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ORIGINAL ARTICLE

A recently developed MRI scoring system for hand osteoarthritis: its application in a clinical setting

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Abstract This study aimed to apply the recently proposed Oslo hand osteoarthritis magnetic resonance imaging (MRI) scoring system to evaluate MRI findings in a cohort of patients affected by long-standing erosive hand osteoarthritis (EHOA). Eleven female EHOA patients (median 59 [interquartile range 62–52] years, disease duration 9.5 [interquartile range 13–3.75] years) underwent MRI (1.5 T) of the dominant hand, and synovitis, bone marrow lesions (BMLs), joint space narrowing, osteophytes, cysts, malalignment, and erosions were scored using the Oslo scoring system. Intra- and inter-reader reliability were assessed. The patients also underwent X-ray examination, and bone features were evaluated using the same scoring system. Pain and tenderness were assessed during a physical examination. Spearman's non-parametric test was used to analyze the correlations between variables. MRI intra- and inter-reader reliability were found between good and moderate for many features. No statistical differences were found between the radiographs and MRI with regard to detection of JSN, malalignment, and bone erosions. Synovitis was detected in 39.8 % of the 80 joints examined (in a mild form in 80 %), erosions were found in 51.1 %, and BMLs were identified in 20.5 and 23.9 % at the distal and the proximal side, respectively. BMLs at both the proximal and distal ends were correlated with tender joints (BML distal $p = 0.0013$, BML proximal $p = 0.012$). The presence of synovitis was correlated with tenderness ($p = 0.004$) and erosions at both the distal and proximal joints ($p = 0.004$). The presence of erosions correlated with tender joints ($p < 0.01$) and the mean visual analog scale (VAS) score (distal $p = 0.03$, proximal $p = 0.01$). Synovitis and BMLs were correlated with clinical symptoms in our patients affected with long-standing EHOA.

Keywords Erosive hand osteoarthritis · Hand osteoarthritis · Inflammatory disease · MRI · Rheumatic disease · X-rays

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Introduction

Characterized by pain, heat, redness, swelling, and loss of function, erosive hand osteoarthritis (EHOA) is considered an inflammatory subset of osteoarthritis (OA) [1]. The prevalence of EHOA has been estimated to be approximately 8.5 % [2]. While onset is abrupt, its evolution leads to deformity. Although some manifestations such as ankylosis and joint instability can be considered exclusive features of the disease, they and other aspects such as Heberden's and Bouchard's nodes or subluxations are at times noted in the nodal form [3]. During the early phase, which generally lasts about 6 months, the clinical course may be accompanied by erythema, pain, and at times hard, jelly-like cysts on finger backs [4]. EHOA development is characterized by frequent inflammatory episodes and a more aggressive disease course with respect to nodal OA [5]. The diagnosis is usually made on the basis of

plain antero-posterior hand radiographs which are able to identify the classic aspects of hand OA such as joint space narrowing (JSN), subchondral sclerosis, and osteophytes, bone proliferation, as well as central erosions considered to be a feature that is linked exclusively to EHOA [6].

The development of new imaging instruments has made it possible to investigate changes not only in the osteochondral but also in the other soft tissues involved in pathogenesis of the disease.

In view of its capacity to three-dimensionally assess all joint components, including the articular cartilage, the subchondral bone, the synovial membrane, the capsule, and the ligaments, each crucially involved in OA [7], magnetic resonance imaging (MRI) has been acquiring an important role in evaluating signs of synovial inflammation and bone marrow edema [8]. OA is, in fact, often associated with low-grade synovitis. Considered a major risk factor for rapid progression of structural joint deterioration, synovial inflammation has been correlated with joint pain and dysfunction [9]. In addition, OA pain has been associated with bone marrow lesions (BMLs) which are detected by MRI [10].

The Oslo Hand OA MRI (OHOA-MRI) score [11] is a recently proposed system for grading relevant features of hand OA that are detectable by MRI and X-rays such as osteophytes, JSN, erosions, cysts, and malalignment. Other signs that are taken into consideration such as synovitis, flexor tenosynovitis, BMLs, and the presence of collateral ligaments are identified exclusively by MRI. Since the Norwegian research group developed the index in 2011 [11] and used it to describe MRI findings in a group of 106 patients [11], only one other group has published data on the score's application in clinical practice [12]. While the former studied 64 patients with EHOA [13], the other used the scoring system to assess 13 Dutch patients affected by EHOA [12].

The current study used the OHOA-MRI scoring system to evaluate MRI findings in a cohort of long-standing EHOA patients. MRI and radiographic features were then compared, and the association between the presence of synovitis and BMLs and clinical symptoms was analyzed.

Methods

Patients

Eleven EHOA outpatients attending the Hand OA Clinic of the Rheumatology Unit of the University of Padova (Italy) Medical Center were enrolled in the study. In accordance with the American College of Rheumatology (ACR) clinical classification criteria for hand OA [14], all the patients had at least one X-ray-confirmed erosion of an IP joint without presence of metacarpophalangeal erosions. All the patients complained about painful hand joints ≥40 mm (0–100) at the visual analog scale (VAS) at study onset. None had a history of traumatic joint injuries or of other arthropathies including rheumatoid arthritis, psoriatic arthritis, gout, or chondrocalcinosis. After receiving a full description of the study's aims and methodology, the patients signed informed consent forms. The ethics committee of the Padova University Medical Center approved the protocol, and the study was carried out in accordance with the principles of the Declaration of Helsinki.

The patients underwent a physical examination of the hands which they were carefully evaluated for signs of hard or soft swellings, pressure pain (from 0 = absent to 3 = severe), or redness and/or warmth.

All the patients were asked to fill out two questionnaires: the Australian/Canadian Osteoarthritis Hand Index (AUSCAN) and Dreiser's algo-functional finger index. The former, which consists in questions concerning three domains (pain, stiffness, and physical function), can result in a score from 0 (none) to 4 (extreme). The latter, which measures functional status in patients with arthropathies of the hand, uses a 4-point scale rating the patient's ability to perform daily tasks (a score of 0 indicates no difficulty, a score of 4 indicates extreme difficulty).

Stiffness was quantified during the physical examination. Patients' grip strength was measured using a pressure gage; three readings for each hand were averaged.

Imaging

All of the patients underwent MRI of the clinically dominant hand using a Siemens Magnetom Avanto 1.5 MRI System. The participants were placed prone with the hand extended above the head, fingers placed spread apart. A surface flex coil was used to assay from the radiocarpal to the DIP joint surface. The imaging protocol included coronal T1, TIRM, and pre- and post-contrast VIBE, sagittal T1 SE, axial T1, and T2 SE sequences. Pre- and post-contrast VIBE sequences were acquired and subtracted images were obtained. Intravenous 0.1 ml/kg gadopentate dimeglumine (Multihance Bracco Imaging, Milan, Italy) was administered using an 18–20-G needle. Three-millimeter slice thickness with no gap was used for all SE and a thickness of 1.5 mm for VIBE, FOV 180 for all sequences, matrix 384 × 512 for T1, 256 × 256 for TIRM and VIBE.

The following aspects of the proximal interphalangeal (PIP) and distal interphalangeal (DIP) joints of the second to fifth fingers (a total of eight joints for every patient) were assessed using the OHOA-MRI scoring system [11] which assesses the following: synovitis (0–3 score), flexor tenosynovitis (0–3 score), erosions (0–3 score), cysts (absent/present), osteophytes (0–3 score), JSN (0–3 score), malalignment (absent/present), BML (0–3 score), collateral ligament (CL) (present/absent), and BML at CL insertion sites (absent/present).

Bilateral hand radiographs were obtained for 10 of the patients; the 11th patient was unavailable as she had moved to another city. The second to fifth DIPs and PIPs of the dominant hand (80 joints) were scored using the Kellgren-Lawrence (K-L) system, which is a widely used radiographic scale classifying HOA severity (grades 0–4) [15]. In addition, the OHOA-MRI scoring system was also used to grade the bone features on the radiographs in order to homogenize the results especially with regard to the erosions which are graded on a 0 to 3 basis by the OHOA-MRI but as absent/present on the Osteoarthritis Research Society International (OARSI) atlas [16]. The OHOA-MRI scale, moreover, scores the distal and proximal parts of the joints separately [11]. All the MRI and radiographs were scored by two clinical radiologists (VS and LC) specialized in musculoskeletal disorders and trained by the reference paper and the atlas provided in the supplemental data available online [11]. Intra- and inter-reader reliability were assessed for both the radiographs and the MRIs.

Statistical analysis

The patients' clinical and demographic data were expressed as median (interquartile range [IQR]: Q1–Q3). Spearman's non-parametric test was used to analyze the correlations between the variables. The number of affected (≥grade 1 pathology) interphalangeal joints of the second to fifth fingers of the dominant hand according to the radiographs and the MRIs was compared using the Wilcoxon signed-rank test. *P* values <0.05 were considered significant.

Concordance between radiographic and MRI findings at the individual joints was assessed with regard to the following features: JSN, osteophytes, erosion, malalignment, and cysts. Agreement between the MRI and radiographic scores was assessed using weighted kappa test (kappa for dichotomous variables such as cysts and malalignments). With regard to kappa or weighted kappa coefficients, <0.00 was considered poor agreement, 0–0.20 slight, 0.21–0.40 fair, 0.41–0.60 moderate, 0.61–0.80 good, and 0.81–1.00 very good agreement. In addition, agreement was assessed using percentage of exact agreement (PEA) for features scored as present/absent and using percentage of close agreement (PCA) for non-dichotomous variables. The PEA was calculated as the percentage of occasions in which the MRI and radiographic scores of the bone features (presence/absence) was identical; a PEA = 100 % was considered a perfect agreement. PCA was similarly calculated as the percentage of occasions in which the difference was ≤1 and should approach 100 %. Reliability was assessed by intra-class correlation coefficient (ICC). Single and average measure ICCs were calculated using two-way mixed effect models. Inter-reader reliability was expressed as single measure ICCs (mean [95 % IC]); intra-reader reliability was expressed as the average measures of two readers (mean [95 % IC]). Interpretation of ICC was similar to kappa: 0–0.20 poor, 0.21–0.40 fair, 0.41–0.60 moderate, 061–0.80 good, 0.81–1–00 very good agreement.

Statistical analysis was performed using the GraphPad Prism 5.0 program or the MedCalc version 15.8.

Results

The patients' clinical and demographic data are outlined in Table 1.

The patients (all female) had a median age of 59 (IQR 62–52) years. Their average age at disease onset was 45.68 (IQR 49.25–41.25) years; disease duration was 9.5 (IQR 13–3.75) years. Disease onset in three of the patients was postmenopausal; it was earlier in the others. Only one patient smoked. Nine reported a family history for hand OA.

MRI features

Mean scores of the DIP and PIP joints evaluated together using the OHOA-MRI system are outlined in Table 2. Wide severity ranges were found in most of the MRI features studied, and most, except for flexor tenosynovitis, bone cysts, and malalignment, were present in all of the patients.

The distribution of MRI features is outlined in Table 3 (Fig. 1). Synovitis was detected in 39.8 % of the 88 joints studied and was more frequently observed in the PIP (28.4 %) with respect to the DIP joints (11.4 %). Synovitis was mild in 80 % of the joints, moderate in 14.3 %, and severe in 5.7 %. Flexor tenosynovitis was detected in only 4.6 % of the joints. Bone erosions were found in 51.1 % of the joints both at the proximal and distal sites. The percentage of erosions was similar in the PIP and DIP joints (25 vs 26.1 %). Erosions, both at the distal and proximal parts of the joints, were assigned a grade of 1 in more than 40 % of the joints, of 2 in approximately 30 % of the joints, and of 3 in more than 20 % of joints.

Osteophytes were detected in 73.9 % of the distal parts of the joints and in 38.6 % of the proximal ones. They were mild in 50.8 %, moderate in 35.9 %, and severe in 13.8 % of the distal parts of the joints. Results with regard to osteophytes on the proximal side were similar; JSN were noted in almost all of the joints analyzed (95.5 %). It was mild in 39.3 %, moderate (bone-to-bone contact in part of the joint) in 36.9 %, and severe (bone-to-bone contact in the whole joint) in 23.8 %.

Malalignment was found in 12.5 % of the frontal planes and in 8 % of the sagittal ones. BMLs were detected in more than 20 % of the joints with greater involvement noted in the PIP with respect to the DIP joints. BMLs were assigned a grade of 1 (indicating 1–33 % of bone with BML) in 33.3 % of both the distal and the proximal parts of the joints, a grade of 2 (indicating 34–66 % of bone with BML) in 16.7 % of the distal and 33.3 % of the proximal parts of the joint, and a grade

Table 1 Patients' demographic and clinical features

Features	Values
Women	11 (100 %)
Median age (IQR) years	59 (62–52)
Median onset age (IQR) years	45.68 (49.25–41.25)
Median disease duration (IQR) years	9.5 (13.00–3.75)
Median body mass index (BMI) (IQR) kg/m^2	23.35 (23.93–21.75)
Median morning stiffness (IQR) minutes	12.50 (30.00–5.00)
Median painful joints (IQR) (number)	6.73 (9.25–3.75)
Median nodules (IQR) (number)	8.14 (9.00–8.00)
Median soft swelling and/or redness and/or heat (IQR) (number)	0.00 (1.00–0.00)
Median VAS (IQR) (0–100 mm)	62.64 (73.75–44.25)
Median AUSCAN (IQR) (0–60 scale)	31.45 (40.50–27)
Median Dresier (IQR) (0–30 scale)	10.91 (14–7.75)
Median grip strength of dominant hand (IQR) (bar)	0.19 (0.28–0.14)
Median Kellgren-Lawrence sum score (0–32) (IQR)	22.00 (26–21)

IQR interquartile range, *VAS* visual analog scale, *AUSCAN* Australian/Canadian Osteoarthritis Hand Index, *Dreiser* Dreiser's algo-functional finger index

of 3 (indicating 67–100 % of bone with BML) in 50 % of the distal parts and in 33.3 % in the proximal parts of the joint.

BMLs at CL insertion proximal sites were detected in 12.5 % of the distal ulnar and in 22.7 % of the proximal ulnar joints and were more frequent in the PIP (both radial and ulnar) with respect to the DIP joints (14.7 vs 8 %). Absence of collateral ligaments was found in approximately 35 % of the joints on both the radial and ulnar sides (Table 3).

Table 2 DIP and PIP joints evaluated as a single entity (range) using the OHOA-MRI system

Features	DIP + PIP
Synovitis (0–24)	3 (0–11)
Flexors tenosynovitis (0–24)	0.5 (0–3)
Erosions (0–48)	15.2 (1–42)
Cysts (0–16)	0.3 (0–1)
Osteophytes (0–48)	14.7 (5–30)
Joint space narrowing (0–24)	14.1 (8–22)
Malalignment frontal (0–8)	1.0 (0–2)
Malalignment sagittal (0–8)	0.6 (0–3)
BMLs (0–48)	7.5 (0–19)
CL absence (0–16)	6.2 (2–9)
BMLs at CL insertional sites (0–32)	5.5 (0–14)

Data are expressed as mean scores (range)

BML bone marrow lesion, *CL* collateral ligament

Radiograph features and concordance with MRI

The K-L scores assigned to the 80 joints that were evaluated were distributed as follows: a grade 1 was assigned to 1 joint (1.1 %), a grade 2 to 26 joints (29.5 %), a grade 3 to 39 joints (44.3 %), and a grade 4 to 22 joints (25 %). None of the joints were assigned a 0 score. Bone features assessed using the OHOA-MRI scoring system are outlined in Table 4. The radiographs detected more joints with cysts than did the MRI (Table 4) (distal part of the joint: 16.3 vs 1.3 %, $p=0.034$; proximal part of the joint: 31.3 vs 2.5 %, $p=0.015$). The radiographs detected more osteophytes at the proximal part of the joints than did the MRIs (66.2 vs 40 %, $p=0.041$). No statistical differences were found between the radiographs and MRI with regard to detection of JSN, malalignment, and bone erosions. The agreement between radiographs and MRI scores evaluated by kappa or kappa-weighted statistic was poor for bone cysts, proximal erosions, and sagittal malalignment. It was fair for JSN, frontal malalignment, distal erosion, and osteophytes. Nevertheless, PEA or PCA was more than 70 % for all the features.

Intra- and inter-reader reliability of radiographic and MRI features

Table 5 outlines the intra- and inter-reader reliability values for the combined DIP and PIP joints. Intra- and inter-reader reliability of the radiographs were between very good and moderate with regard to all radiological features except for malalignment in the sagittal plane which was fair. MRI intra-reader reliability resulted very good for JSN; good or moderate for malalignment, erosions, osteophytes, synovitis, BML, and bone cysts distal; and poor for bone cyst proximal and flexor tenosynovitis. MRI inter-reader reliability was moderate for JSN, distal bone erosions, distal bone cysts, osteophytes, and synovitis; fair for malalignment, BML, and bone erosions; and poor for bone cyst proximal and flexor tenosynovitis. In general, intra- and inter-reliability was higher for the radiographs than for the MRIs.

The correlation between clinimetric properties and clinical parameters

The agreement between clinical parameters (number of tender joints) and clinimetric properties was evaluated using the AUSCAN, a self-report questionnaire assessing pain, disability, and joint stiffness in hand EHOA, ($p=0.026$) and the Dresier index, which measures functional status in patients with arthropathies of the hand ($p=0.011$). The number of active joints (NAJ) (swelling and/or heat-redness) was found to be correlated with the visual analog scale (VAS) score ($p=0.019$). Disease duration was correlated with both tenderness ($p=0.01$) and the Dresier index ($p=0.045$).

Table 3 Distribution of MRI features (PIP and DIP joints analyzed together and separately)

		TOT	PIP	DIP
Synovitis *n* (%)		35 (39.8 %)	25 (28.4 %)	10 (11.4 %)
Flexor tenosynovitis *n* (%)		4 (4.6 %)	3 (3.4 %)	1 (1.2 %)
Bone erosions *n* (%)	Distal	45 (51.1 %)	22 (25 %)	23 (26.1 %)
	Proximal	45 (51.1 %)	22 (25 %)	23 (26.1 %)
Bone cysts	Distal	1 (1.1 %)	1 (1.1 %)	0 (0 %)
	Proximal	2 (2.2 %)	1 (1.1 %)	1 (1.1 %)
Osteophytes *n* (%)	Distal	65 (73.9 %)	32 (36.4 %)	33 (37.5 %)
	Proximal	34 (38.64 %)	18 (20.45 %)	16 (18.18 %)
JSN *n* (%)		84 (95.5 %)	40 (45.5 %)	44 (50 %)
Malalignment *n* (%)	Frontal plane	11 (12.5 %)	2 (2.3 %)	9 (10.2 %)
	Sagittal plane	7 (8 %)	3 (3.4 %)	4 (4.6 %)
BML *n* (%)	Distal	18 (20.5 %)	12 (13,6 %)	6 (6.9 %)
	Proximal	21 (23.9 %)	14 (15.9 %)	7 (8 %)
CL absence *n* (%)	Radial	35 (39.8 %)	13 (14.8 %)	22 (25 %)
	Ulnar	33 (37.5 %)	12 (13.6 %)	21 (23.9 %)
BML at CL insertional sites *n* (%)	Radial distal	11 (12.5 %)	5 (5.7 %)	6 (6.8 %)
	Radial proximal	19 (21.6 %)	13 (14.8 %)	6 (6.8 %)
	Ulnar distal	11 (12.5 %)	5 (5.7 %)	6 (6.8 %)
	Ulnar proximal	20 (22.7 %)	13 (14.8 %)	7 (8 %)

n number, *JSN* joint space narrowing, *BML* bone marrow lesions, *CL* collateral ligament

The correlation between clinical parameters and imaging assessment

The presence of nodules (or hard swellings) was found to be correlated with the K-L scores ($p = 0.02$).

BMLs both at the proximal and distal sites were correlated with the tender joints (BML distal $p = 0.0013$, BML proximal $p = 0.012$). Moreover, BML was significantly ($p < 0.01$) correlated with both the K-L score assigned to the radiographs and JNS evaluated on the X-rays and MRI scans. Interestingly, BMLs were correlated with the presence of synovitis (BML distal $p = 0.0003$, BML proximal $p = 0.0009$) and erosions on MRI ($p < 0.001$ for distal erosions, $p < 0.05$ for proximal erosions). The presence of synovitis was correlated with

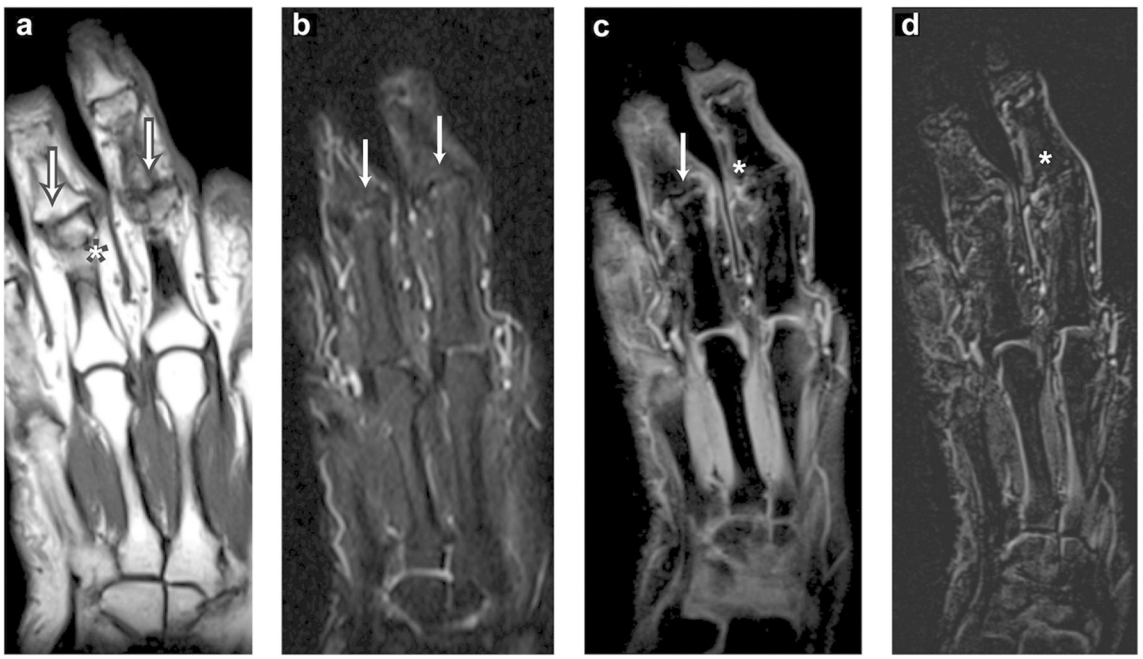

Fig 1 Magnetic resonance imaging of EHOA fingers **a** COR T1 SE III (on the *left*) and IV (on the *right*) finger, PIPJ: central erosions with seagull appearance (*arrows*), collateral ligaments hypertrophy (*asterisk*); **b** COR TIRM III, IV PIPJ, and III DIPJ erosions (edema) (*arrow*); **c** COR VIBE pre contrast III, IV PIPJ and III DIPJ erosions (*arrow*), and hypertrophic capsule, synovitis (*asterisk*); and **d** COR VIBE subtraction: tiny hyperintense focus on III DIPJ ulnar side, possible focus of inflammation, synovitis (*asterisk*)

Table 4 Radiographic compared to MRI features (80 joints)

		X-ray	MRI	*p*	§PEA (%) ¥PCA (%)	*k*
JSN *n* (%), median (IQR range)		80 (100 %) 16 (12–20)	77 (96.3 %) 14 (12–16)	0.3052	¥92.5 %	0.39[a]
Malalignment *n* (%), median (IQR range)	Frontal plane	21 (26.3 %) 1 (1–3)	11 (13.8 %) 1 (1–2)	0.1248	§80 %	0.39
	Sagittal plane	5 (6.3 %) 0 (0–1)	7 (8.8 %) 0 (0–1)	0.8241	§87.5 %	0.10
Bone erosions *n* (%), median (IQR range)	Distal	48 (60 %) 11 (4–14)	44 (55 %) 8 (3–9)	0.5074	¥75 %	0.25[a]
	Proximal	53 (66.2 %) 11 (5–13)	45 (56.3 %) 8 (3–11)	0.6098	¥71.3 %	0.15[a]
Bone cysts, median (IQR range)	Distal	13 (16.3 %) 1 (0–2)	1 (1.3 %) 0 (0–0)	0.0335*	§82.5 %	0.04
	Proximal	25 (31.3 %) 3 (1–4)	2 (2.5 %) 0 (0–0)	0.0146*	§68.8 %	0.03
Osteophytes *n* (%), median (IQR range)	Distal	61 (76.3 %) 13 (10–16)	57 (71.3 %) 9 (7–12)	0.2131	¥78.8 %	0.23[a]
	Proximal	53 (66.2 %) 8 (6–15)	32 (40 %) 4 (3–5)	0.0408*	¥83.8 %	0.28[a]

n number, *JSN* joint space narrowing, *IQR* interquartile range, *PEA* percentage of exact agreement, *PCA* percentage of close agreement

*$p < 0.05$

[a] Weighted kappa

tenderness ($p = 0.004$) and erosions at both the distal and proximal ends of the joints ($p = 0.004$). Synovitis was correlated with NAJ ($p = 0.02$). The erosions were correlated with tender joints ($p < 0.01$) and the total VAS score (distal $p = 0.03$, proximal $p = 0.01$).

Discussion

MRI imaging has been found to be useful in evaluating inflammatory signs of rheumatic diseases and particularly in rheumatoid arthritis and spondyloarthritis patients. Despite the fact that many studies focusing on MRI findings in knee OA have been published, only a few have been carried out to evaluate MRI features of the hand OA [17–19].

A new index, the OHOA-MRI scoring system [11], has recently been proposed to grade key features of hand OA, but only a few studies have tested its reliability and validity [12, 13, 20].

Long-standing EHOA patients attending our Rheumatology Unit were prescribed radiographs and MRIs that were scored by two radiologists specialized in musculoskeletal disorders. Although in our study the intra- and inter-observer reliability of MRI examination was lower than those of the data reported in the literature [11, 12], it was between good and moderate for many features: synovitis, osteophytes, bone cysts distal, bone erosions, and JSN. Haugen et al. [11], who established the OHOA-MRI scoring system, demonstrated good to very good intra- and inter-observer reliability with regard to the following MRI features: synovitis, flexor tenosynovitis, erosions, osteophytes, malalignment, and BMLs. Koterkaas's study showed good or very good intra-reader reliability, but the reader had the opportunity of receiving a week of training with the designers of the OHOA-MRI scoring system [12]. It is possible that the lower level of intra- and inter-reliability found by our study was due to differences in applying the MRI scoring system. Electronic tools designed to optimize and homogenize scoring will be able to overcome this obstacle in the future. Unlike in previous reports, MRI did not appear to be more sensitive than X-rays in detecting erosions and osteophytes [12, 13], and the agreement we found between MRI and X-ray scores was only poor or fair. The PEA and PCA resulted nevertheless higher than 70 % for all the features examined (Table 4). Haugen et al. [13], instead, reported a good concordance with regard to central erosions, a poor one for cysts, and a moderate one for erosions, malalignment, JSN, and osteophytes [13]. Koterkaas et al. likewise found a lower correlation than expected (0.32) for erosions detected on MRI with respect to X-rays [12]. Future studies utilizing computed tomography or histology will be able to confirm or contradict MRI findings.

Interestingly, in our study, MRI was found to be less sensitive than radiographs in detecting osteophytes on the proximal end of the joint. This finding, which was already reported by Wittoek et al. [21], could be explained by a signal void of densely packed calcium in osteophytes. Just as Koterkaas, we found that bone cysts were more frequently detected by X-

Table 5 Intra- and inter-reader reliability of radiographic and MRI features

	Intra-reader reliability		Inter-reader reliability	
	Average measure ICC (95 % CI)		Single measure ICC (95 % CI)	
	X-ray	MRI	X-ray	MRI
JSN	0.91 (0.86 to 0.95)	0.88 (0.79 to 0.92)	0.52 (0.31 to 0.68)	0.59 (0.40 to 0.73)
Malalignment frontal plane	0.76 (0.60 to 0.76)	0.60 (0.34 to 0.76)	0.64 (0.47 to 0.76)	0.33 (0.09 to 0.53)
Malalignment sagittal plane	0.35 (−0,07 to 0.60)	0.60 (0.34 to 0.76)	0.21 (−0.04 to 0.43)	0.23 (−0.015 to 0.45)
Bone erosions distal	0.86 (0.77 to 0.91)	0.59 (0.33 to 0.75)	0.74 (0.61 to 0.84)	0.51 (0.30 to 0.67)
Bone erosions proximal	0.84 (0.73 to 0.90)	0.66 (0.44 to 0.79)	0.67 (0.51 to 0.78)	−0.31 (−0.07 to 0.52)
Bone cysts distal	0.75 (0.59 to 0.85)	0.50 (0.17 to 0.69)	0.48 (0.27 to 0.65)	0.40 (0.17 to 0.58)
Bone cysts proximal	0.51 (0.59 to 0.85)	−0.11 (−0.82 to 0.32)	0.41 (0.81 to 0.66)	−0.05 (−0.29 to 0.19)
Osteophytes distal	0.91 (0.86 to 0.94)	0.66 (0.43 to 0.79)	0.85 (0.76 to 0.90)	0.48 (0.27 to 0.65)
Osteophytes proximal	0.85 (0.75 to 0.9)	0.61 (0.35 to 0.76)	0.76 (0.63 to 0.85)	0.48 (0.26 to 0.65)
Synovitis	N/A	0.63 (0.38 to 0.79)	N/A	0.41 (0.16 to 0.60)
Flexor tenosynovitis	N/A	−0.06 (−0.80 to 0.38)	N/A	−0.03 (0.28 to 0.23)
BML distal	N/A	0.51 (0.18 to 0.70)	N/A	0.34 (0.10 to 0.53)
BML proximal	N/A	0.56 (0.28 to 0.73)	N/A	0.34 (0.10 to 0.54)

ICC interclass correlation coefficient, *JSN* joint space narrowing, *BML* bone marrow lesions, *N/A* not applicable

rays than by MRI [12]. X-ray evaluation hypothetically overestimates the presence of cysts. MRI probably depicts the loss of a fluid signal between the cyst and the joint space that defines the presence of a geode more efficaciously, while erosions may seem cyst-like on X-rays [12, 13].

While agreement between malalignment detected in the sagittal plane was poor, it is important to remember that hands are splayed and tightened over a flat peripheral coil during MRI exams, and this may affect the real joint alignment on the coronal plane. The fingers are depicted without restraint on X-rays, especially in the oblique projections. The OHOA-MRI scoring system was developed using a 1-T MRI scanner; Koterkaas, instead, used a 3-T MRI, and the scanner used by our study was a 1.5 MRI instrument. Differences in scanners may have affected the results produced by these studies.

MRI can detect synovitis and bone marrow edema-like signal lesions, which are signs of local inflammation. It can, moreover, detect joint enhancement when contrast with gadolinium-based contrast agents are utilized [22]. Synovitis was detected in approximately 40 % of the joints; the form was mild in 80 % of the cases. Koterkaas et al. [12], instead, reported that synovitis was present in 97 % of the joints studied, and in 43 % of the cases, it was assigned a moderate or severe grade. This discrepancy could be due to differences in patient variables characterizing the two study groups. The population studied by Koterkaas et al. had, in fact, shorter disease duration (median 6.5 vs. 9.5 years) and a larger number of swollen joints (median 2.5 vs. 0.00). We found a high percentage of low-grade synovitis in our patients, and approximately 70 % of the joints received a K-L score of 3 or 4. These data may indirectly confirm other literature findings [13] demonstrating that synovitis is more frequent in joints with mild OA with respect to what is found in severe forms and hypothetically reflects a "burn out" of the inflammation at later disease stages.

In fact, in another study, we noted mild synovitis in the histological samples of two patients with long-standing disease who underwent proximal interphalangeal joint replacement due to severe erosive OA (paper submitted).

Our data on BMLs, which were detected in 23 % of our patients, were comparable with literature findings reporting detection in between 13 and 27 % of joints [12, 18]. BMLs and synovitis correlated with joint tenderness in our study and were associated with the presence of erosions. As it has already been demonstrated, the presence of erosions was found to be associated with clinical symptoms (tenderness and VAS) [17].

This study's major limitation was the small number of patients, even if the actual number of joints studied was relevant (80 joints).In addition, no attempt was made to evaluate the prevalence of MRI attrition which has been shown to be correlated with the presence of central erosions [23].

X-rays are still considered the gold standard for hand OA given their economy, feasibility, and availability [24], and, in fact, bone sclerosis, subchondral cysts, osteophytes and joint space narrowing, and indirect signs of cartilage loss are all detected by radiographs. Synovial inflammation and BMLs have been found to be correlated with pain and dysfunction and, what is more important, with OA disease progression. X-rays are, however, unable to detect these soft tissue changes [8]. While the OHOA-MRI scoring system was developed for research purposes, it could also be useful in the clinical setting

to detect signs (synovitis and BMLs) associated to joint tenderness in hand OA and to confirm or predict radiographic progression [18, 25]. These MRI findings can be useful to identify relapsing patients who require prompt therapeutic intervention. In fact, synovitis and BMLs correlated with clinical symptoms in our patients with long-standing EHOA.

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