Rheumatoid Arthritis of the Hand: Monitoring with a Simplified MR Imaging Scoring Method—Preliminary Assessment

Catherine Cyteval, MD, PhD
Anne Miquel, MD
Denis Hoa, MD
Jean Pierre Daures, MD, PhD
Xavier Mariette, MD, PhD
Bernard Combe, MD, PhD

Purpose: To assess a simplified scoring method (Simplified Rheumatoid Arthritis Magnetic Resonance Imaging Score [SAMIS]) developed to shorten interpretation time, while retaining both correlation with Rheumatoid Arthritis Magnetic Resonance Imaging Score (RAMRIS) and same or better intra- and interreader reliability.

Materials and Methods: Ethics board approval and written patient consent were obtained. The study was HIPAA compliant. Thirty-eight patients with rheumatoid arthritis and 20 patients with no or early unclassified arthritis underwent magnetic resonance imaging of both wrists and hands. RAMRIS was used to evaluate erosions (scale, 0–10), edema (scale, 0–3), and synovitis (scale, 0–3). SAMIS assessed only one hand and was based on the radiographic Simple Erosion Narrowing Score, thus reducing the number of study areas from 116 to 36. Erosions were scored with a scale from 1 to 10. Edema and synovitis were, respectively, scored with scales from 0 to 1 and 0 to 2. SAMIS correlation with RAMRIS was tested by using the Spearman test. Last, the intra- and interobserver reproducibility of both scores were calculated.

Results: SAMIS was closely correlated with RAMRIS for the entire series ($r = 0.91, 0.79$, and 0.94, respectively, for erosion, edema, and synovitis), as well as in patients with rheumatoid arthritis ($r = 0.93, 0.81$, and 0.92) and those with no or unclassified arthritis ($r = 0.83, 0.73$, and 0.94). The time needed to assess examination results with RAMRIS ranged from 5 to 20 minutes (13 minutes ± 3.90 [standard deviation]), whereas it ranged from 2 to 7 minutes (5 minutes ± 1.45) with SAMIS. For each of the three features (erosion, edema, and synovitis), intraobserver agreement (RAMRIS: $\kappa = 0.67, 0.94, 0.81$, respectively; SAMIS: $\kappa = 0.66, 1.0, 0.91$) and interobserver agreement (RAMRIS: $\kappa = 0.61, 0.58, 0.74$, respectively; SAMIS: $\kappa = 0.59, 0.81, 0.81$) were good to excellent.

Conclusion: This simplified reproducible scoring scheme could be used to monitor joint damage in rheumatoid arthritis.

© RSNA, 2010

1 From the Departments of Medical Imaging (C.C., D.H.) and Rheumatology (B.C.), Hôpital Lapeyronie, 371 avenue du Doyen Gaston Giraud, 34295 Montpellier Cedex 5, France; Departments of Medical Imaging (A.M.) and Rheumatology (X.M.), Bicêtre Hospital, Le Kremlin-Bicêtre, France; and Department of Medical Data Processing, Carémeau Hospital, Nîmes, France (J.P.D.). Received September 21, 2009; revision requested November 13; revision received February 3, 2010; accepted February 26; final version accepted March 3. Supported by an unrestricted grant from Merck Sharp & Dohme. Supported by grants from INSERM. Supported by the French Rheumatology Society, Abbott, Roche, and Wyeth. Address correspondence to C.C. (e-mail: c-cyteval@chu-montpellier.fr).

© RSNA, 2010
Radiography is the traditional reference standard for diagnosing and monitoring structural joint damage in patients with rheumatoid arthritis (1,2). With the development of new therapeutic strategies for rheumatoid arthritis, such as anti–tumor necrosis factor α, there is now a need for close monitoring for signs of synovitis and treatment failure (3), as is provided with magnetic resonance (MR) imaging.

The issue is how best to harness and quantify the large amount of information generated at MR imaging. The Outcome Measures in Rheumatology Clinical Trials (OMERACT) Rheumatoid Arthritis Magnetic Resonance Imaging Score (RAMRIS) system was developed (4,5) as the useful standard for assessment of rheumatoid arthritis. However, use of the RAMRIS system is time-consuming and tedious and requires a long learning curve (5).

The aim of this pilot study was to develop an easier MR imaging scoring method for rheumatoid arthritis. We assess a simplified scoring method (Simplified Rheumatoid Arthritis Magnetic Resonance Imaging Score [SAMIS]) developed to shorten interpretation time, while retaining both correlation with RAMRIS and same or better intra- and interreader reliability.

**Materials and Methods**

**Patients**

Ethics board permission and written informed patient consent were obtained for this study. The study was Health Insurance Portability and Accountability Act compliant. From 2004 to 2008, 58 patients (44 women [mean age, 53 years; age range, 18–71 years] and 14 men [mean age, 45 years; age range, 27–64 years]) with painful, swollen wrists were prospectively included in the study and underwent MR imaging of both wrists and up to just distal to the metacarpal phalangeal joints. Thirty-eight patients from two centers within the framework of a French multicentric cohort study of adults with early arthritis (Study and Follow-up of Undifferentiated Early Arthritis [ESPOIR] cohort) had at least two swollen joints for a duration of 6 weeks to 6 months and were not receiving treatment with disease-modifying and antirheumatic drugs (6). Twenty of the patients, from the Montpellier Teaching Hospital, had wrist pain for more than 2 years: 11 patients already had a diagnosis of established rheumatoid arthritis, seven had unclassified arthritis, and two did not have arthritis. After a 3-year follow-up, 27 of the ESPOIR cohort patients were given a diagnosis of rheumatoid arthritis according to the 1987 American College of Rheumatology criteria (7), and 11 were classified as patients with unclassified inflammatory arthritis. We divided our patients into two groups: group 1 consisted of 38 patients with rheumatoid arthritis and group 2 included 20 patients with no or unclassified arthritis (Table 1).

**MR Imaging Protocol**

Two 1.5-T units (Magnetom, Siemens, Munich, Germany; Achieva, Philips, Eindhoven, the Netherlands), both equipped with a dual phased-array wrist coil for wrist and metacarpophalangeal joint examinations, were used. MR imaging of the wrists and the second to the fifth metacarpophalangeal joints of the two hands was performed. Patients were placed in the prone or lateral position, with both hands held together within splints to minimize movement and standardize the position.

T1-weighted spin-echo images, T2-weighted fat-saturated spin-echo images, and axial and coronal T1-weighted postgadolinium fat-saturated spin-echo images were obtained with the following parameters: section thickness, 3 mm without any intersection gap; field of view, 130 × 130; and matrix, 230 × 256 pixels. For T2-weighted images, a repetition time of 3500 msec, an echo time of 60 msec, and an echo train of seven were used. For T1-weighted images, a repetition time of 500 msec and an echo time of 20 msec were used. Gadopentetate dimeglumine (Magnevist; Schering, Berlin, Germany) was administered by using hand injection at 0.1 mmol per kilogram of body weight. The total imaging time was 35 minutes.

Two trained musculoskeletal radiologists (C.C. and A.M., with 4 and 5 years of experience with RAMRIS) performed the procedure by using MR

---

**Advances in Knowledge**

- We report a simplified MR imaging scoring method (Simplified Rheumatoid Arthritis Magnetic Resonance Imaging Score [SAMIS]) for assessing wrist and metacarpal joint damage in rheumatoid arthritis.
- The simplified score is closely correlated with the MR imaging score standard Rheumatoid Arthritis Magnetic Resonance Imaging Score (RAMRIS).
- SAMIS requires less examination time than RAMRIS (5 minutes vs 20 minutes) and shows good or excellent intra- and interobserver agreement.

**Implication for Patient Care**

- SAMIS is a simplified, quicker method for MR imaging scoring of joint damage in rheumatoid arthritis.
Radiology: Volume 256: Number 3—September 2010

MUSCULOSKELETAL IMAGING: Simplified Scoring Method to Monitor Rheumatoid Arthritis
Cyteval et al

Erosion was a sharply marginated, juxtaarticular bone lesion, with typical signal intensity characteristics, seen in two planes with a cortical break in at least one plane (Fig 2a). Its evaluation scale (0–10) is based on the proportion of eroded bone compared with the assessed bone volume, determined on all available images (0 = no erosion, 1 = 1%–10% of bone eroded, 2 = 11%–20% of bone eroded, etc). For long bones, the assessed bone volume extends from the articular surface (or if absent, its best-estimated position) to a depth of 1 cm. For carpal bones, the whole bone is assessed.

MR imaging bone edema was considered as a lesion within the trabecular bone, with ill-defined margins and signal intensity characteristics consistent with increased water content (high signal intensity on T2-weighted images) (Fig 2c). Its evaluation scale (0–3) is based on the proportion of bone with edema (0 = no edema, 1 = 1%–33% of bone edema, 2 = 34%–66% of bone edema, 3 = 67%–100% of bone edema).

Synovitis was visible as an area in the synovial compartment that shows higher than normal postgadolinium enhancement of a thickness greater than the width of the normal synovium. Enhancement was assessed by comparison of T1-weighted images obtained before and after intravenous administration of gadolinium-based contrast material (Fig 2d, 2e). Its evaluation scale ranges from 0 to 3. Score 0 is normal, and scores 1 to 3 (mild, moderate, severe, respectively) are thirds of the presumed maximum volume of enhancing tissue in the synovial compartment.

A simplified score, SAMIS, was developed as follows (Table 2). (a) Only one hand was evaluated, either the most painful or the dominant one if both hands were equally painful. (b) Some bones were ruled out for erosion and edema analysis, according to van der Heijde et al’s radiographic assessments (8). The following 15 bones were studied: metacarpal head and phalangeal base of the second to the fifth metacarpophalangeal joints, first metacarpal base, trapezium, scaphoid, lunate, and distal end of both the ulna and radius. (c) Both intracarpal and radiocarpal joints were combined for synovitis scoring. The analysis was performed in the distal radioulnar joint, the second to fifth metacarpophalangeal joints, and combined carpal joints. (d) The scales for synovitis and edema were reduced (Fig 1c, 1d). The synovitis scale ranged from 0 to 2: Score 0 is normal, 1 was mild, and 2 was severe. For marrow edema, bones were scored with a scale from 0 to 1 for the presence of the feature.

### Table 1

<table>
<thead>
<tr>
<th>Arthritis</th>
<th>Total No.</th>
<th>Rheumatoid Arthritis</th>
<th>Unclassified Arthritis</th>
<th>No Arthritis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early</td>
<td>38</td>
<td>27</td>
<td>11</td>
<td>0</td>
</tr>
<tr>
<td>More than 2-year evolution</td>
<td>20</td>
<td>11</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>58</td>
<td>38</td>
<td>18</td>
<td>2</td>
</tr>
</tbody>
</table>

Note.—Data are numbers of patients.
Table 2

<table>
<thead>
<tr>
<th>Method</th>
<th>Erosion</th>
<th>Edema</th>
<th>Synovitis</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAMRIS (two hands)</td>
<td>23 areas × 2—wrist, distal radius, distal ulna, carpal bones, metacarpal bases; second to fifth MCP joints: metacarpal heads, phalangeal bases</td>
<td>23 areas × 2—same areas as those for erosions</td>
<td>Distal radioulnar joint, radiocarpal joint, intracarpal joints, second to fifth MCP joints</td>
</tr>
<tr>
<td>SAMIS (one hand)</td>
<td>15 areas—wrist, distal radius, distal ulna, trapezium, scaphoid, lunate, first metacarpal base; MCP joints: metacarpal heads and phalangeal base of the second to fifth MCP joints</td>
<td>15 areas—same areas as those for erosions</td>
<td>Distal radioulnar joint, global evaluation of the radiocarpal joint and intracarpal joints, second to fifth MCP joints</td>
</tr>
</tbody>
</table>

Note.—MCP = metacarpophalangeal.

Figure 2

(a–e) MR images show sharply marginated bone lesions detected with a hypointense signal on T1-weighted images, with juxtaarticular localization and a cortical break, visible in two planes of the third-finger metacarpal head, consistent with an erosion. (a) Coronal plane and (b) axial plane show erosion of the index metacarpal (arrow in a) (grade 1) and erosion of the ulnar side of the third metacarpophalangeal joint (arrow in b) (grade 4). (c) Coronal plane shows abnormal signal of ill-defined margins with increased water content (high signal intensity on T2-weighted images) within the trabecular bones of the wrist, consistent with bone edema. (d) Coronal and (e) axial planes show thickened enhanced synovium (arrows in d and e) on T1-weighted images after intravenous administration of gadolinium-based contrast material, consistent with synovitis.

To determine interobserver variability, trained radiologists (C.C., A.M.), who were blinded to clinical information and the other reader’s scoring, independently evaluated the cases within the same period. In addition, each reader evaluated 20 cases from the ESPOIR cohort twice, with a 1-month washout period to evaluate intraobserver variability. After a 6-month washout period and a new randomization of the cases, a new reading was performed by the same radiologists by using SAMIS. The intra- and interobserver reproducibility of both scores were calculated, and
correlations were tested. The average time necessary to analyze MR images by using RAMRIS and SAMIS was recorded.

**Discussion**

A reproducible scoring scheme is useful in evaluating disease progression and in making therapeutic decisions and treatment evaluations, regardless of the modality. RAMRIS is widely approved as a reference standard in rheumatoid arthritis trials (10,11), although barely applied in usual clinical practice, because of its time commitment. MR imaging is now not only used in protocols and trials but also in routine practice for arthritis diagnosis and outcome (12). A simplified scoring method with acceptable interpretation time that correlated with the RAMRIS method would be of great help in everyday practice.

Sufficient reproducibility is a prerequisite for any scoring method. This study confirmed others in showing that the OMERACT RAMRIS had acceptable intra- and interreader reliability (5,13,14) when performed by trained readers. Our proposed, simplified score had good to excellent intra- and interreader reliability. This high degree of agreement may be explained by both the reduced scale and the two readers’ previous experience in reading MR images.
of the hands and wrists, as already mentioned by Bird et al for radiographs (15). Furthermore, radiologists were initially trained by using the OMERACT atlas of images of rheumatoid arthritis joints (16). This might have further enhanced standardized assessment of rheumatoid arthritis joints and reproducible scoring of MR imaging lesions.

Our scoring system allows a reduction in the number of bones to be analyzed from 23 to 15. In accordance with van der Heijde et al’s method, we decided to simplify RAMRIS by evaluating only carpal bones and metacarpal bases. Van der Heijde et al’s method, derived from the Sharp score, has been shown to be suitable for use in clinical practice as a simplified radiologic scoring system (17). Sharp et al (18) had previously reported that a simplified scheme, with a combination of fewer bones to score, more accurately reflects the extent of abnormalities perceived by a panel of experts than does the original scheme including more bones.

To save more time, we chose to only assess the dominant hand. As demonstrated by Ejbjerg et al (19), MR imaging, regardless of whether it covers unilateral wrist and metacarpophalangeal joints or bilateral wrists and metacarpophalangeal joints plus unilateral metatarsophalangeal joints, is significantly superior to radiography of the hands, wrists, and forefeet with respect to the detection of progressive joint destruction in rheumatoid arthritis.

Although this score proved to be closely correlated with RAMIS and more reproducible, our study had limitations. The degree of agreement in the results...
may be explained by the two readers’ previous experience in reading MR images of the hands and wrists. As a scoring system needs to be reliable, the score needs to be tested by using readers with different levels of experience. Even if MR imaging is most useful for clinicians in early rheumatoid arthritis, or when radiographic results remain normal, the score should be further tested in more patients with advanced disease. Nevertheless, a few high-grade lesions were included in our series. SAMIS will also have to be evaluated in early unclassified arthritis to assess its possible interest as a rheumatoid arthritis predictor, thus allowing early treatment and preventing further structural damage. In the future, SAMIS sensitivity to change should be evaluated and compared with that of RAMRIS. This was a preliminary report, and further longitudinal studies aiming at evaluating follow-up and least discernable changes when using SAMIS are mandatory, because the follow-up of these patients is more important than the initial score. Although SAMIS must be further validated in more patients and in longitudinal studies, our results indicated that damage to joints in patients with rheumatoid arthritis could be reliably evaluated with this simplified MR imaging scoring method. SAMIS is closely correlated with and as reproducible as RAMRIS, while being less time-consuming.

Acknowledgments: We thank Nathalie Rincheval, MD, who performed expert monitoring and data management, and all the investigators who recruited and monitored the patients: F. Berenbaum, MD, Paris-Saint Antoine; M. Dougados, MD, Paris-Cochin; B. Fauret, MD, F. Liote, MD, Paris-Lariboisière; O. Vittecoq, MD, Rouen; A. Saraux, MD, Brest.

References