WHOLE-BODY MRI IN PSORIATIC ARTHRITIS, RHEUMATOID ARTHRITIS AND HEALTHY CONTROLS – INTERSCAN, INTRAREADER AND INTERREADER AGREEMENT AND DISTRIBUTION OF LESIONS

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Running head: Interscan agreement of WBMRI

ABSTRACT

Objective: Whole-body MRI (WBMRI) is promising for monitoring patients' global disease activity in inflammatory joint diseases. The validation of WBMRI is limited; no studies have evaluated the test-retest agreement (interscan agreement) and only few have assessed the intra- and interreader agreement. Therefore we examined the interscan agreement of WBMRI in patients with psoriatic arthritis (PsA), rheumatoid arthritis (RA) and healthy controls (HC); and secondly evaluated the intra- and interreader agreement and agreement with conventional hand MRI and determined the distribution of lesions.

Methods: WBMRI was performed twice with a one-week interval in 14 patients with PsA, 10 with RA and 16 HC. Images were anonymized and read in pairs with unknown chronological order by experienced readers according to the OMERACT WBMRI, the Canada-Denmark MRI and the RAMRIS/PsAMRIS scoring systems. Ten image sets were re-anonymized for assessment of intra- and interreader agreement. Agreement was calculated on lesion level by percentage exact agreement (PEA) and Cohen's kappa, and for sum scores by absolute agreement single-measure intraclass correlation coefficient (ICC).

Results: WBMRI of the spine and peripheral joints and entheses generally showed moderate to almost perfect interscan agreement with PEA ranging from 95-100%, kappa 0.71-1.00 and ICC 0.95-1.00. Intra- and interreader data generally showed moderate to almost perfect agreement. Agreement with conventional MRI varied. More lesions were found in patients than HC.

Conclusion: WBMRI showed good interscan agreement, implying that repositioning of the patient between examinations does not markedly affect scoring of lesions. Intra- and interreader agreement was moderate to almost perfect.

INTRODUCTION

Psoriatic arthritis (PsA) and rheumatoid arthritis (RA) are chronic inflammatory diseases, which may affect both axial and peripheral joints. RA is mostly symmetrically distributed and characterized by inflammation of the small joints of the hands and feet, while PsA tends to affect axial and/or peripheral joints in an asymmetrical pattern (1, 2). Modern imaging methods such as magnetic resonance imaging (MRI) and ultrasound (US) allows monitoring of disease activity and progression in clinical trials and practice (3, 4). Conventional MRI allows sensitive visualization of axial and peripheral inflammatory and structural lesions of a limited anatomical area in one examination. Whole-body MRI (WBMRI) is a relatively new technique, first used for oncologic disease monitoring, which makes it possible to assess both axial and peripheral joints and entheses in one examination (5). Imaging the entire body in one examination within 50 minutes without repositioning the patient makes it a potential future tool for monitoring disease activity in clinical trials and supporting clinical decision-making in inflammatory joint diseases (5, 6). WBMRI seems particularly promising in patients with PsA, since PsA presents with varying patterns of axial and peripheral joint and enthesis involvement (6). WBMRI scoring systems for both the spine and peripheral joints and entheses have been proposed (7, 8), but the validation of WBMRI is limited. Studies assessing the intra- and interreader agreement are available (9-13), however no studies have evaluated the agreement of test-retest (interscan agreement), which is crucial to assess the significance of observed changes over time and is one of several types of validation that is needed in the verification of outcome measures. The primary aim of this study was to evaluate the interscan agreement of WBMRI. Secondary aims were to examine the intra- and interreader reliability for WBMRI, to compare detection of inflammatory changes in the small joints of the hands by WBMRI and conventional MRI, and to evaluate the distribution of axial and peripheral lesions in patients with PsA and RA as well as healthy controls.

PATIENTS AND METHODS

Patients. Patients with PsA, defined by the CASPAR (Classification for Psoriatic Arthritis) criteria (14), or RA, defined by the ACR (American College of Rheumatology)/ EULAR (European League Against Rheumatism) criteria (15), aged 18-70 years and with clinically active disease were recruited from two rheumatological clinics in the Copenhagen area. Furthermore, healthy controls were recruited. For PsA clinically active disease was defined as ≥2 (of 76) swollen joints and ≥3 (of 78) painful joints at clinical examination and involvement of hands defined as swelling of ≥1 finger joint (in metacarpophalangeal joints 2-5 (MCP), and proximal or distal interphalangeal joints (PIP or DIP 2-5)) and/or ≥1 dactylitis. Clinically active disease for RA was defined as ≥2 (of 76) swollen joints and ≥3 (of 78) painful joints at clinical examination and involvement of hands defined as swelling of ≥1 finger joint (MCP 2-5, PIP 2-5 or DIP 2-5).

Exclusion criteria included (1) changes in or initiation of treatment with non-steroidal anti-inflammatory drugs (NSAIDs), glucocorticoids and conventional disease modifying anti-rheumatic drugs (cDMARDs) ≤1 month before inclusion and biological treatment ≤3 months before inclusion, (2) pregnancy or breastfeeding, (3) contraindications for MRI, including the use of contrast agents containing gadolinium (Gd), (4) known recent drug or alcohol abuse. Exclusion criteria for healthy controls were (1) pain in peripheral joints or the spine <3 months before inclusion, (2) presence of swollen joints (of 76) and/or tender joints (of 78) at clinical examination.

The study was approved by the local ethical committee, H4-2012-044, and all participants signed informed content before any study procedures.

Demographics. Background information on age, sex, symptom duration and diagnosis as well as treatment status (NSAIDs, cDMARDs, biological DMARDs and glucocorticoids) for patients and healthy controls was collected.

Clinical examination. For all participants the following clinical and laboratory parameters were collected before the first MRI examination: clinical examination of joints for swelling (76) and tenderness (78) and entheses for tenderness (33), Disease Activity Score-28 (DAS28), Health Assessment Questionnaire (HAQ), Bath Ankylosing Spondylitis Disease Activity Index (BASDAI), Bath Ankylosing Spondylitis Functionality Index (BASFI) and Bath Ankylosing Spondylitis Metrology Index (BASMI), C-reactive protein and s-creatinine.

Image acquisition. WBMRI of the entire body (axial and peripheral joints and entheses except elbows and head) and conventional MRI of the right hand were performed twice for each participant with a one-week interval.

WBMRI was performed on a Philips 3T Ingenia unit using phased array coils (2 anterior and 1 built-in posterior) with patients in supine position for the following areas: (1) coronal images of shoulders and anterior chest wall, (2) sagittal images of the cervical, thoracic and lumbar spine, (3) coronal images of the pelvis and hips, (4) coronal images of hands (positioned behind the buttocks), (5) sagittal images of knees, (6) sagittal images of ankles and (7) axial images of the ankles/feet. Short-tau inversion recovery (STIR) and pre- and post-Gd (0.1 mmol/kg body weight gadoterate meglumine; Dotarem®, Guerbet, France) T1 weighted spin echo sequences were obtained of all regions, with a slice thickness of 3 mm for hands and ankles/feet, 4 mm for the spine and 5 mm for shoulders, hips, knees and ankles.

Conventional MRI of the hand was performed on the same scanner using a dedicated 8 canal hand/wrist for coronal images of the hand and wrist. STIR and pre- and post-Gd T1weigthed spin

echo sequences were obtained of the right hand and wrist, with a slice thickness of 2.5 mm for STIR sequences and a slice thickness of 0.8 mm for pre- and post-Gd T1 weighted sequences.

The procedure for the MRI sessions was that pre-contrast WBMRI was performed first, then coils were changed, and then pre-contrast conventional hand and wrist MRI was done. Then contrast was injected intravenously and the post-contrast conventional MRI was performed, followed by change of coils and performance of the post-contrast WBMRI.

Further details on the MRI protocol are specified in an additional file (see Supplementary Table 1).

MRI assessment. All WBMRI and conventional MRI images were anonymized and read in pairs, i.e. the two timepoints in continuation of each other, in unknown chronological order, by experienced readers blinded for all clinical and biochemical information. For WBMRI, peripheral joints and entheses were scored according to the OMERACT WBMRI for peripheral joints and entheses (WIPE) scoring system (7, 16) by an experienced musculoskeletal radiologist (IE). Using this system bone marrow edema (BME) and synovitis are scored in all peripheral joints, except elbows, and BME and soft tissue inflammation (STI) are scored in 33 entheses (see (16) for details). Axial joints (spine) were scored according to the Canada-Denmark scoring system (8) by a second reader, experienced in reading spinal MRI of inflammatory arthritis (SK). Using this system BME, fat lesion, bone erosion and new bone formation are scored separately at numerous locations in each vertebrae (see (8) for details) Conventional MRI of the wrist, MCP2-5 and PIP2-5 was scored according to the RAMRIS (17-19) and PsAMRIS scoring systems (20) for synovitis, tenosynovitis, BME, erosions and periarticular inflammation by a third reader, experienced in reading hand MRI reading (DG). Ten image sets (4 patients with PsA, 3 with RA and 3 healthy controls) were re-anonymized and re-scored by the above readers to investigate the intrareader agreement. Furthermore, the same 10 sets were scored according to all the applied scoring methods by an additional reader (MØ), experienced in all

three scoring methods, to investigate the interreader agreement. All readers calibrated before scoring, as recommended (9).

Statistical analysis. Only patients with complete image sets of WBMRI and conventional MRI were included in the statistical analyses. Scorings at lesion level were assessed using percentage exact agreement (PEA) and Cohen's kappa, quadratically weighted. For both WBMRI and conventional MRI, PEA and kappa were calculated per type of pathology for the different joint regions (Peripheral WBMRI: hands, shoulders, hips, knees, ankles/feet. Spinal WBMRI: not subdivided. Conventional MRI: wrist, MCP and PIP) and for all joints together. Scorings at patient level were assessed using a two-way random effects single measure model of intraclass correlation coefficient (ICC) based on absolute agreement. For WBMRI and conventional MRI ICC was calculated per type of pathology for the different joint regions and for all joints together. PEA, kappa and ICC for total inflammation, all inflammatory lesions considered together, were calculated both per joint region and for all joints together. Periarticular inflammation was not included in the statistical analyses, since it was only found in two patients. Intra- and interreader agreement analyses were done on pooled data from the two timepoints, i.e. a total of 20 datasets were analyzed. Cohen's kappa 0–0.20 was considered as no agreement, 0.21–0.39 as slight, 0.40–0.59 as weak, 0.60–0.79 as moderate, 0.80–0.90 as strong and >0.90 as almost perfect agreement (21). ICC values <0.50 were considered as poor, 0.51–0.75 as moderate, 0.76–0.90 as good and >0.91 as excellent reliability (22).

The distribution of lesions in each group (PsA, RA and healthy controls) was calculated as the percentage of participants with any positive grade of the individual lesion in each specific anatomical area.

The correlation between right hand WBMRI (WMBRI scoring methods) and conventional MRI (RAMRIS/PsAMRIS scoring methods) was assessed using Spearman's rho for the sum scores of wrists, MCP2-5 and PIP2-5, synovitis and bone marrow edema.

Missing data at one timepoint was transferred as missing data to the other timepoint. For sum scores missing data were imputed as zero.

All statistical analyses were made in SPSS v. 25 or R v. 3.4.2.

RESULTS

Patients. Forty-three participants were included in the study, three were excluded from statistical analyses due to incomplete image sets. Thus, data from 40 participants (14 patients with PsA, 10 with RA and 16 healthy controls) were analyzed. Demographics and baseline characteristics are shown in table 1.

Readability and distribution of lesions. The readability of conventional MRI and WBMRI was generally high, but in certain areas, mainly the lower sternocostal joints, it was lower (table 2). Table 2 shows the readability and the total number of lesions for the anatomical areas for WBMRI and conventional MRI. In general lesions on WBMRI were more frequent in patients with PsA and RA than healthy controls, see Figures 1 and 2.

WBMRI, peripheral joints and entheses. For all the four assessed pathologies (joint BME and synovitis; entheseal BME and STI), interscan PEA ranged between 95-98%. For all joints considered together, interscan kappa for synovitis and bone marrow edema were 0.82 and 0.88 (strong), respectively (Table 3) and ICC 0.96 and 0.99 (i.e. excellent). For entheses, interscan kappa for soft tissue inflammation and bone marrow edema were 0.79 and 0.71 (moderate), respectively, and ICC 0.96 and 0.93 (excellent) For all inflammatory lesions considered together, kappa was 0.83 (strong) and ICC 0.97 (excellent).

Regarding intrareader data, PEA was >90%, kappa 0.52–0.67 (weak to moderate), with one exception, and ICC 0.14–0.87 (poor to good), for the various lesion types (Table 4). Interreader data

showed PEA ranging between 84–97%, kappa 0.34–0.72 (slight to moderate) and ICC 0.35– 0.93 (poor to excellent) for the various lesion types.

WBMRI, spine. For interscan data, PEA was 100%, kappa 0.99–1.00 (almost perfect) (Table 3) and ICC ranged between 0.99–1.00 (excellent) for the various lesion types. For intrareader lesion level data, PEA was 99–100%, kappa was 0.91–1.00 (almost perfect) at lesion level (Table 4) and ICC ranged between 0.99–1.00 (excellent) for the various lesion types. For interreader data, PEA ranged between 98–100%, kappa from 0.82–0.93 (strong to almost perfect) with one exception, new bone formation, and ICC ranged between 0.23–0.97 (poor to excellent) for the various lesion types.

Conventional MRI. For interscan data, PEA was 98–100%, kappa 0.93–1.00 (almost perfect) (Table 3), and ICC was 0.91–1.00 (excellent) across the various lesion types. Intrareader data showed PEA ranging between 85–100%, kappa 0.75–1.00 (moderate to almost perfect) and ICC 0.75–1.00 (moderate to excellent) (Table 4). Interreader data showed PEA ranging between 63–100%, kappa 0.19–1.00 (none to almost perfect) and ICC 0.20–0.99 (poor to excellent) for the various lesion types. Periarticular inflammation was seen in two patients at both scans. In the analysis of the correlation between WBMRI and conventional MRI of the wrist, MCP and PIP, Spearmann's rho for synovitis were 0.17, 0.51 and 0.28, respectively, and for bone marrow edema 0.38, 0.82 and not available for PIP (data not shown in table).

DISCUSSION

This study is, to our knowledge, the first study to assess the interscan agreement (agreement between repeated scans) of WBMRI in inflammatory joint diseases. The overall interscan agreement of WBMRI for both axial and peripheral inflammatory changes in patients with PsA and RA and in healthy controls was good.

WBMRI of the individual areas in the spine and peripheral joints and entheses generally showed good interscan agreement. The overall agreement was comparable for soft tissue and bone changes in joints and entheses. The interscan agreement for the total MRI inflammatory activity, i.e. the sum of joint and entheseal soft tissue and bone inflammation was good, both for individual regions (ICC>0.80) and for the entire patient (ICC 0.97). The few exceptions (pelvis/hip and shoulder) showed low kappa and ICC, but not a low PEA. This can be explained by only few patients having lesions, which will lower the kappas and ICCs. There were no definite patterns of poor agreement for one particular joint or enthesis across evaluated pathologies nor was there any pathology showing poor agreement for all joints or entheses. For example, poor agreement among the shoulder pathologies was only seen for entheseal STI while for pathologies in the pelvis poor agreement was only seen for entheseal BME. This indefinite pattern probably results from the low prevalence of lesions and the limited sample size and it is unlikely to represent true differences in agreement between individual sites. Our results imply that repositioning the patient between examinations does not markedly affect scoring of lesions. This robustness is an important aspect of WBMRI that should be considered when assessing treatment-induced changes over time in clinical trials. This type of validation is rarely done. However, knowing of the variability between two examinations is very important when evaluating whether a change occurring after a treatment is real or not. It is a limitation that most patients had low disease activity, since we cannot rule out that larger interscan differences may be found in patients with more severe disease.

WBMRI showed good readability of all the assessed areas, except the lower sternocostal joints. Elbows were not included in the protocol since earlier studies have shown poor readability for this area due to its location at the edge of the MRI image (i.e. partly outside the field of view (FOV)) (13). Compared to earlier studies (10-12) using 3T WBMRI, we found overall similar good readability. In

future studies it is relevant to consider whether scoring of the 3rd to 7th sternocostal joints should be included as part of the WBMRI protocol or omitted from scoring.

The assessment of the distribution of lesions showed more hand lesions in RA than PsA, and more involvement of acromioclavicular and sternoclavicular joints and certain entheses in PsA than RA. This is in accordance with the known disease patterns. Overall RA patients had more MRI lesions than PsA. This was not explained by clinical differences in the participants, since the RA and PsA groups were similar regarding number of clinically swollen and tender joints and symptom duration. In healthy controls, markedly fewer lesions were detected compared to in PsA and RA. However, low grade inflammatory findings in healthy controls were fairly frequent. It is well-known that low-grade inflammation may be seen in healthy controls (23, 24). This may be due to osteoarthritis or mild inflammation in joints/entheses related to the normal physiology of having an active lifestyle or overuse. The most frequent finding in healthy controls was synovitis, particularly in the wrist/CMC1 and MTP1-5. This may be explained by a relatively low image resolution compared to joint size, which may make the discrimination between normal joint fluid and synovitis difficult, and by the likely presence of subclinical osteoarthritis. This is in accordance with previous studies which have found low grade synovitis in small joints of hands and feet in control populations (23, 24). Furthermore, WBMRI assessment is still less certain than optimal conventional MRI, due to poorer image resolution and signal-to-noise ration.

Intra- and interreader data generally showed moderate to good agreement. Entheseal bone marrow edema had numerically lower kappa and ICC, but similar PEA, compared to the other pathologies. Previously reported interreader agreement (ICC) for inflammation using the OMERACT WBMRI scoring system (16) was lower (0.67) compared to the ICC (0.93) in this study. In the study by Krabbe et al (8) the median interreader ICC for inflammation, fat, erosion and new bone formation in the spine was 0.78 (range 0.61-0.92) while 0.79 (range 0.23-0.87) in the present study, i.e. the interreader

ICC was comparable. Other studies (9-12) have assessed the intra- and interreader agreement for WBMRI, using different scoring systems and by this precluding direct comparison. It is likely that the reliability may be further improved by future improvements of the technical quality of WBMRI and the development of standard reference images as proposed by the OMERACT MRI group.

The exploratory analysis of the correlation between WBMRI and conventional MRI of the wrist, MCP and PIP showed the highest values in MCP for both synovitis and bone marrow edema. The low correlation in wrists may be explained by the different scoring methods. Using the OMERACT WBMRI scoring system the wrist is scored as one joint, whereas it in RAMRIS/PsAMRIS scoring systems is scored as several individual joints. Furthermore, the reduced image quality of WBMRI is probably an important factor. Conventional MRI overall found more lesions than WBMRI of the same joints. Interscan variation for conventional MRI was, as for WBMRI, good to very good. Therefore, repositioning between examinations does not seem to affect scoring of lesions for neither of the two approaches.

Strengths of this study were that an extensive MRI protocol including both conventional MRI of one wrist/hand and WBMRI of axial and peripheral joints and entheses was repeated within 7 days. This made it possible to assess the interscan agreement. Another strength was that healthy controls were included. Furthermore, the use of the new scoring systems based on international consensus (Canada-Denmark and OMERACT WBMRI WIPE) is a strength, since these methods are likely to be used in future studies. The limitations of this study include that the patients generally had low disease activity with few lesions observed. Reading image sets pairwise rather than as individual image sets was chosen as it was expected to allow a more reliable detection of changes in lesions between the two timepoints, and this is also the convention in clinical trials. The image quality of WBMRI was not optimal, particularly for identifying small structures, but this is gradually improving due to technical advantages.

CONCLUSION

In conclusion, WBMRI of the spine and peripheral joints and entheses showed good to very good interscan agreement for patients with PsA and RA and this indicates that repositioning of the patient does not markedly affect the scoring of pathologies between two timepoints. The intra- and interreader agreement was overall moderate to good.

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FIGURE LEGENDS

Figure 1: Percentage of participants with lesions found on WBMRI in the examined peripherl joints and entheses. The specific joints and entheses can be seen in (16).

Figure 2: Percentage of participants with lesions in the spine.

TABLE LEGENDS

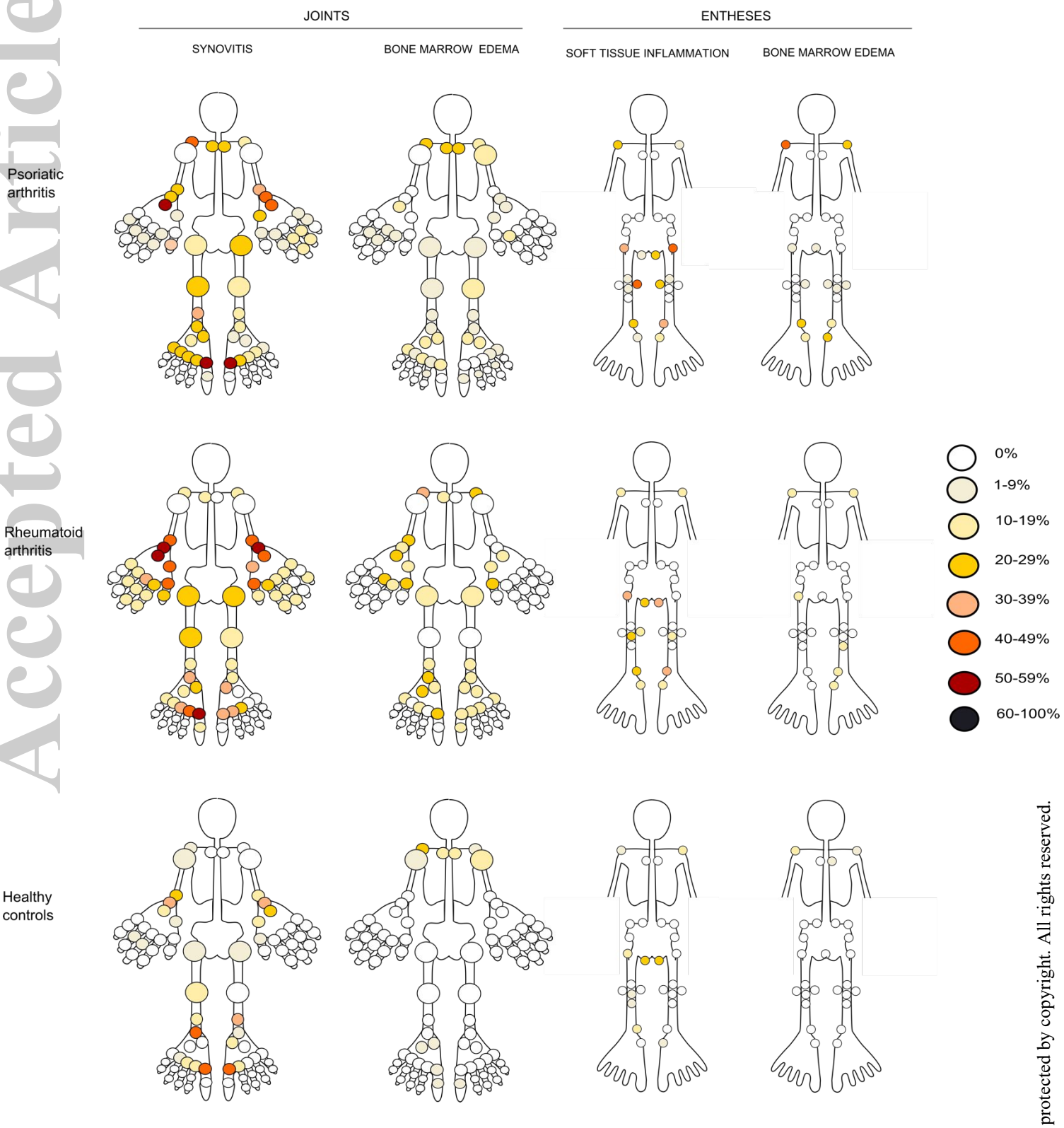
Table 1: Baseline characteristics

Table 2: WBMRI and conventional MRI readability and frequency of lesions in patients with PsA and RA and healthy controls.

Table 3: Interscan agreement between two WBMRI examinations performed with a one-week interval (all participants).

Table 4: Intra- and interreader agreement.

Supplementary Table 1: Details on the MRI acquisition.



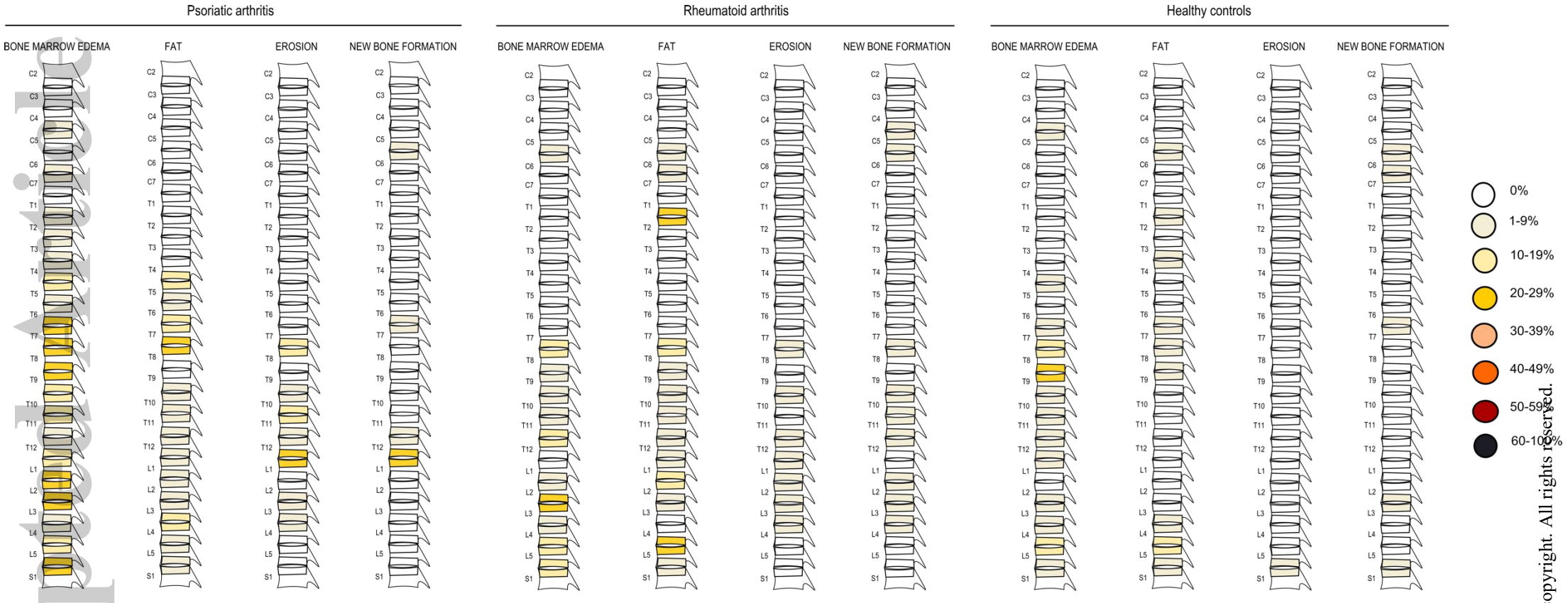


Table 1: Baseline characteristics.

	PsA (n=14)	RA (n=10)	HC (n=16)
Age (years)	48 (31-68)	49 (26-58)	35 (23-54)
Female (n, %)	10 (71)	8 (80)	9 (56)
Symptom duration (years)	10 (0-24)	7 (3-24)	-
BASDAI (0-100mm VAS)	36 (2-77)	34 (7-71)	2 (0-14)
BASFI (0-100mm VAS)	22 (0-54)	15 (0-66)	1 (0-7)
BASMI (0-100)	0 (0-30)	0 (0-0)	0 (0-10)
Axial physician global (0-100mm VAS)	25 (2-61)	26 (6-57)	0 (0-1)
Axial pain (0-100mm VAS)	33 (3-83)	32 (4-76)	0 (0-23)
Axial patient global (0-100mm VAS)	37 (0-86)	25 (4-76)	0 (0-22)
HAQ (0-100mm)	0.5 (0-1.5)	0.7 (0.3-1.8)	0 (0-0.1)
Peripheral pain (0-100mm VAS)	31 (4-78)	33 (0-75)	0 (0-35)
Fatique (0-100mm VAS)	37 (0-88)	57 (0-78)	4 (0-40)
Peripheral patient global (0-100mm VAS)	47 (0-84)	41 (0-77)	0 (0-36)
Number of swollen joints (0-76)	5 (2-12)	6 (3-15)	0 (0-0)
Number of tender joints (0-78)	11 (3-24)	8 (3-31)	0 (0-1)
Number of tender entheses (0-31)	10 (0-21)	4 (0-14)	0 (0-3)
Serum C-reactive protein (mg/dl)	5 (1-13)	5 (1-23)	5 (1-14)

Values are median (range).

PsA: psoriatic arthritis, RA: rheumatoid arthritis, HC: healthy controls

BASDAI: Bath Ankylosing Spondylitis Disease Activity Index, BASFI: Bath Ankylosing Spondylitis Functionality Index, BASMI: Bath Ankylosing Spondylitis Methology Index, VAS: visual analogue scale, HAQ: Health Assesment Questionaire

Table 2: WBMRI and conventional MRI readability and frequency of lesions in patients with PsA and RA and healthy controls.

WBMRI - Peripheral joints

	Readability, %				No. of lesions, % of all readable areas[1]											
					Synovitis			JBME			Soft tissue inflammation			EBME		
	Syn	STI	JBME	EBME	PsA	RA	HC	PsA	RA	HC	PsA	RA	HC	PsA	RA	HC
Shoulders and AC	95	*96*	96	*95*	18	10	4	11	6	11	15	6	11	28	14	10
Wrists and 1st CMC	94	-	95	-	29	48	19	5	11	0	-	-	-	-	-	-
Hands, MCP2-5	96	-	96	-	5	21	1	3	6	0	-	-	-	-	-	-
Hands, PIP2-5	95	-	94	-	4	8	0	0	0	0	-	-	-	-	-	-
Hands, DIP2-5	95	-	93	-	13	8	0	1	0	0	-	-	-	-	-	-
SC joint 1	-	94	-	94	-	-	-	-	-	-	2	0	0	0	0	2
SC joint 2	-	93	-	93	-	-	-	-	-	-	0	0	0	4	0	0
SC joints 3-7	-	6	-	5	-	-	-	-	-	-	0	0	0	0	0	0
Pelvis/hip[2]	93	94	93	94	22	19	3	7	6	0	10	12	8	1	0	0
Knees	99	98	98	98	19	13	13	7	0	0	8	4	1	4	1	0
Ankles and TMT	97	95	96	95	17	14	15	11	11	2	20	20	11	19	7	1
Feet, MTP 1-5	91	-	89	-	29	21	20	8	9	0	-	-	-	-	-	-
Feet, PIP 1-5	83	-	83	-	1	1	1	3	2	1	-	-	-	-	-	-
Feet, DIP 1-5	81	-	81	-	0	0	0	0	0	0	-	-	-	-	-	-

WBMRI - Spine

	Readability, %				No. of lesions (% of all readable areas)											
					Bone marrow edema			Fat			Erosion			New bone formation		
	BME	Fat	Ero	NBF	PsA	RA	HC	PsA	RA	HC	PsA	RA	HC	PsA	RA	HC
Cervical vertebral bodies	100	100	100	100	0.7	0.9	0.2	0	2	0.8	0	0	0	0.4	0.6	0.8
Cervical posterior parts	100	100	100	100	0	0	0	0	0	0	0	0	0	0	0	0
Thoracic vertebral bodies	100	100	100	100	2.1	0.8	0.4	0.7	0.7	0.5	0.8	0.7	0	0.3	0.7	0.2
	100	100	100	100	0.2	0	0	0	0	0	0	0	0	0	0	0
Thoracic posterior parts																
Lumbar vertabral bordies	100	100	100	100	1.5	0.7	0.3	0.5	0.8	0.4	1	0.5	0	0.7	1.2	0.4
Lumbar posterior parts	100	100	100	100	0	0	0	0	0	0	0	0	0	0	0	0

Conventional MRI

	Readability, %				No. of lesions (% of readable)											
					Synovitis			Tenosynovitis			Bone marrow edema			Erosion		
	Syn	TS	BME	Ero	PsA	RA	HC	PsA	RA	HC	PsA	RA	HC	PsA	RA	HC
MCP 2-5	86	86	94	95	42	36	5	19	32	0	1	17	0	8	9	0
PIP 2-5	82	83	91	93	32	25	2	10	18	1	0	11	0	1	1	0
Wrist	86	83	94	95	61	40	23	12	20	3	5	11	0	5	5	0

[1]No. of lesions are the total number of lesions for all participants in each group, percentage is the number of observed lesions divided by the total number of possible lesions, i.e. the number of readable areas.

[2]Sacroiliac joints not included.

AC: acromioclavicular joints, BME: bone marrow edema, CMC: carpometcarpal joint, DIP: distal interphalangeal joint, EBME: entheseal bone marrow edema, Ero: erosion, NBF: new bone formation, HC: healthy controls, JBME: joint bone marrow edema, MCP: metacarpophalangeal joint, MTP: metatarsophalangeal joint, PIP: proximal interphalangeal joint, PsA: psoriatic arthritis, RA: rheumatoid arthritis, SC: sternoclavicular, STI: soft tissue inflammation, Syn: synovitis, TMT: tarsometatarsal joint, TS: tenosynovitis, WBMRI: Whole-body

Table 3: Interscan agreement between two WBMRI examinations performed with a one-week interval (all participants).

			PEA	Kappa	ICC
WBMRI; Peripheral	Synovitis	All	95	0.82	0.96
		Ankles/Feet	96	0.83	0.93
		Hands	96	0.84	0.95
		Shoulders	92	0.54	0.60
		Pelvis*	97	0.94	0.93
		Knees	87	0.64	0.79
	Joint BME	All	98	0.88	0.99
		Ankles/Feet	98	0.84	0.98
		Hands	99	0.87	0.91
		Shoulders	95	0.87	0.91
		Pelvis	99	0.95	1.00
		Knees	100	0.97	1.00
	Entheseal STI	All	97	0.79	0.96
		Ankles/Feet	98	0.96	0.98
		Hands	*NA*	*NA*	*NA*
		Shoulders	95	0.27	0.40
		Pelvis	96	0.82	0.93
		Knees	97	0.75	0.95
	Entheseal BME	All	98	0.71	0.93
		Ankles/Feet	96	0.59	0.71
		Hands	*NA*	*NA*	*NA*

		Shoulders	96	0.70	0.60
		Pelvis/hip	99	0.40	0.04
		Knees	100	0.87	1.00
	Total inflammation**	All	97	0.83	0.97
		Ankles/Feet	97	0.83	0.96
		Hands	97	0.85	0.94
		Shoulders	95	0.72	0.80
		Pelvis	98	0.85	0.96
		Knees	98	0.83	0.99
WBMRI; Axial	BME	All	100	0.99	0.99
	Fat	All	100	0.99	1.00
	Erosion	All	100	1.00	1.00
	New bone formation	All	100	1.00	1.00
Conv. MRI	Synovitis	All	98	0.97	0.99
		MCP	98	0.97	0.98
		PIP	98	0.95	0.97
		Wrist	98	0.97	0.99
	Tenosynovitis	All	99	0.98	0.99
		MCP	98	0.97	0.99
		PIP	98	0.95	0.91
		Wrist	100	1.00	1.00
	BME	All	100	0.99	1.00
		MCP	99	0.98	0.99
		PIP	100	1.00	1.00

	Wrist	99	0.99	1.00
Erosion	All	100	0.97	0.98
	MCP	99	0.93	0.92
	PIP	100	1.00	1.00
	Wrist	100	1.00	1.00
Inflammation	All	99	0.98	1.00
	MCP	99	0.98	0.99
	PIP	99	0.96	0.98
	Wrist	100	0.99	1.00

**Pelvis: the hip joints, (sacroiliac joints not included).*

***Total inflammatory activity; the sum of joint and entheseal soft tissue and bone inflammation.*

BME: bone marrow edema, Conv. MRI: conventional MRI, ICC: two-way random effects intraclass correlation coefficient, single measure absolute agreement, Kappa: Cohen's Kappa, quadratic weighted, MCP: metacarpophalangeal joints, PEA: percentage exact agreement, PIP: proximal interphalangeal joints, STI: soft tissue inflammation, WBMRI: Whole-body MRI

Table 4: Intra- and interreader agreement.

		INTRAREADER		
		PEA	Kappa	ICC
WBMRI; Peripheral	Synovitis	90	0.58	0.87
	Joint BME	97	0.52	0.45
	Entheseal STI	92	0.67	0.85
	Entheseal BME	97	0.08	0.14
	Total inflammation*	94	0.58	0.86
WBMRI; Axial	BME	100	0.93	0.99
	Fat	99	0.91	0.99
	Erosion	100	1.00	1.00
	New bone formation	100	1.00	1.00
Conv. MRI	Synovitis	85	0.87	0.96
	Tenosynovitis	85	0.75	0.92
	BME	97	0.95	0.99
	Erosion	99	0.83	0.79
	Inflammation	91	0.90	0.99
		INTERREADER		
		%-agreement	Kappa	ICC
WBMRI; Peripheral	Synovitis	84	0.41	0.85
	Joint BME	97	0.72	0.91
	Entheseal STI	93	0.41	0.74
	Entheseal BME	97	0.34	0.35
	Total inflammation*	92	0.50	0.93

WBMRI; Axial	BME	100	0.93	0.67
	Fat	99	0.82	0.97
	Erosion	100	0.83	0.91
	New bone formation	98	0.17	0.23
Conv. MRI	Synovitis	76	0.83	0.93
	Tenosynovitis	89	0.68	0.87
	BME	94	0.88	0.99
	Erosion	93	0.19	0.20
	Inflammation	89	0.84	0.99

Values are for ten participants (psoriatic arthritis: 4, rheumatoid arthritis: 3, healthy controls: 3), and for all anatomical areas considered together.

**Total inflammatory activity, i.e. the sum of joint and entheseal soft tissue and bone inflammation. BME: bone marrow edema, Conv. MRI: conventional MRI, ICC: two-way random effects intraclass correlation coefficient, single measure absolute agreement, Kappa: Cohen's Kappa, quadratic weighted, MCP: metacarpophalangeal joints, PEA: percentage exact agreement, PIP: proximal interphalangeal joints, STI: soft tissue inflammation, WBMRI: Whole-body MRI*