Validation of the OMERACT Psoriatic Arthritis Magnetic Resonance Imaging Score (PsAMRIS) for the Hand and Foot in a Randomized Placebo-controlled Trial

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ABSTRACT. ***Objective.*** To assess changes following treatment and the reliability and responsiveness to change of the Outcome Measures in Rheumatology (OMERACT) Psoriatic Arthritis Magnetic Resonance Imaging Score (PsAMRIS) in a randomized controlled trial.

Methods. Forty patients with PsA randomized to either placebo or abatacept (ABA) had MRI of either 1 hand (n = 20) or 1 foot (n = 20) at baseline and after 6 months. Images were scored blindly twice by 3 independent readers according to the PsAMRIS (for synovitis, tenosynovitis, periarticular inflammation, bone edema, bone erosion, and bone proliferation).

Results. Inflammatory features improved numerically but statistically nonsignificantly in the ABA group but not the placebo group. Baseline intrareader intraclass correlation coefficients (ICC) were good (≥ 0.50) to very good (≥ 0.80) for all features in both hand and foot. Baseline interreader ICC were good (ICC 0.72–0.96) for all features, except periarticular inflammation and bone proliferation in the hand and tenosynovitis in the foot (ICC 0.25–0.44). Intrareader and interreader ICC for change scores varied. Guyatt's responsiveness index (GRI) was high for inflammatory features in the hand and metatarsophalangeal joints (GRI –0.67 to –3.13; bone edema not calculable). Minimal change and low prevalence resulted in low ICC and GRI for bone damage.

Conclusion. PsAMRIS showed overall good intrareader agreement in the hand and foot, and inflammatory feature scores were responsive to change, suggesting that PsAMRIS may be a valid tool for MRI assessment of hands and feet in PsA clinical trials. (First Release November 1 2015; J Rheumatol 2015;42:2473–9; doi:10.3899/jrheum.141010)

Key Indexing Terms:
OMERACT MAGNETIC RESONANCE IMAGING PSORIATIC ARTHRITIS PsAMRIS

Joint involvement in psoriatic arthritis (PsA) is heterogeneous, and inflammation is often present in both axial and peripheral joints, including the small joints of the hands and feet[1,2]. Rapidly evolving treatment options have increased the requirement for developing efficient measures for assessing treatment response.

Magnetic resonance imaging (MRI) can assess inflammation as well as bone damage and has been used extensively as an outcome measure in rheumatoid arthritis (Rheumatoid Arthritis MRI Scoring System, RAMRIS, assessing synovitis, bone marrow edema, and bone erosion)[3,4].

In 2009, the PsA MRI Score (PsAMRIS) for peripheral PsA was presented by the Outcome Measures in Rheumatology (OMERACT) MRI in arthritis working group. The scoring system assessed the joints of the fingers and was based on the same features as the rheumatoid arthritis

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instrument, RAMRIS, with the addition of tenosynovitis, periarticular inflammation, and bone proliferation[5]. In previous studies, the application of the PsAMRIS to the hand has showed overall moderate-to-high intrareader and interreader agreement and has been proved sensitive to change[6,7,8]. In the present multireader exercise, we used images from a randomized, placebo-controlled trial.

We assessed changes following treatment, intrareader and interreader reliability, and responsiveness to change of PsAMRIS features in the hand and foot of patients with PsA.

MATERIALS AND METHODS

Patients. In the primary study[9], 170 patients with PsA were included. Key inclusion criteria were: fulfillment of the ClASsification for Psoriatic ARthritis (CASPAR) Study Group criteria, ≥ 3 swollen joints and ≥ 3 tender joints, active plaque psoriasis, disease duration of ≥ 3 months and inadequate response to 1 or more disease-modifying antirheumatic drugs (DMARD). The patients were randomized 1:1:1:1 to 3 different doses of abatacept (ABA) or placebo at days 1, 15, and 29 and then once every 28 days thereafter. Selection of patients and image acquisition in the OMERACT exercise is described in Figure 1. All patients gave their written informed consent prior to the study.

Image evaluation. Twenty paired sets of MRI of the hand (7 received 30/10 mg/kg, 6 received 10 mg/kg, and 7 received placebo) and 20 image sets of the foot (6 received 30/10 mg/kg, 8 received 10 mg/kg, and 6 received placebo) were used for this exercise. Each MR image set consisted of images acquired at 2 timepoints: Baseline and after 6 months of treatment (2 patients in the hand placebo group and 1 patient in the foot placebo group had followup MRI at 3 mos). The 1st–5th metacarpophalangeal (MCP) joint, 1st–5th proximal interphalangeal (PIP), and 2nd–5th distal interphalangeal (DIP) joints in the hand; or the 1st–5th metatarsophalangeal (MTP), and 1st interphalangeal (IP) joint in the foot were assessed. The DIP joints of the foot were considered unreadable because of small joint size. Each joint was scored according to the OMERACT PsAMRIS[5] for synovitis (0–3), flexor tenosynovitis (0–3), periarticular inflammation (0–2), bone marrow edema (0–6), bone erosion (0–20), and bone proliferation (0–1). MR images were read twice by 3 readers (FG, MØ, PB), all experienced MRI readers familiar with the scoring system. A calibration session was performed, using similar images, in the evening before the exercise. All images were anonymized and randomized. Prior to the second reading, the images were reanonymized and rerandomized. The readers were blinded for treatment and patient data, but not for time order, as suggested by van Tuyl, *et al*[10]. The individual readers used the same computer workstations for both readings, and the MR images were assessed using OsiriX software version 4.1.2 (Pixmeo, Geneva, Switzerland).

Statistics. Status and change scores were described by calculating the mean score of the 2 individual readings, and were presented as the mean of the readers' mean scores. Change over time was estimated using the Wilcoxon signed-rank test. Difference between treatment groups was assessed using the Mann-Whitney U test.

Intrareader and interreader reliability was assessed using single measure and average measure intraclass correlation coefficients (ICC), respectively. The smallest detectable change (SDC) was calculated for change scores[11].

Responsiveness of the PsAMRIS features was estimated using Guyatt's effect size (Guyatt's responsiveness index; GRI), which is calculated by dividing the mean change score in the ABA group with the standard deviation of the change score in the placebo group[12].

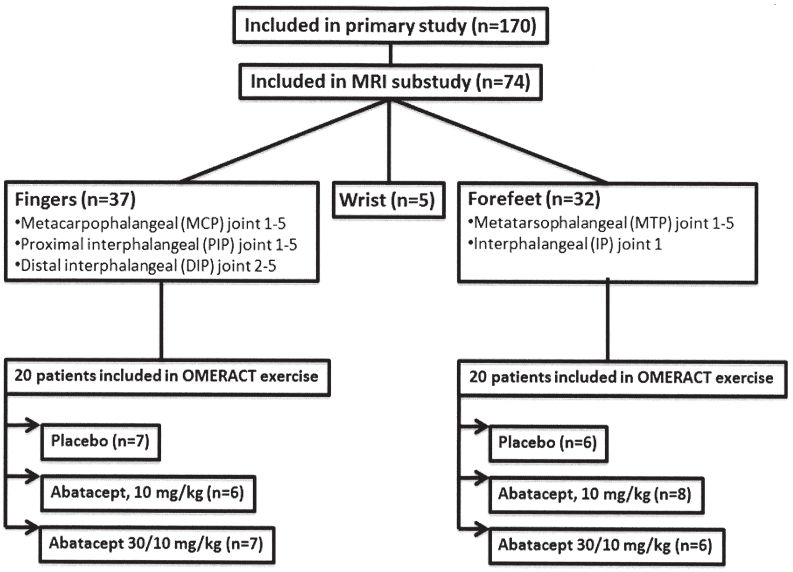

Figure 1. Selection of patients and image acquisition for the OMERACT Psoriatic Arthritis Magnetic Resonance Imaging Score exercise. Of the 170 patients with PsA included in the randomized clinical trial[9], unilateral magnetic resonance imaging (MRI) was performed in 74 patients in 1 of 3 predefined joint areas, based on the clinically most inflamed joint area at baseline. Accordingly, 37 had MRI of fingers and thumb (metacarpophalangeal, proximal interphalangeal, and distal interphalangeal joints), 5 of wrists and 32 of forefeet (metatarsophalangeal and interphalangeal joints). Because the primary publication by Mease, *et al*[9] showed that the 2 highest abatacept doses (30 mg/kg in 2 initial administrations followed by 10 mg/kg; and 10 mg/kg) generated the highest response rate, patients from these 2 dose groups and from the placebo group (total n = 40) were selected for the OMERACT exercise. MRI was performed on 1 T (Philips Medical system Panorama) or 1.5 T (General Electric Signa, and Siemens Sonata) MRI scanners. Axial, T1-weighted, precontrast images, axial and coronal 3-D postcontrast fat-suppressed images, coronal and sagittal fat suppressed T2-weighted images, and coronal short-tau inversion recovery images were acquired. Slice thickness was 0.6–1.0 mm for 3-D images and 3.0 mm for remaining images. PsA: psoriatic arthritis.

RESULTS

MRI scores at baseline and during treatment. Overall, the inflammatory variables showed numerical improvement in the ABA group but not the placebo group in the hand and foot. The synovitis score of the MTP joints in the ABA group was the only variable showing a statistically significant improvement in score: 1.1 ($p = 0.04$). Bone damage scores were overall unchanged in all groups (Table 1).

The Mann-Whitney U test showed no statistically significant differences between the placebo group and the ABA group (data not shown).

Reliability. In the hand, intrareader ICC for baseline scores were good to very good for all features except synovitis and bone proliferation in 1 reader (Table 2). Intrareader ICC for change scores were good to very good in all or some readers for the inflammatory features, and were poor for bone damage features. Interreader ICC for baseline scores were good to very good for all features, except periarticular inflammation and bone proliferation. Interreader ICC for change scores were very good for tenosynovitis (Figure 2) and bone marrow edema, and poor for the remaining features. SDC was low for all features, except intrareader SDC for synovitis and periarticular inflammation in 1 reader.

In the foot, intrareader ICC for baseline scores was good to very good for all or some readers for all features. Intrareader ICC for change scores was good to very good for all or some readers for synovitis, tenosynovitis, and bone erosion; and poor for the remaining features. Interreader ICC for baseline scores were good to very good for all features except tenosynovitis. Interreader ICC for change scores were good for synovitis, periarticular inflammation, and bone marrow edema, and poor for remaining features. SDC was low for all features.

When analyzed for separate joint areas, the ICC tended to improve with the size of the joint (data not shown).

Responsiveness. In the hand, GRI was excellent for total score, and MCP and PIP joint scores for tenosynovitis and for total scores, and MCP joint scores for periarticular inflammation (Table 3). GRI for synovitis was moderate to good whereas the GRI for the remaining features were poor or not calculable because no change was detected in the placebo group for that feature by any of the 3 readers (actually suggesting high responsiveness for some features, because improvement was observed in the ABA group).

In the foot, GRI was excellent for total score and MTP joint scores of synovitis, and for total scores of periarticular inflammation. GRI was good for bone erosion total score and moderate for tenosynovitis and bone erosion in the MTP joints. GRI of the remaining features were poor or not calculable.

DISCUSSION

This multireader exercise evaluating the OMERACT PsAMRIS in a randomized, placebo-controlled trial showed numerical improvements in the inflammatory features in patients treated with ABA but not with placebo. Bone damage did not change during the 6-month followup period. The baseline intrareader and interreader agreement and the responsiveness of inflammatory variables were high overall for some or all readers.

Synovitis in the MTP joints of the foot was the only feature showing a statistically significant improvement during ABA therapy. However, the PsAMRIS features of inflammation all showed numerical, although statistically nonsignificant, improvements after 6 months of ABA therapy, both in hands and feet. This indicates that a larger sample size than the current 13–14 actively treated patients would likely have resulted in more statistically significant PsAMRIS score improvements.

In our present study, we analyzed feet and hands separately. By analyzing both groups together in a posthoc analysis (data not shown), statistically significant improvement was seen in total synovitis score in the patients treated with ABA, supporting that higher sample sizes would provide statistically significant differences. In agreement with the present study, our previous observational study of patients receiving tumor necrosis factor-α (TNF-α) inhibitor[8] showed improvements of PsAMRIS tenosynovitis, synovitis, and periarticular inflammation in the hand of patients receiving TNF-α inhibitors. It should be mentioned that the purpose of the present study was not to detect a statistically significant change in PsAMRIS score because the sample size was very small.

Intrareader reliability assessed by ICC for the hand was generally good for all features, but not for some or all readers regarding change scores of periarticular inflammation, bone marrow edema, bone erosion, and bone proliferation. A probable explanation for these low ICC values on change scores for these features is that the change was low, making the ICC sensitive to minor disagreements within or between readers. For the bone damage features, a low ICC was to be expected because these features did not show any change over the 6 months. The low SDC for these features suggests a good reliability and supports the proposed reason for low ICC.

Interreader reliability for baseline periarticular inflammation and bone proliferation was low for the hand, which suggests that there is less consensus about how to score these PsA-specific features compared to the features included in the RAMRIS, which have been summarized in an atlas[13,14,15].

The ICC for the foot showed a pattern similar to that of the hand. However, the intrareader ICC for periarticular inflammation and bone proliferation was generally lower than in the hand. This may be explained by the smaller structures in the toes and less experience by the readers in scoring MR images of the foot.

Responsiveness was high for the inflammatory features of

Table 1A. PsAMRIS baseline and change scores of the hand.

	Total Score				MCP				PIP				DIP			
	Placebo		ABA		Placebo		ABA		Placebo		ABA		Placebo		ABA	
PsAMRIS features (range of total score)	Baseline	Change	Baseline	Change	Baseline	Change	Baseline	Change	Baseline	Change	Baseline	Change	Baseline	Change	Baseline	Change
Hand																
Synovitis (0–42)	7.2 (6.0 to 9.1)	–0.2 (–0.2 to –0.2)	7.1 (5.6 to 9.1)	–1.3 (–3.1 to 0.0)	3.9 (2.5 to 4.9)	–0.2 (–0.4 to –0.1)	4.2 (3.0 to 5.6)	–0.4 (–0.7 to 0.0)	2.2 (1.7 to 3.1)	0.0 (–0.1 to 0.0)	2.3 (1.5 to 3.4)	–0.2 (–0.7 to 0.0)	0.3 (0.1 to 0.6)	–0.1 (–0.2 to 0.0)	0.5 (0.2 to 0.8)	–0.1 (–0.2 to 0.0)
Flexor tenosynovitis (0–42)	3.1 (2.1 to 4.8)	0.1 (–0.4 to 0.6)	3.7 (2.8 to 4.2)	–1.4 (–2.2 to –0.5)	1.7 (1.2 to 2.7)	0.0 (–0.4 to 0.3)	1.8 (1.5 to 2.1)	–0.6 (–1.1 to 0.0)	1.1 (0.8 to 1.7)	0.1 (0.0 to 0.1)	1.4 (1.0 to 1.6)	–0.5 (–0.7 to –0.3)	0.2 (0.0 to 0.4)	0.1 (0.0 to 0.2)	0.5 (0.4 to 0.7)	–0.3 (–0.4 to –0.2)
Periarticular inflammation (0–28)	0.0 (0.0 to 0.1)	0.0 (0.0 to 0.0)	1.5 (0.5 to 3.3)	–0.8 (–1.8 to –0.2)	0.5 (0.0 to 1.4)	0.0 (0.0 to 0.0)	0.7 (0.1 to 1.8)	–0.4 (–1.0 to 0.0)	0.0 (0.0 to 0.0)	0.0 (0.0 to 0.0)	0.6 (0.2 to 1.4)	–0.2 (–0.5 to 0.0)	0.0 (0.0 to 0.0)	0.0 (0.0 to 0.0)	0.2 (0.0 to 0.3)	–0.1 (–0.1 to 0.0)
Bone marrow edema (0–84)	0.3 (0.1 to 0.7)	0.0 (0.0 to 0.0)	1.9 (1.1 to 2.8)	–0.5 (–0.7 to –0.4)	0.1 (0.0 to 0.1)	0.0 (0.0 to 0.0)	1.1 (0.6 to 1.7)	–0.3 (–0.6 to –0.1)	0.2 (0.0 to 0.6)	0.0 (0.0 to 0.0)	0.6 (0.2 to 1.2)	–0.2 (–0.4 to –0.1)	0.0 (0.0 to 0.0)	0.0 (0.0 to 0.0)	0.2 (0.0 to 0.5)	0.1 (0.0 to 0.1)
Bone erosion (0–280)	0.9 (0.7 to 1.1)	–0.1 (–0.4 to 0.0)	2.5 (1.8 to 2.9)	0.0 (0.0 to 0.0)	0.3 (0.0 to 0.5)	–0.1 (–0.2 to 0.0)	1.7 (0.6 to 2.3)	0.0 (–0.1 to 0.1)	0.3 (0.2 to 0.6)	0.0 (–0.1 to 0.0)	0.4 (0.1 to 0.7)	0.0 (0.0 to 0.0)	0.1 (0.1 to 0.1)	0.0 (0.0 to 0.0)	0.1 (0.0 to 0.1)	0.0 (0.0 to 0.0)
Bone proliferation (0–14)	0.2 (0.0 to 0.3)	0.0 (–0.1 to 0.0)	0.5 (0.1 to 0.8)	0.0 (–0.1 to 0.0)	0.1 (0.0 to 0.1)	0.0 (0.0 to 0.0)	0.3 (0.1 to 0.7)	0.0 (0.0 to 0.0)	0.0 (0.0 to 0.1)	0.0 (0.0 to 0.0)	0.1 (0.0 to 1.0)	0.0 (–0.1 to 0.0)	0.1 (0.0 to 0.1)	0.0 (–0.1 to 0.0)	0.1 (0.0 to 0.3)	0.0 (0.0 to 0.0)

Table 1B. PsAMRIS baseline and change scores of the foot.

	Total score				MTP				IP			
	Placebo		ABA		Placebo		ABA		Placebo		ABA	
PsAMRIS features (range of total score)	Baseline	Change	Baseline	Change	Baseline	Change	Baseline	Change	Baseline	Change	Baseline	Change
Foot												
Synovitis (0–18)	2.6 (1.8 to 3.3)	0.4 (0.0 to 0.8)	5.4 (4.8 to 6.1)	–1.2 (–1.3 to –1.1)	1.6 (0.8 to 2.4)	0.3 (0.0 to 0.7)	4.0 (2.7 to 5.1)	–1.1 (–1.1 to 1.0)*	0.4 (0.2 to 0.8)	0.1 (0.0 to 0.2)	0.8 (0.6 to 1.0)	–0.1 (–0.2 to –0.2)
Flexor tenosynovitis (0–18)	0.4 (0.1 to 0.7)	0.6 (0.3 to 0.8)	1.0 (0.5 to 1.7)	–0.1 (–0.7 to 0.6)	0.5 (0.3 to 0.8)	0.3 (0.1 to 0.5)	1.0 (0.5 to 1.6)	–0.5 (–0.9 to –0.2)	0.1 (0.0 to 0.2)	0.1 (0.0 to 0.2)	0.1 (0.1 to 0.2)	0.0 (0.0 to 0.1)
Periarticular inflammation (0–12)	0.1 (0.0 to 0.2)	0.1 (0.0 to 0.2)	1.5 (0.3 to 2.1)	–0.3 (–0.4 to –0.1)	0.1 (0.0 to 0.2)	0.0 (0.0 to 0.0)	0.7 (0.2 to 1.7)	–0.1 (–0.4 to 0.0)	0.0 (0.0 to 0.1)	0.1 (0.0 to 0.2)	0.1 (0.0 to 0.1)	–0.1 (–0.1 to 0.0)
Bone marrow edema (0–36)	0.7 (0.3 to 0.9)	0.0 (0.0 to 0.0)	2.9 (2.5 to 3.1)	–0.5 (–0.9 to –0.1)	0.4 (0.3 to 0.6)	0.0 (0.0 to 0.0)	1.9 (1.8 to 2.0)	–0.4 (–0.8 to –0.2)	0.2 (0.0 to 0.4)	0.0 (0.0 to 0.0)	1.0 (0.7 to 1.3)	0.0 (–0.1 to 0.2)
Bone erosion (0–120)	1.3 (0.9 to 1.5)	0.0 (–0.1 to 0.0)	3.3 (2.3 to 5.0)	0.0 (–0.1 to 0.1)	1.0 (0.9 to 1.2)	0.0 (–0.1 to 0.0)	3.0 (1.8 to 4.9)	–0.1 (–0.2 to 0.0)	0.3 (0.0 to 0.5)	0.0 (0.0 to 0.0)	0.4 (0.3 to 0.5)	0.0 (0.0 to 0.1)
Bone proliferation (0–6)	0.5 (0.2 to 0.8)	0.0 (–0.1 to 0.0)	0.2 (0.1 to 0.3)	0.0 (0.0 to 0.0)	0.3 (0.2 to 0.5)	0.0 (–0.1 to 0.0)	0.1 (0.0 to 0.2)	0.0 (0.0 to 0.0)	0.1 (0.0 to 0.2)	0.0 (0.0 to 0.0)	0.1 (0.1 to 0.1)	0.0 (0.0 to 0.0)

*$p < 0.05$. Scores are presented as the mean (range) of the 3 readers' mean scores of the 2 readings. PsAMRIS: Psoriatic Arthritis MRI Score; MCP: metacarpophalangeal, PIP: proximal interphalangeal, DIP: distal interphalangeal, MTP: metatarsophalangeal, IP: interphalangeal; ABA: abatacept.

Table 2. Intrareader and interreader reliability for the PsAMRIS features in the hand and foot.

PsAMRIS Features	Baseline SmICC (range reader 1 to 3)	Change SmICC (range reader 1 to 3) Intrareader	Change SDC (range reader1 to 3)	Baseline AvmICC	AvmICC Change Interreader	Change SDC
Hand						
Synovitis	0.30 to 0.71	0.06 to 0.66	1.7 to 5.5	0.72	0.41	2.9
Flexor tenosynovitis	0.69 to 0.89	0.78 to 0.88	2.2 to 2.6	0.92	0.87	1.9
Periarticular inflammation	0.74 to 0.95	0.22 to 0.85	0.4 to 5.8	0.37	0.12	1.8
Bone marrow edema	0.60 to 0.93	–0.06 to 0.72	1.5 to 2.9	0.84	0.81	0.8
Bone erosion	0.67 to 0.95	–0.06 to 0.04	0.0 to 1.4	0.90	0.23	0.4
Bone proliferation	0.00 to 0.74	NP*/0.00	0.0 to 0.3	0.25	0.06	0.2
Foot						
Synovitis	0.70 to 0.77	0.19 to 0.90	1.7 to 2.9	0.90	0.72	1.7
Flexor tenosynovitis	0.57 to 0.66	0.42 to 0.79	0.8 to 2.4	0.44	0.40	1.6
Periarticular inflammation	0.14 to 0.60	0.00 to 0.38	0.6 to 2.5	0.76	0.77	0.8
Bone marrow edema	0.70 to 0.96	–0.04 to 0.38	2.3 to 4.0	0.96	0.75	1.0
Bone erosion	0.75 to 0.97	–0.02 to 0.61	0.3 to 1.6	0.73	0.30	0.7
Bone proliferation	–0.15 to 0.59	NP*/0.00	0.0 to 0.3	0.50	0.07	0.1

*Not possible to calculate owing to zero variance in scores. Intraclass correlation coefficients (ICC) are expressed as single measure (SmICC) for intrareader reliability and average measure (AvmICC) for interreader reliability. Smallest detectable change (SDC) is shown for change scores. Interreader reliability was calculated from the mean value of each reader's 2 readings for each patient. ICC is interpreted as follows: Very good: ≥ 0.80, good 0.50–0.79, poor < 0.49. PsAMRIS: Psoriatic Arthritis Magnetic Resonance Imaging Score.

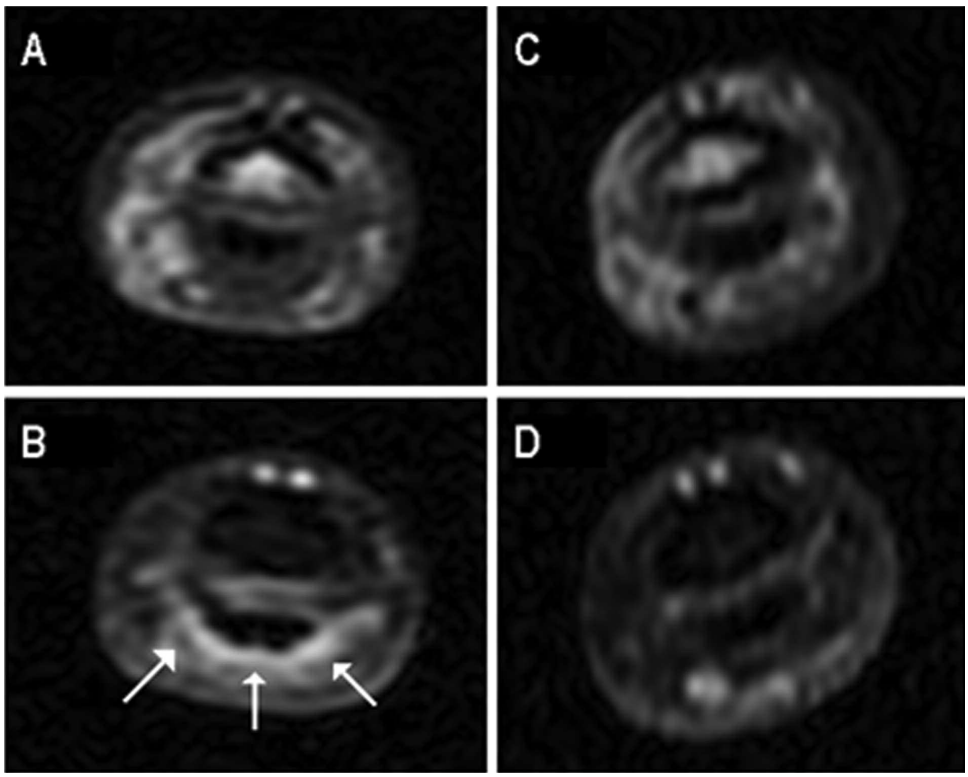

Figure 2. Magnetic resonance imaging, illustrating flexor tenosynovitis at distal interphalangeal joint level. Axial T1-weighted precontrast (A and C) and fat-suppressed postcontrast (B and D) magnetic resonance images of the 3rd distal interphalangeal joint. At baseline (A and B), the tenosynovium of the flexor tendon shows postcontrast enhancement, indicating tenosynovitis (arrows). After 6 months (C and D), the tenosynovitis is resolved.

PsAMRIS in the hand and the MTP joints of the foot, despite bone marrow edema not being calculable. For many PsAMRIS features, calculation of GRI was not possible owing to zero variance in the placebo group. However, this illustrates that none of the 3 readers detected any change in the placebo group, while a change in score was recorded in

Table 3A. Responsiveness of the PsAMRIS features, presented as Guyatt's effect size (Guyatt's responsiveness index; GRI) in the hand.

	Total Score	MCP	PIP	DIP
Hand				
Synovitis	–0.75	–0.87	–0.77	–0.67
Flexor tenosynovitis	–1.47	–1.45	–1.26	–0.78
Periarticular inflammation	–3.13	–1.73	NP*	NP*
Bone marrow edema	NP*	NP*	NP*	NP*
Bone erosion	–0.05	0.00	–0.10	NP*
Bone proliferation	NP*	NP*	NP*	NP*

Table 3B. Responsiveness of the PsAMRIS features, presented as Guyatt's effect size (Guyatt's responsiveness index; GRI) in the foot.

	Total Score	MTP	IP
Foot			
Synovitis	–1.19	–1.13	–0.44
Flexor tenosynovitis	–0.15	–0.76	0.35
Periarticular inflammation	–1.05	NP*	–0.17
Bone marrow edema	NP*	NP*	NP*
Bone erosion	0.52	–0.87	NP*
Bone proliferation	0.00	0.00	NP*

Values are expressed as the mean of the 3 readers. GRI is interpreted as follows: Excellent: > 1.00 or < –1.00, good: ± 0.80–0.99, moderate: ± 0.50–0.79, poor: ± 0.00–0.49. *Not possible to calculate owing to zero variance in scores in the placebo group. PsAMRIS: Psoriatic Arthritis MRI Score; MTP: metatarsophalangeal, IP: interphalangeal; MRI: magnetic resonance imaging; MCP: metacarpophalangeal; PIP: proximal interphalangeal; DIP: distal interphalangeal.

the ABA group (e.g., bone marrow edema as seen in Table 1), suggesting responsiveness even though GRI was not calculable.

Overall, the DIP joints of the hand showed low responsiveness to change. This may be explained by poor image quality and difficulties scoring the features as a result of small anatomical size. Good visualization of DIP joints is relevant considering that the DIP joints of the hands and feet are commonly involved clinically in PsA[2]. The DIP and 2nd–4th PIP joints of the foot are smaller than the hand and were not considered readable in this trial. In addition, the responsiveness of all the features of the IP joint of the foot were poor or not calculable. Higher image resolution based on increased magnetic field strength and smaller voxel size may be needed to increase the accuracy of the scorings of the small anatomical structures of the hand and foot.

The course of changes, reproducibility, and responsiveness to change in the foot were comparable to the hand, which supports further validation of the PsAMRIS on the foot.

This randomized controlled trial showed numerical improvements in the inflammatory variables of PsAMRIS during ABA but not placebo therapy. For all or some readers, the PsAMRIS showed high intrareader and interreader agreement for most baseline scores, and the inflammatory variables showed high responsiveness, especially for synovitis and tenosynovitis. The PsAMRIS was tested for the first time in the foot, providing results similar to those of the hand. The OMERACT PsAMRIS may be a valuable tool for assessing the MRI features in the hand and foot of PsA patients in clinical trials.

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REFERENCES

1. Gladman DD, Cook RJ, Schentag C, Feletar M, Inman RI, Hitchon C, et al. The clinical assessment of patients with psoriatic arthritis: results of a reliability study of the Spondyloarthritis Research Consortium of Canada. J Rheumatol 2004;31:1126-31.
2. Veale D, Rogers S, Fitzgerald O. Classification of clinical subsets in psoriatic arthritis. Br J Rheumatol 1994;33:133-8.
3. McQueen FM, Dalbeth N, Doyle A. MRI in psoriatic arthritis: insights into pathogenesis and treatment response. Curr Rheumatol Rep 2008;10:303-10.
4. Ostergaard M, Peterfy C, Conaghan P, McQueen F, Bird P, Ejbjerg B, et al. OMERACT Rheumatoid Arthritis Magnetic Resonance Imaging Studies. Core set of MRI acquisitions, joint pathology definitions, and the OMERACT RA-MRI scoring system. J Rheumatol 2003;30:1385-6.
5. Ostergaard M, McQueen F, Wiell C, Bird P, Boyesen P, Ejbjerg B, et al. The OMERACT psoriatic arthritis magnetic resonance imaging scoring system (PsAMRIS): definitions of key pathologies, suggested MRI sequences, and preliminary scoring system for PsA Hands. J Rheumatol 2009;36:1816-24.
6. McQueen F, Lassere M, Bird P, Haavardsholm EA, Peterfy C, Conaghan PG, et al. Developing a magnetic resonance imaging scoring system for peripheral psoriatic arthritis. J Rheumatol 2007;34:859-61.
7. McQueen F, Lassere M, Duer-Jensen A, Wiell C, Conaghan PG,

Gandjbakhch F, et al. Testing an OMERACT MRI scoring system for peripheral psoriatic arthritis in cross-sectional and longitudinal settings. J Rheumatol 2009;36:1811-5.
8. Boyesen P, McQueen FM, Gandjbakhch F, Lillegraven S, Coates L, Wiell C, et al. The OMERACT Psoriatic Arthritis Magnetic Resonance Imaging Score (PsAMRIS) is reliable and sensitive to change: results from an OMERACT workshop. J Rheumatol 2011;38:2034-8.
9. Mease P, Genovese MC, Gladstein G, Kivitz AJ, Ritchlin C, Tak PP, et al. Abatacept in the treatment of patients with psoriatic arthritis: results of a six-month, multicenter, randomized, double-blind, placebo-controlled, phase II trial. Arthritis Rheum 2011;63:939-48.
10. van Tuyl LH, van der Heijde D, Knol DL, Boers M. Chronological reading of radiographs in rheumatoid arthritis increases efficiency and does not lead to bias. Ann Rheum Dis 2014;73:391-5.
11. Bruynesteyn K, Boers M, Kostense P, van der Linden S, van der Heijde D. Deciding on progression of joint damage in paired films of individual patients: smallest detectable difference or change. Ann Rheum Dis 2005;64:179-82.
12. Guyatt G, Walter S, Norman G. Measuring change over time: assessing the usefulness of evaluative instruments. J Chron Dis 1987;40:171-8.
13. Bird P, Conaghan P, Ejbjerg B, McQueen F, Lassere M, Peterfy C, et al. The development of the EULAR-OMERACT rheumatoid arthritis MRI reference image atlas. Ann Rheum Dis 2005;64 Suppl 1:i8-10.
14. Ejbjerg B, McQueen F, Lassere M, Haavardsholm E, Conaghan P, O'Connor P, et al. The EULAR-OMERACT rheumatoid arthritis MRI reference image atlas: the wrist joint. Ann Rheum Dis 2005;64 Suppl 1:i23-47.
15. Conaghan P, Bird P, Ejbjerg B, O'Connor P, Peterfy C, McQueen F, et al. The EULAR-OMERACT rheumatoid arthritis MRI reference image atlas: the metacarpophalangeal joints. Ann Rheum Dis 2005;64 Suppl 1:i11-21.