Comparison between several ultrasound (US) hand joint scores and conventional radiography in diagnosing hand osteoarthritis (OA)

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Abstract:

- This is the first study to investigate the usefulness of a standardised ultrasound (US) examination protocol in diagnosing hand osteoarthritis (OA). We conducted a cross-sectional study including 62 patients, ultimately diagnosed with hand OA based on imaging evidence of osteoarthritic changes with the particular distribution required for fulfilment of ACR diagnosis criteria.. We compared a 32 joint US score (wrists, metacarpo-phalangeal – MCPs, proximal and distal interphalangeal – PIPs and DIPs, and carpometacarpal – CMC1 joints), with smaller, pre-defined joint scores, assessing 22 joints (wrists, MCPs and PIPs or PIPs, DIPs and CMC-1), 10 joints (MCP 2-3, PIP 2-3 and CMC-1 or PIP 2-3, DIP 2-3 and CMC-1) and 6 joints (DIP 2-3, CMC-1), respectively. The US findings were correlated with radiographic scores for erosions and osteophytes. Radiographic osteophyte scores correlated well with all the US scores mentioned above ($R=0.381$ to 0.645, $P<0.05$), despite low sensitivity for detection of osteophytes (43.5%), and erosions (28.9%), when compared with the 32 joint US score. Both 10 joint US protocols (assessing MCP 2-3, PIP 2-3 and CMC-1 or PIP 2-3, DIP 2-3 and CMC-1 joints) performed better than conventional radiography, by identifying osteophytes in an additional 25.6% and 23.9% of patients, respectively. The conclusion of this study is that the US examination of 10 preselected hand joints is more sensitive than conventional radiography in diagnosing hand OA in patients who do not fulfil ACR clinical criteria, finding likely to have practical implications for facilitating diagnosis of hand OA.

Keywords: hand osteoarthritis; ultrasound; Power Doppler; conventional radiography.

Introduction:

Hand osteoarthritis (OA) diagnosis is based on a combination of clinical and imaging features and assessment of risk factors, together with clinical associations and outcomes (Zhang, et al. 2009). The American College of Rheumatology (ACR) classification criteria for hand OA are frequently used as diagnostic criteria (Altman, et al. 1990). In the context of characteristic clinical picture and absence of additional features of other inflammatory arthritides, the diagnostic of hand OA is straightforward (Altman, et al. 1990).

The challenges encountered by the clinician are related to the difficulty to confidently diagnose hand OA when there is no clear clinical picture and patients describe inflammatory hand pains. In absence of established Heberden and Bouchard nodes and/or bony enlargement and characteristic involvement of proximal and distal interphalangeal joints (PIPs and DIPs), thumb base and index and middle metacarpophalangeal joints (MCPs), the early diagnosis of hand OA is more difficult. The European League Against Rheumatism (EULAR) initiative aimed at helping clinicians to diagnose hand OA rather than classifying it, by identifying clinical subsets, which help differentiating OA from other hand joint pathology (Zhang, et al. 2009). A Framingham analysis of incidence of hand OA showed an age-standardised prevalence of 44.2% in women and 37.7% in men (Haugen, et al. 2011).

In terms of imaging hand OA, it is widely accepted that radiography is the gold standard and that other imaging techniques are rarely indicated for diagnosis (EULAR recommendation 9) (Zhang, et al. 2009). Recent studies evaluated the role of ultrasound (US) examination of hand joints in diagnosing hand OA and predicting the disease progression (Mancarella, et al. 2010, Mathiessen, et al. 2016). In a large general population study, hand OA was detected by

US in a proportion of up to 70%, and were more frequently found at the distal interphalangeal (DIP) level (Abraham, et al. 2014).

In a real-life context, clinicians face the difficulty to differentiate between OA and other hand arthropathies, in particular when the clinical examination is equivocal (e.g. no obvious bony enlargement with the characteristic distribution for hand OA). Despite recent effort in establishing US scores for hand OA (Keen, et al. 2008), there are no guidelines recommending a certain US protocol for hand examination in OA.

Our study aimed to investigate the usefulness of a standardised US examination protocol for hand joints in diagnosing OA when the clinical picture is equivocal, and to compare different US scores. In addition, we correlated the US findings with clinical, inflammatory and radiographic parameters. We also aimed to establish the proportion of patients with imaging evidence of osteophytes with the distribution required for diagnosis of hand OA, identified by various hand US protocols versus conventional radiography, to assess if a simplified US examination protocol can have clinical utility for early diagnosis of hand OA .

Methods:

Patient recruitment

This is a prospective, cross-sectional study, which evaluated patients referred to our US rheumatology outpatient clinics, presenting with hand joint pain and no obvious clinical signs of synovitis, gouty tophi or osteophytes to support a diagnosis of inflammatory, crystal arthropathy or OA. As these patients did not fulfil the clinical ACR classification criteria for hand OA, they needed an US scan and additional investigations to facilitate diagnosis. For each patient, a set of demographic, clinical and laboratory data were recorded at the time of the scan, as well as their provisional diagnosis. Patients ultimately diagnosed with another

hand pathology were excluded. A number of 62 patients diagnosed with hand OA based on EULAR recommendations (Zhang, et al. 2009) were included in the final analysis. All the patients were assessed clinically at the time of their US scan, and had the laboratory tests results done within 8 weeks of the US scan.

Ethical issues

The data was collected as standard of practice in our rheumatology department. The study analysed the results of the US examinations of patients seen in our US clinics over a defined period of time (January 2015 – December 2017) using our local US clinic proforma. The study was approved by the local ethics committee (ref. 13/LO/0999). Each participant consented to take part in the study.

Disease assessment

We collected information about disease duration (in months), clinical joint examination findings including hand tender joint count (TJC) and hand swollen joint count (SJC), as well as a patient reported global assessment score (GVAS). All patients included in the final analysis had bilateral hand radiographs (postero-anterior view) within 12 months from the time of the US scan.

Additional data about the high sensitivity C-reactive protein (hsCRP), erythrocyte sedimentation rate (ESR), presence of rheumatoid factor (RF), anti citrullinated cyclic peptides antibodies (ACPA) and anti-nuclear antibodies (ANA) was also collected at the time of the scan (needed to exclude associated hand joint pathology).

Ultrasound examination

We used an established protocol of US examination of hands comprising 32 joint assessments (dorsal longitudinal and transverse views of wrists, MCPs, PIPs, DIPs and carpometacarpal 1

joint – CMC-1). The presence of active joint inflammation was defined as Power Doppler (PD) signal within a region of grey scale (GS) synovitis, which was graded 1-3; synovial thickening - GS synovitis was graded 1-3; and joint effusion as present/absent, as per the Outcome Measures in Rheumatoid Arthritis Clinical Trials (OMERACT) definitions developed for RA (Mandl, et al. 2011). Erosions were defined as an intra-articular discontinuity of the bone surface that is visible in two perpendicular planes (Wakefield, et al. 2005), and osteophytes as characteristic cartilage pathology as defined by OMERACT/OARSI initiative (Iagnocco, et al. 2012). US examination was performed by the same clinician (CC), with 6 years' experience in running weekly US clinics. Figure 1 shows examples of hand OA US features scored according to OMERACT/OARSI protocols. For the diagnosis of OA on US, we considered mandatory the presence of osteophytes, associated or not with joint erosions, effusion, synovial hypertrophy or PD signal. The osteophytes were defined as hyperechoic signal in the area of the attachment of the joint capsule to the bony cartilaginous margin that correspond with the eventual appearance of osteophytes visualized on the conventional radiography, as previously described (Moller, et al. 2008). US examination was performed using an Logiq S8 US machine (GE Medical Systems Ultrasound and Primary Care Diagnostics, Wauwatosa, WI, USA), equipped with a multi-frequency linear matrix array transducer (8-22 MHz). B-mode and PD machine settings were optimised for all US examinations.

For the conventional hand radiography osteophyte scoring, we used the Kellgren-Lawrence method to assess for the presence of osteophytes (Kellgren and Lawrence 1957). Only scores above or equal to 2 were considered definite for the presence of osteophytes. The erosions were defined as a cortical break visible on plain radiograph, and were scored as present/absent. The radiographs were read by one assessor (CC). Intra-rater reliability was excellent (unweighted mean kappa = 0.94, mean percentage agreement = 98%).

94 Scoring systems

95 To address our research question and assess how many joints would require scanning, and
96 which joints are most likely to provide the answer as to whether or not patients have OA
97 rather than other inflammatory hand arthropathy, we tested and compared the following
98 scoring systems:

99 For OA, we compared the following US scoring systems (bilateral examination):

100 - 32 joints (wrists, MCPs, PIPs, DIPs, CMC-1)
101 - 22 joints (RA protocol – wrists, MCPs, PIPs)
102 - 22 joints (PIPs and DIPs, CMC-1)
103 - 10 joints (MCP 2-3 and PIP 2-3, CMC-1)
104 - 10 joints (PIP 2-3, DIP 2-3, CMC-1)
105 - 6 joints (DIP 2-3, CMC-1)

106 The selection of these scoring systems was based on the ACR criteria for hand OA and
107 clinician experience related to which joints are the most commonly affected in hand OA.
108

109 Bilateral hand Xrays

110 Two readers scored the paired hand radiographs (32 joints), same as included in the US score
111 detailed above) for the presence of osteophytes (Kellgren-Lawrence score more or equal to 2)
112 and erosions, which were scored as present/absent per each joint examined. The radiography
113 reading was blinded to clinical and US examination.

114 Statistical analysis

115 All data was transferred and collated from paper questionnaires to a Microsoft Excel
116 spreadsheet. Using IBM SPSS Statistics 22 (IBM 2013. Armonk, New York, USA) for

117 further analysis and statistical tests, descriptive statistics were used to characterize the OA
118 population further, using mean and standard deviations (SD) and median with inter-quartile
119 ranges (IQR) depending on the data distribution. Mann-Whitney U test was implemented to
120 compare different joint scoring systems for OA. A p-value of <0.05 was considered a
121 statistically significant result. Spearman's correlation coefficients were used to correlated US
122 with Xrays and clinical and laboratory parameters. Pearson's R or phi coefficient was used to
123 assess the correlation between dichotomous variables.

124 **RESULTS:**

125 Patients' characteristics and the main US and radiographic findings are summarised in **Table**
126 **1**. The tested intra-observer reliability was very good (unweighted mean kappa = 0.92, mean
127 percentage agreement = 96%). The 32 joint US examination, including scoring of US
128 parameters took approximately 30 min/patient (patients had 30 min appointment slots in our
129 US clinics). There was a significant difference between the number of osteophytes detected
130 by US examination of 32 joints compared to conventional radiography (9.58^{+}/-5.74 vs.
131 4.83^{+}/-5.39, P=0.03). Joint tenderness correlated more strongly with the presence of
132 osteophyte on US (R=0.56, P=0.03) than on conventional radiography (R=0.12, P=0.02),
133 while the presence of soft tissue swelling assessed clinically as swollen joints did not
134 correlate with the presence of osteophytes on either US or conventional radiography (R=
135 0.23, P=0.18, and R=0.23, P=0.24, respectively).

136 We also correlated the osteophyte scores with the duration of symptoms in our hand OA
137 patient group and found that only the radiographic osteophyte score correlated with the
138 duration of symptoms (R=0.51, P<0.05), while the US detected osteophytes did not correlate
139 with the duration of symptoms (R= - 0.91, P>0.05).

Comparison between different US joint scores tailored according to the ACR classification criteria for hand OA

In order to investigate which US protocols were equivalent in terms of GS, PD, osteophyte and erosion scores (defined as lack of statistically significant difference between the US findings associated with every score - $p>0.05$), we compared all the US scores detailed above in pairs (**Table 2**). As expected, a small number of patients had positive PD signal on US, irrespective of the US scoring systems used (1.6-4.8%); however, a larger proportion had at least one joint with synovial hypertrophy on US (11.3-88.7%, depending on the number of joints examined). The comparison between different simplified US hand scores showed that a variable proportion of 12.9-54.9% patients were misdiagnosed as having no osteophytes because of the simplification of the US examination protocol **(Table 2)**.

Comparison between different US joint scores in detecting osteophytes associated with hand OA

An additional purpose of our study was to compare different US scoring systems for hand OA. There was no significant difference between the assessments for the presence of osteophytes between the scores assessing 10-32 joints, whereas the 6 joint score did not correlate significantly with the other US scores. As expected, the exclusion of MCP and PIP joints from the hand US examination was likely to underdiagnose a significant proportion of patients (Table 1, supplementary information). The comparison between the osteophytes scores generated by various US examination protocols found that only the 6 joint score (assessing DIP 2-3 and CMC1) differed significantly when compared to the 32 and 22 joint scores ($P= 0.03$ and $P=0.013$, respectively) (Table 2 , supplementary information).

Comparison between different US joint scores and conventional radiography in detecting osteophytes

In addition, we compared the radiographic total osteophyte score with each of the US hand scores detailed above, to assess if the conventional hands radiographs correlated or not with the US findings. We found a significant correlation with all the US hand scores **(Table 3).**

Conventional hand radiography had a lower sensitivity score for detection of osteophytes (43.5%) and erosions (28.9%) compared to the 32 joint US score (only 11.2% patients had erosions on Xrays compared to 38.7% on US). All the osteophytes detected by radiography were also found on US. The most meaningful finding was that even a simplified US examination protocol assessing only 10 joints (PIP 2-3, DIP 2-3 and CMC-1 or MCP 2-3, PIP 2-3 and CMC-1) outperformed conventional radiography in diagnosing the presence of osteophytes, which were found in an additional 23.9 - 25.6% patients, compared to hand radiography alone **(Table 3).** In addition, an extensive US protocol examination of 32 joints, although time consuming, identified the presence of osteophytes in twice as many patients than those diagnosed on conventional radiography alone (56.5% patients included in the final analysis had only osteophytes on US, while their Xrays were reported as normal) **(Table 3).** Our findings can have significant diagnostic implications, as the two US examination protocols assessing 10 joints (PIP 2-3, DIP 2-3 and CMC-1 or MCP 2-3, PIP 2-3 and CMC-1) had a sensitivity of 74.4- 76.1% for diagnosing hand OA, when compared to the extensive 32-joint US protocol as gold standard. As a sensitivity of above 70% is acceptable for a diagnostic test, the two simplified 10 joint US examination protocols could be implemented as a screening imaging method for early diagnosis of hand OA, proving to be a rapid, cheap and non-radiative diagnostic tool.

Discussion:

This cross-sectional study compared for the first time different US scoring systems in patients with hand OA, and found that even simplified US examination scores were more sensitive in

188 facilitating the diagnosis of hand OA in comparison with clinical examination and hand
189 radiography.

190 Our study results showed that inflammatory markers and clinical examination were not
191 particularly useful in diagnosing hand OA when considered alone, and that in absence of
192 radiographic evidence of osteophytes, the US characterisation of joint structural
193 abnormalities is a useful diagnostic tool.

194 Previous studies showed that erosive hand OA was associated with US detectable
195 inflammatory changes in the affected joints (Mancarella, et al. 2010). Contrast enhanced US
196 (CEUS) was previously used to appreciate the joint-space narrowing and capsule size in
197 patients with OA of the thumb carpometacarpal joint; although it did not identify any
198 correlation between US parameters and symptoms severity (Mallinson, et al. 2013).
199 Quantitative and semi-quantitative US scores have been previously compared in RA
200 (Ellegaard, et al. 2014) and have been found to be sensitive to change. The most
201 comprehensive study comparing several US score systems in RA found them all sensitive to
202 change when assessing the response of RA patients to biologic therapy (Hammer and Kvien
203 2011); however there are no similar studies assessing the usefulness of different US scores
204 for diagnosis of hand OA.

205 Our comparative analysis of several US scoring systems in patients with OA showed that
206 there is no significant difference between several US scoring systems (unless only a small
207 number of joints are examined, as detailed in Table 2, supplementary information). Our study
208 found that it is important to capture information about the structural changes of the joints that
209 are included in the ACR criteria for hand OA classification, to increase the chance of
210 detecting osteophytes. In addition, US gave the possibility to exclude additional pathology

211 (such as gout and chondrocalcinosis) and enabled the diagnosis of patients who did not fulfil
212 the criteria of hand OA based on clinical examination and radiography alone.

213 US detected joint inflammation was effective in predicting the development of osteophytes in
214 patients with hand OA in several longitudinal studies (Kortekaas, et al. 2015, Mancarella, et
215 al. 2015). There is a controversy regarding the correlation between hand pain in OA and the
216 level of inflammation detected by US examination. Whereas one study found no correlation
217 between hand pains and US detected inflammatory features in OA (Kortekaas, et al. 2014),
218 another concluded that pain in OA is associated with inflammation, which can be detected by
219 US (Kortekaas, et al. 2010). Erosive OA was associated with more frequent US inflammatory
220 features when compared with patients with non-erosive OA, and also was found to affect a
221 large proportion of patients with hand OA (51% of patients with hand OA had erosions)
222 (Kortekaas, et al. 2013). In our study, only a proportion of 38.7% of OA patients had
223 erosions, difference that can be justified by our inclusion selection bias (patients diagnosed
224 clinically with hand OA were not referred to have a hand US).

225 If the presence of chronic inflammatory changes leading to erosions is very well documented
226 in RA (Nguyen, et al. 2014), and US scoring systems comparisons are documented in the
227 literature (Naredo, et al. 2013), less data related to the role of US in hand OA diagnosis are
228 available. In our study, only 4.8 % patients had PD signal in their joints, which is less than
229 observed in a small study of patients with severe hand OA (Mancarella, et al. 2010), which is
230 not unexpected, considering that our patients were less likely to have severe erosive hand
231 OA, for the reasons detailed above.

232 In conclusion, this is the largest real-life cohort study of hand OA (assessing 2108 joints),
233 which provided evidence that US examination of hand joints is a useful diagnostic tool for
234 hand OA. Our study also showed that US examination was twice as sensitive as conventional

radiography in detecting OA changes. In addition, the two simplified scoring system examining only 10 joints used in this study had a sensitivity of above 70% in diagnosing early hand OA, when compared with the time-consuming US examination protocol assessing 32 hand joints. The use of simplified US scores is feasible for routine clinical use and can improve significantly clinicians' ability to diagnose early hand OA.

Limitations:

Our study did not have strict inclusion criteria: the patients were included based on fulfilling the ACR classification criteria for OA following clinical, laboratory and imaging assessments. We recruited only those patients referred by their clinicians to have an US scan of their hands to help with diagnosing hand OA, and did not include a healthy control group. The US scans were performed by only one examiner as per standard of practice in our hospital. Our study could not demonstrate the validity and inter observer reliability or our findings, as these will need further validation in a new cohort study. Our study could not provide any suitable information regarding the temporal relationship between the presence of PD, erosions and osteophytes in hand OA, apart from the correlation of radiographic osteophytes with the disease duration.

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258 **References:**

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Table 1

Table 1: Demographic, clinical, ultrasonographic and radiographic features of the study group (GS score = Grey scale score; PDUS score – Power Doppler ultrasound score; SJC – swollen joint count, SH – synovial hypertrophy, TJC – tender joint count).

Baseline characteristics	***N = 62***
Sex, (% female)	80.6%
Age, mean (SD) years	51.1±15.3
Symptom duration (months)	Median: 48 IQR: 108
NSAIDs (% of patients)	16.1%
CRP (median and IQR)	Median: 1.45 IQR: 3.3
ESR (median and IQR)	Median: 10 IQR: 17
SJC (28 joint count)	1.18±2.25
TJC (28 joint count)	7.69±9.06
Pain VAS	6.08±1.96
US findings (32 joint examination)	
SH grade 1 (% of patients)	43.5%
SH grade 2 (% of patients)	46.7%
SH grade 3 (% of patients)	0.09%
SH grade 1 score/patient Mean +/- SD	1.45 +/- 2.23
SH grade 2 score/patient Mean +/- SD	1.77 +/- 2.88
SH grade 3 score/patient Mean +/- SD	0.51+/-1.69
GS score/patient Mean +/- SD	**7.35+/- 8.12**
PDUS (% of patients)	4.8%
PDUS score/patient Mean +/- SD	**0.048+/-0.21**
Osteophytes (% of patients)	100%
Osteophyte score/patient Mean +/- SD	**9.58+/-5.74**
Erosions (% of patients)	38.7%
Erosion score/patient Mean +/- SD	**2.29+/-4.18**
Radiographic findings (bilateral hand Xrays)	
Osteophytes (% patients)	43.5%
Osteophyte score/patient	4.83+/-5.39
Erosions, (% of patients)	11.2%
Erosion score/patient	1.03+/-1.82

Table 2: Comparison between different US scores for hand OA assessment (CMC-1– carpometacarpal; DIP – distal interphalangeal; GS – grey scale; MCP – metacarpophalangeal; PD – Power Doppler; PIP – proximal interphalangeal, US - ultrasound).

		OA US Joint Score				
US Findings	32 joints (wrists, MCPs, PIPs, DIPs, CMC-1)	22 joints (PIPs and DIPs, CMC-1)	22 joints (wrists, MCPs and PIPs)	10 joints (MCP 2-3, PIP 2-3, CMC-1)	10 joints (PIP 2-3, DIP 2-3, CMC-1)	6 joints (DIP 2-3, CMC-1)
N of patients (%) with joints with **GS synovitis**:	55 (88.7)	53 (85.5)	52 (83.8)	43 (69.3)	23 (37.1)	7 (11.3)
% of patients with no GS synovitis	11.3	14.5	16.2	21.7	62.9	88.7
N of patients (%) with **PD signal**:	3 (4.8)	3 (4.8)	1 (1.6)	2 (3.2)	3 (4.8)	2 (3.2)
% of patients with no **PD signal**	95.2	95.2	98.4	96.8	95.2	98.6
N of patients (%) with **osteophytes**	62 (100)	54 (87.1)	26 (41.9)	44 (70.1)	48 (77.4)	28 (45.1)
% of patients with misdiagnosed as having **no osteophytes** compared to the 34 US joint score	N/A	12.9	58.1	29.9	22.6	54.9
N of patients (%) with **erosions**:	24 (38.7)	24 (38.7)	6 (9.7)	16 (25.8)	22 (35.5)	18 (29)
% of patients with misdiagnosed as having **no erosions** compared to the 34 US joint score	N/A	0	29	12.9	3.2	9.7

Table 3: Correlation between the osteophyte scores detected by conventional radiography of both hands in comparison with various US scoring systems (Spearman's correlation).
(CMC-1- carpometacarpal; DIP – distal interphalangeal; GS – grey scale; MCP – metacarpophalangeal; PD – Power Doppler; PIP – proximal interphalangeal, US – ultrasound, Xrays – hand radiography).

US scores	32 joints (wrists, MCPs, PIPs, DIPs, CMC-1)	22 joints (PIPs and DIPs, CMC-1)	22 joints (wrists, MCPs and PIPs)	10 joints (MCP 2-3, PIP 2-3, CMC-1)	10 joints (PIP 2-3, DIP 2-3, CMC-1)	6 joints (DIP 2-3, CMC-1)
Correlation with Xrays	0.484 < 0.05	0.622 < 0.05	0.572 < 0.05	0.381 < 0.05	0.608 < 0.05	0.645 < 0.05
% patients with osteophytes on US only compared to Xrays	56.5	43.6	-1.6	25.6	23.9	1.6

Table 1 (supplementary information): Comparison between different US hand score for assessment of osteophytes in OA (Spearman's correlation test).
(CMC-1 – carpometacarpal; DIP – distal interphalangeal; GS – grey scale; MCP – metacarpophalangeal; PD – Power Doppler; PIP – proximal interphalangeal, US – ultrasound).

US hand score	32 joints (wrists, MCPs, PIPs, DIPs, CMC-1)	22 joints (PIPs and DIPs, CMC-1)	22 joints (wrists, MCPs and PIPs)	10 joints (MCP 2-3, PIP 2-3, CMC-1)	10 joints (PIP 2-3, DIP 2-3, CMC-1)	6 joints (DIP 2-3, CMC-1)
32 joints (wrists, MCPs, PIPs, DIPs, CMC-1)	-	R= 0.886 P= <0.05	R= 0.978 P= >0.05	R= 0.750 P= <0.05	R= 0.711 P= >0.05	**R= 0.207** **P= >0.05**
22 joints (PIPs and DIPs, CMC-1)	R= 0.886 P= <0.05	-	R= 0.851 P= <0.05	R= 0.791 P=<0.05	R= 0.532 P= <0.05	**R= - 0.181** **P= >0.05**
22 joints (wrists, MCPs and PIPs)	R= 0.978 P= >0.05	R= 0.851 P= <0.05	-	R=0.750 P= <0.05	R=0.764 P= <0.05	**R= 0.281** **P= >0.05**
10 joints (MCP 2-3, PIP 2-3, CMC-1)	R= 0.750 P= <0.05	R= 0.791 P=<0.05	R=0.750 P= <0.05	-	R= 0.742 P= <0.05	**R= 0.033** **P= >0.05**
10 joints (PIP 2-3, DIP 2-3, CMC-1)	R= 0.711 P= >0.05	R= 0.532 P= <0.05	R=0.764 P= <0.05	R= 0.742 P= <0.05	-	R= 0.608 P= <0.05
6 joints (DIP 2-3, CMC-1)	**R= 0.207** **P= >0.05**	**R= - 0.181** **P= >0.05**	**R= 0.281** **P= >0.05**	**R= 0.033** **P= >0.05**	R= 0.608 P= <0.05	-

Table 2 (supplementary information): Comparison between different US hand score for assessment of osteophytes in OA (Z score for proportions).
(CMC-1 – carpometacarpal; DIP – distal interphalangeal; GS – grey scale; MCP – metacarpophalangeal; PD – Power Doppler; PIP – proximal interphalangeal, US – ultrasound).

US hand score	32 joints (wrists, MCPs, PIPs, DIPs, CMC-1)	22 joints (PIPs and DIPs, CMC-1)	22 joints (wrists, MCPs and PIPs)	10 joints (MCP 2-3, PIP 2-3, CMC-1)	10 joints (PIP 2-3, DIP 2-3, CMC-1)	6 joints (DIP 2-3, CMC-1)
32 joints (wrists, MCPs, PIPs, DIPs, CMC-1)	-	P= 0.96	P= 0.52	P=0.21	P=0.36	**P=0.03**
22 joints (PIPs and DIPs, CMC-1)	P= 0.96	-	P=0.96	P=0.64	P=0.72	P=0.21
22 joints (wrists, MCPs and PIPs)	P= 0.52	P=0.96	-	P=0.45	P=0.61	**P=0.013**
10 joints (MCP 2-3, PIP 2-3, CMC-1)	P=0.21	P=0.64	P=0.45	-	P=0.43	P=0.11
10 joints (PIP 2-3, DIP 2-3, CMC-1)	P=0.36	P=0.72	P=0.61	P=0.43	-	P=0.36
6 joints (DIP 2-3, CMC-1)	**P=0.03**	P=0.21	**P=0.013**	P=0.11	P=0.36	-

Figure 1
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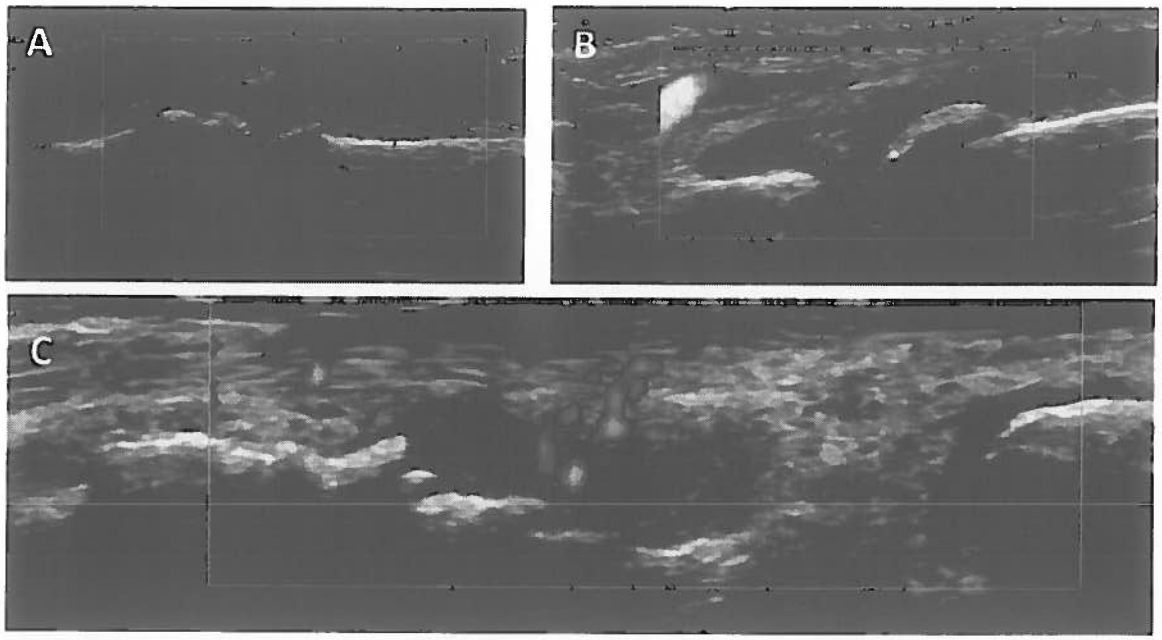

Figure 1: Ultrasound features of hand OA:

A) PIP joint osteophyte and synovial hypertrophy grade 2.

B) MCP joint osteophyte and synovial hypertrophy grade 2

C) Wrist osteophyte, synovial hypertrophy grade 2 and Power Doppler signal grade 2

Legend: MCP – metacarpophalangeal; PIP – proximal interphalangeal