysis there was no internationally accepted scoring system for MR images in RA, as later developed by the OMERACT MRI in RA Group (20). Accordingly, the scoring in the preliminary MR image evaluation was based on the methods used by our group in previous studies (21, 22).

Each image set (low-field spin echo, low-field gradient echo, and high-field spin echo) was evaluated in a blinded setting for presence or absence of MRI-erosions and synovitis. The evaluation of bone erosions comprised separate assessment of each MCP quadrant and wrist bone, while the evaluation of synovitis covered assessment of each joint (23). Based on the results of the preliminary evaluation (see later), we chose to use the 3D-GE recalled images from the low-field unit for the subsequent main MR image evaluation.

In the preliminary “sequence selection” phase, bone marrow edema was not assessed, because the low-field MRI unit used only allows assessment of bone marrow edema by means of the STIR sequence, while spectral fat saturation is not technically possible.

MRI interpretation – main evaluation: Each image set was evaluated separately for presence or absence of MRI-erosions, synovitis and bone marrow edema by an observer being blinded to findings by other modalities.

MRI bone erosions were evaluated separately in the metacarpal head and the phalangeal base of each MCP joint and in each wrist bone. Synovitis in MCP joints was evaluated on a “whole-joint basis”, while the wrist joint was divided into three regions: The radio-ulnar area, the radio-carpal
area and the intercarpal-carpometacarpal area. Finally, bone marrow edema was evaluated separately in the metacarpal head and the phalangeal base of each MCP joint and in each wrist bone. MRI bone erosions, synovitis and bone marrow edema were defined according to the latest OMERACT recommendations (20).

Statistical analysis
Agreement rates were calculated as sensitivity, specificity and accuracy. Intraobserver agreement was expressed as intra class correlation coefficients (24) (ICC, two-way mixed effects model with absolute agreement) using the Statistical Package for the Social Sciences for Windows, version 12 (SPSS, Chicago, Illinois). For the ICC-calculations a p-level below 0.05 was considered statistical significant.

Results
The characteristics of the patients are shown in table 1.
The results of the evaluations of the MR images are divided into two parts, i.e. the results from the preliminary MR image evaluation and the results from the main MR image evaluation.

Results of the preliminary MR image evaluation
Below, the performance of spin echo and gradient echo imaging on the low-field unit, with high-field MRI as standard reference, is described.
For destructive joint changes, the sensitivity of the T1-weighted gradient echo images (T1-GE) was markedly higher than the sensitivity of the T1-weighted spin echo images (T1-SE) (table 2). This gain in sensitivity was obtained without compromising the specificity and accuracy.
When synovitis was evaluated, the sensitivity was moderately higher on T1-GE images compared to the T1-SE images, but this was at the expense of slightly lower specificity, but not accuracy.
Based on the findings of an overall higher accuracy of the GE sequence in the preliminary study, it was decided to do all subsequent analyses, i.e. the “main MRI evaluation”, based on the data obtained on the low-field MRI units’ T1-GE images.

Results of the main MR image evaluation
Bone erosions on high-field and low-field MRI: In total 1431 wrist and MCP joint bones were evaluated for the presence of bone erosions. High-field MRI detected 318 erosions and low-field MRI detected 370 erosions. The mean sensitivity, specificity, accuracy and intra class correlation coefficients (ICC) of low-field MRI with respect to detection and grading of erosions, when high-field MRI was considered the standard reference, was found to be 94%, 93%, 94% and 0.936 (p<0.005), respectively.
Bone erosions on high-field MRI and X-ray: The amount of erosions detected by X-ray and high-field MRI in the wrist and MCP joint bones displayed 123 and 318 erosions, respectively. The bone erosions were detected in 1495 bones. The mean sensitivity, specificity and accuracy of X-ray with respect to detection of erosions, when high-field MRI was considered the standard, was found to be 33%, 98% and 83%, respectively.
Bone marrow edema on high-field and low-field MRI: The amount of bones with bone marrow edema detected by high-field MRI and low-field MRI in the wrist and MCP joint bones were 102 and 55, respectively. As for erosions, 1431 bones were evaluated for the presence of bone marrow edema. The mean sensitivity, specificity and accuracy of low-field MRI with respect to detection of bone marrow edema (high-field MRI was considered the standard reference) was 39%, 99% and 95%. The overall ICC could not be computed because some of the measurements had less than two non-zero values.
Synovitis on high-field and low-field MRI: The numbers of areas with synovitis detected by high-field MRI and low-field MRI in the three wrist areas (distal radioulnar joint, radiocarpal joint and the intercarpal-carpometacarpal area) and the MCP joints in all subjects were 172 and 164, respec-
tively. The mean sensitivity, specificity, accuracy and ICC of low-field MRI with respect to detection of synovitis, when high-field MRI was considered the standard, was 90%, 96%, 94% and 0.923 (p<0.05), respectively.

Discussion

The main objective of this study was to investigate whether a low-field dedicated extremity MRI unit could provide equivalent information on destructive and inflammatory joint changes as a standard high-field whole body MRI unit.

A most pertinent but often difficult question to answer when testing a new method is which reference method the new method should be tested against. In the present study, we chose to use high-field MRI as the standard reference since most published MRI data are based on this method and the fact that findings from high-field MRI has been shown to be highly correlated with histopathological and miniarthroscopic findings (25-28) and with future development of radiographic progression (29-32).

Very few published data are concerning the direct comparison of different MRI systems with respect to detection of arthritic joint pathologies. These studies have not incorporated any attempts to optimize the standard before the initiation of the studies (13, 14).

The results of the study were divided into two major parts, namely the results of the preliminary MR image evaluation and the results of the main study. In the preliminary image evaluation the performance of the low-field spin echo and gradient echo sequences were compared with high-field MRI as the standard reference. Due to markedly better sensitivity for bone erosions without loss of specificity and better sensitivity for synovitis although with a minor loss of specificity, the gradient echo sequence of the low-field MRI unit was selected for the subsequent main image evaluation.

Another advantage of gradient echo imaging was patient compliance, as time consumption of the MR examinations of the wrist and 2nd through 5th MCP joints, was about 45 minutes and 14 minutes for spin echo and gradient echo imaging, respectively.

Comparison of findings on X-ray and MRI showed that MRI detects more erosions than plain film radiography. This finding is in accordance with reports by several authors (7, 33-35). It should be noted that plain film radiography seems to detect a higher proportion of erosions in small bones, i.e. the pisiform and base of 5th metacarpal bone compared to the bigger ones (table 3). This was also reported recently by Forslind et al., who found plain film radiography to be as sensitive as MRI with respect to the detection of bone erosions in 5th MTP joints (36).

Low-field MRI in the main MR image evaluation demonstrated an overall very good agreement with high-field MRI with respect to detection of bone erosions and synovitis. For bone erosions, the agreement rates of the low-field MRI unit and the high-field were very encouraging with overall sensitivities, specificities, accuracies and intra class correlation coefficients of 94%, 93%, 94% and 0.926 (p<0.005) respectively. The findings are to some degree in accordance with data published by Savnik et al. and Taouli et al. (13, 14). However, Savniks’ group found similar rates based on total destruction scores, but at the level of the individual bone or joint area the agreement rates were not as high (13). Taouli et al. has recently reported that high-field and low-field MRI was equally informative with respect to erosive joint changes in wrists and finger joints. However, Taouli did only report erosion scores and not the results of the assessments of the individual bones. Our data show that the low-field dedicated extremity MRI unit could provide equivalent information on bone erosions as high field MRI on the level of the individual bone – both with respect to detection and grading.

The agreement rates for synovitis were comparable to the findings for the destructive changes. The low-field MRI unit displayed overall sensitivities, specificities, accuracies and intra class correlation coefficients of 90%, 96%, 94% and 0.923 (p<0.05) respectively. These findings are also com-
parable to previously published data, although the agreement rates were slightly lower (13). The poorer accuracy for synovitis, as well as erosions, in this study may be attributed to the lack of optimizing the scanning sequences on the reference MRI unit (13). The study by Taouli et al. did also compare the synovitis scores, but this study only assessed synovitis by means of non-enhanced MRI in the coronal plane. The study by Taouli may suffer from a lack in sensitivity due to the fact that the assessment of synovitis was performed on non-enhanced MR images – but on the other hand, the premises were the same for both images sets (high-field and low-field).

Based on our data we conclude that with optimal MRI sequence selection, the low-field dedicated extremity MRI unit can provide comparable information on inflammatory changes (synovitis) in RA peripheral joints as contrast-enhanced high-field MRI, using standard 2D spin echo sequences. The results of the comparison of the two MRI units with respect to detection of bone marrow edema were not as encouraging as the corresponding findings for erosions and synovitis. The overall sensitivity, specificity and accuracy of the low field MRI unit were 39%, 99% and 95% respectively. The ICC levels were generally low. Our conclusion was that the sensitivity for bone marrow edema on the low-field MRI unit was low. However, when bone marrow edema was demonstrated on the low-field MRI unit the findings were almost always correct (high specificity).

The low sensitivity of the low-field MRI unit with respect to detection of bone marrow edema may have negative impact of the usefulness of this type of scanner in RA if bone marrow edema will be proven to be a pathological event of major prognostic significance, as it has been proposed by McQueen and others (29, 37). But if bone marrow edema is only an interim phase between synovitis and bone erosion, this may not have major impact on the usefulness of low-field MRI in RA since the precursor of bone marrow edema is generally accepted as being synovitis. The latter still needs to be validated in further scientific studies.

We did find joint changes resembling bone erosions and synovitis in the healthy population, although few and only low grade changes. On the contrary, bone marrow edema was not detected in any healthy subject. A more detailed description of these aspects has been reported elsewhere (38). In conclusion the low-field dedicated extremity MRI unit used in this study provided information on bone erosions and synovitis comparable to the information from high-field MRI. High overall agreement was achieved for these types of pathologies. X-ray displayed a markedly lower sensitivity and accuracy, albeit the specificity for detection of bone erosions was slightly higher than in low-field MRI.

The low-field MRI unit displayed high specificity but only moderate sensitivity for detection of bone marrow edema. Further studies are needed to clarify the diagnostic and prognostic significance of the observed sensitivity of low-field MRI for bone marrow edema.
**Figure Legends:**

**Figure 1. Synovitis in RA MCP joints visualized by high-field and low-field MRI**

High-field (a + b) and low-field (c + d) axial images of the 2nd-5th MCP joints before (a + c) and after (b + d) intravenous contrast injection. Post contrast images show high grade synovitis (OMERACT grade 3) (arrows) in the 2nd MCP joint on high-field MRI as well as on low-field MRI, while low grade synovitis (OMERACT grade 1) (thin arrows) is seen in the 3rd MCP joint on images obtained on both field strengths.

**Figure 2. Synovitis in RA wrist joints visualized by high-field and low-field MRI**

High-field (a + b + c + d) and low-field (e + f + g + h) axial images of the wrist joint before (a + c + e + g) and after (b + d + f + h) intravenous contrast injection. Post contrast images in patient I (upper 4 images) show low grade synovitis (OMERACT grade 1) (arrows) in the intercarpal area of the wrist joint on high-field MRI as well as on low-field MRI, while high grade synovitis (OMERACT grade 3) (arrows) is seen in the radiocarpal area of the wrist joint in patient II (lower 4 images) on images obtained on both field strengths.

**Figure 3. Erosions in RA MCP joint bones visualized by high-field and low-field MRI**

High-field (a + b + c + d) and low-field (e + f + g + h) coronal (a + c + e + g) and axial (b + d + f + h) images of the 2nd-5th MCP joints. On high-field MRI as well as low-field MRI, an erosion (OMERACT grade 2) (arrows) is depicted in the 3rd metacarpal head (a + b + e + f) in patient I (upper 4 images). In patient II (lower 4 images) an erosion (OMERACT grade 3) (arrows) is depicted in the 2nd metacarpal head on both field strengths. All displayed images were obtained before contrast injection.

**Figure 4. Erosions in RA wrist joint bones visualized by high-field and low-field MRI**

High-field (a + b + c + d) and low-field (e + f + g + h) coronal (a + c + e + g) and axial (b + d + f + h) images of the wrist joints. On high-field MRI as well as low-field MRI, an erosion (OMERACT grade 5) (arrows) is depicted in the lunate (a + b + e + f) in patient I (upper 4 images). In patient II (lower 4 images) an erosion (OMERACT grade 1) (arrows) is depicted in radius (c + d + g + h) on both field strengths. All displayed images were obtained before contrast injection.

**Figure 5. Bone marrow edema in RA wrist joint bones visualized by high-field and low-field MRI**

High-field (a) and low-field (b) STIR images of the wrist. On high-field MRI, a low grade bone marrow edema (OMERACT grade 1) (arrow) is seen in the distal radius. The edema at this site is not detected on low-field MRI.
Table 1. Characteristics of patients and healthy controls.

<table>
<thead>
<tr>
<th></th>
<th>Controls (n=28)</th>
<th>Patients (n=37)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age [years]</strong></td>
<td>38 [24-57]*</td>
<td>52 [33-84]*</td>
</tr>
<tr>
<td><strong>Gender – female/male</strong></td>
<td>20/8</td>
<td>24/13</td>
</tr>
<tr>
<td><strong>Disease duration [years]</strong></td>
<td>0 [0-0]*</td>
<td>5 [1-37]*</td>
</tr>
<tr>
<td><strong>Tender joints [0-28]</strong></td>
<td>0 [0-0]*</td>
<td>8 [0-22]*</td>
</tr>
<tr>
<td><strong>Swollen joints [0-28]</strong></td>
<td>0 [0-0]*</td>
<td>6 [0-16]*</td>
</tr>
<tr>
<td><strong>Morning joint stiffness (minutes)</strong></td>
<td>0 [0-0]</td>
<td>15 [0-120]</td>
</tr>
<tr>
<td><strong>HAQ [0-3]</strong></td>
<td>0 [0-0]*</td>
<td>0.875 [0-2.375]*</td>
</tr>
<tr>
<td><strong>S-CRP [ref. &lt; 10 mg/L]</strong></td>
<td>8 [8-16]*</td>
<td>10 [8-111]*</td>
</tr>
<tr>
<td><strong>IgM-RF [ref. &lt; 17 kiu/L]</strong></td>
<td>&lt; 10 [&lt;10-31]*</td>
<td>123[&lt;10-4220]*</td>
</tr>
<tr>
<td><strong>IgM-RF positivity</strong></td>
<td>3.5%</td>
<td>73%</td>
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<tr>
<td><strong>DAS28 (serum CRP based)</strong></td>
<td>NA</td>
<td>4.36 [2.0-6.9]</td>
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<tr>
<td><strong>High disease activity (&gt;5.1)</strong></td>
<td>-</td>
<td>9</td>
</tr>
<tr>
<td><strong>Intermediate disease activity (3.2 - 5.1)</strong></td>
<td>-</td>
<td>23</td>
</tr>
<tr>
<td><strong>Low disease activity (2.6 - 3.2)</strong></td>
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<td>0</td>
</tr>
<tr>
<td><strong>Clinical remission (&lt;2.6)</strong></td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td><strong>HAQ</strong></td>
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<td>0.75 [0-2.38]*</td>
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<td><strong>Medication</strong></td>
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<tr>
<td>• <strong>DMARD</strong></td>
<td>-</td>
<td>70%</td>
</tr>
<tr>
<td>• <strong>Targeted biological therapy</strong></td>
<td>-</td>
<td>13%</td>
</tr>
<tr>
<td>• <strong>Corticosteroids</strong></td>
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<td>16%</td>
</tr>
<tr>
<td>• <strong>NSAID</strong></td>
<td>≠</td>
<td>35%</td>
</tr>
<tr>
<td>• <strong>Analgesics</strong></td>
<td>≠</td>
<td>29%</td>
</tr>
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*values are medians with ranges in [brackets]. DAS28 = Disease Activity Score based on 28 joints assessment, HAQ = Health Assessment Questionnaire, IgM-RF = IgM rheumatoid factor, s-CRP = serum C reactive protein. ≠ = Occasional use due to e.g. headache. DMARD = disease modifying antirheumatic drugs.
Table 2. Preliminary MRI evaluation*: agreement rates for bone erosions and synovitis of low field spin echo and gradient echo MRI with high-field spin echo MRI as standard reference.

<table>
<thead>
<tr>
<th>Type of MRI</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
<th>Accuracy (%)</th>
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<tbody>
<tr>
<td></td>
<td>T1-SE</td>
<td>T1-GE</td>
<td>T1-SE</td>
</tr>
<tr>
<td>Wrist erosions</td>
<td>56</td>
<td>87</td>
<td>95</td>
</tr>
<tr>
<td>MCP erosions</td>
<td>35</td>
<td>94</td>
<td>99</td>
</tr>
<tr>
<td>Wrist synovitis</td>
<td>85</td>
<td>92</td>
<td>86</td>
</tr>
<tr>
<td>MCP synovitis</td>
<td>65</td>
<td>81</td>
<td>97</td>
</tr>
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</table>

T1-SE = T1-weighted spin echo. T1-GE = T1-weighted gradient echo. *Based on assessment of 10 patients and 10 controls.
Table 3. Bone erosions and bone marrow edema in wrist and MCP joint bones. Performance of low-field MRI and X-ray when high-field MRI is considered as standard reference.

<table>
<thead>
<tr>
<th>Examined bone (No of examined bones)</th>
<th>High-field MRI</th>
<th>Low-field MRI</th>
<th>X-ray</th>
<th>High-field MRI</th>
<th>Low-field MRI</th>
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<tbody>
<tr>
<td></td>
<td>(No)</td>
<td>(No)</td>
<td>Sens. (%)</td>
<td>Spec. (%)</td>
<td>Acc. (%)</td>
</tr>
<tr>
<td>2nd MCP prox. (57)</td>
<td>21</td>
<td>22</td>
<td>100</td>
<td>97</td>
<td>98</td>
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<td><strong>Total (1431)</strong></td>
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<td><strong>370</strong></td>
<td><strong>94</strong></td>
<td><strong>93</strong></td>
<td><strong>94</strong></td>
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</tbody>
</table>

MCP = metacarpophalangeal. MCP prox = the head of the metacarpal bone. MCP dist = the base of the phalanx. Base = base of the metacarpal bone. * p-values < 0.005. ** p-values < 0.05. § not computable. # not significant. No = number of erosions. Hi = high-field MRI. Lo = low-field MRI. Sens. = sensitivity. Spec. = specificity. Acc. = accuracy. ICC = intra class correlation coefficient. Note: Eight persons had a limb size that precluded MRI examination of the MCP joints due to the size of FOV.
Table 4. Synovitis in wrist joint areas and MCP joints detected on high-field and low-field MRI. Agreement rates of low-field MRI were calculated with high-field MRI as standard reference.

<table>
<thead>
<tr>
<th>Examed joint/joint area (Number of joints/joint areas)</th>
<th>High-field MRI</th>
<th>Low-field MRI</th>
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<tr>
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<td>(No)</td>
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<td>3rd MCP (57)</td>
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<tr>
<td>5th MCP (57)</td>
<td>15</td>
<td>14</td>
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<tr>
<td>Ra-Ul (65)</td>
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<td>27</td>
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<tr>
<td>Ra-Carp (65)</td>
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<td>39</td>
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<tr>
<td>ICMC (65)</td>
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<td>26</td>
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<tr>
<td>Total (423)</td>
<td>172</td>
<td>164</td>
</tr>
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</table>

MCP = metacarpophalangeal, Ra-Ul = distal radioulnar joint, Ra-Carp = radiocarpal area of wrist joint, ICMC = intercarpal-carpometacarpal area of wrist joint. ICC = intra class correlation coefficient. * p < 0.05. No = numbers of joints/joint areas. Note: Eight persons had a limb size that precluded MRI examination of the MCP joints due to the size of FOV.
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edema scored on magnetic resonance imaging scans of the dominant carpus at presentation predicts radiographic joint damage of the hands and feet six years later in patients with rheumatoid arthritis. Arthritis Rheum 2003;48(7):1814-27.


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Bo Ejbjerg, Eva Narvestad, Søren Jacobsen, Henrik S. Thomsen and Mikkel Østergaard

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