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ORIGINAL RESEARCH

High prevalence of radiographic erosions in early, untreated PsA: results from the SpARRO cohort

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ABSTRACT

Aims To investigate the prevalence and distribution of bone erosions in an early psoriatic arthritis (PsA) population using conventional radiography (CR) and to explore the agreement between CR and ultrasound (US) detected bone erosions.

Methods Newly diagnosed, treatment naïve PsA patients fulfilling the ClASsification for Psoriatic Arthritis (CASPAR) classification criteria of ≤5 years symptom duration were recruited as part of the Leeds Spondyloarthropathy Register for Research and Observation and underwent CR and US examination of hands and feet.

Results Overall, 4655 hand and feet joints were assessed in 122 patients. CR erosions were detected in 24.6% (n=30) with lowest prevalence seen below 8 months of symptoms (17.5% vs 24.3%>24 months). The number of erosions was higher on CR (1.55% (63/4,655); US 1.04% (34/3,270)), with 5th metatarsophalangeal (MTP) joint being the most affected site in both CR (5.21% (11/211)) and US (7.14% (15/210)). Erosions in CR were more evenly distributed compared with US where three-quarters of the total number of bone erosions were detected in wrists, second metacarpophalangeal (MCP) and fifth MTP joints. Most joints had almost perfect prevalence-adjusted bias-adjusted kappa values ranging from 0.91 to 1.

Conclusions Erosions were seen in a quarter of patients with newly diagnosed, untreated PsA with a declining trend around the 8-month symptom duration cut-off. High levels of agreement between CR and US were seen with CR detecting more erosions. A focused US assessment of the wrist, second MCP and fifth MTP joints may be useful to detect bone erosions in early PsA.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Radiographic erosions can occur in newly diagnosed psoriatic arthritis (PsA) and are associated with poor outcome.

WHAT THIS STUDY ADDS

⇒ This study showed erosions in a quarter of patients with newly diagnosed, untreated early PsA with a declining trend around the 8-month duration cut-off and high levels of agreement between conventional radiography and ultrasound (US).

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ These results highlight the need to shorten the diagnostic delay in PsA and suggest that a limited US assessment of the wrist, second metacarpophalangeal and fifth metatarsophalangeal may suffice to confirm the presence of erosions in early PsA.

INTRODUCTION

Psoriatic arthritis (PsA) is an inflammatory condition characterised by its heterogeneity of manifestations involving the skin, peripheral and axial joints, tendons, entheses and extra-articular organs.[1] Early diagnosis is paramount for good disease control and prevention of disability since a diagnostic delay of just 6 months from symptom onset is associated with inferior outcomes and greater functional impairment.[2]

The distinct radiographic findings of bone erosion, joint space narrowing, bony proliferation with periarticular and shaft periostitis, osteolysis including 'pencil in cup' deformity and acro-osteolysis seen in peripheral joints in PsA point towards a complex immunopathology where inflammatory and bone forming pathways are activated. These radiographic features aid the differential diagnosis with other inflammatory arthritides such as rheumatoid arthritis (RA) and are incorporated as one of the criterium of the ClASsification criteria for Psoriatic ARthritis (CASPAR) criteria of PsA.[3] Conventional radiography (CR) is, therefore, routinely performed in clinical practice, especially in the presence of small joint involvement, since establishing a radiographic baseline at the time of diagnosis is essential for the further assessment of structural progression at later stages, considered a biomarker for suboptimal treatment response, in both clinical and research settings.

Most studies evaluating CR in PsA have focused on therapy response in cohorts with long disease duration where nearly two-thirds of the study population had erosions at baseline[3–7] Data from the Dublin cohort recruited between 1994 and 2000[8] showed that 27% of patients had erosions at baseline (mean disease duration 9.9 months (range 0.3–48)) and this increased to 47% at 2-year follow-up despite treatment confirming the progressive nature of PsA in many patients in the prebiological era. Despite the wide availability of early arthritis clinics, only a few studies have since looked at bone erosions in PsA of short symptom duration (5 years or less) with varying prevalences reported. With the current scientific interest focusing in the very early identification of joint disease, with a view to prevention, further knowledge is needed on the current prevalence of bone erosions in early PsA.

In recent years, ultrasound (US) has become more routinely used in daily clinical practice, given the high sensitivity and accuracy of this imaging tool for the detection of both signs of 'active' inflammation (ie, synovitis, tenosynovitis and enthesitis) and structural damage in PsA.[9 10] However, to date, the role of US in early PsA remains unclear, especially the additional value of this imaging technique in comparison with the traditional 'gold standard' for the detection of bone erosions in this population, that is, CR.[11]

The aims of our study were, therefore, twofold: first, to report the prevalence of radiographic erosions and their location in an early, treatment naive PsA population, and second, to explore the agreement between CR and US detected bone erosions.

METHODS

Data from early (≤5 years symptoms duration), disease-modifying antirheumatic drug (DMARD) naïve PsA patients meeting CASPAR classification criteria and recruited into the Leeds Spondyloarthropathy Register for Research and Observation (SpARRO) between 2014 and 2022 were included in this analysis. Baseline characteristics of the cohort have been previously reported[12 13] and included demographics (ie, age and sex), body mass index (BMI), 78/76 (tender/swollen) joint count, presence or history of dactylitis, psoriatic nail dystrophy. Laboratory tests included anticyclic citrullinated peptide antibodies (normal value <2.99 U/mL), rheumatoid factor (normal value <20 iu/mL) and C reactive protein (CRP) (normal value <10 mg/L). All patients underwent CR and US imaging of the hands and feet. The patient selection flow chart is presented in figure 1.

Conventional radiography

CR of hands including wrists (radial+ulnar), metacarpophalangeal joints (MCPs) (1st–5th), interphalangeal (Ips), proximal interphalangeals (PIPs) (2nd–5th), distal interphalangeal (DIPs) (2nd–5th) and feet metatarsophalangeal (MTPs) (1st–5fth) were scored for the presence of erosions by one experienced reader blinded to clinical characteristics using the Sharp-van der Heijde score modified for PsA.[14] Two sets of analyses were performed: at patient and at joint level. Patients with at least one radiographic erosion and patients without bone erosions were identified. The first analysis focused on the prevalence of patients with erosions as well as patients' characteristics compared with the erosion-free group. The joint-focused analysis encompassed a comprehensive comparison of all aforementioned joints, elucidating the overall frequency and distribution of erosions across the joints, irrespective of the individual patients.

US erosion assessment

Experienced sonographers blinded to clinical details scanned the joints using the GE Logiq E9 machine with linear ML 15–6 MHz or small-footprint linear array 18–8 MHz transducer on the same day of the clinical assessment. One of four experienced sonographers each with over 5 years experience conducted the US scans. Sonographer calibration was regularly conducted at least twice per year at the same institution to ensure performance, quality assurance, image interpretation, scoring and recording of results were maintained to a high and consistent standard and in line with the study protocol. Erosions were defined by periarticular cortical bone discontinuity present in two perpendicular planes (longitudinal/transverse).[15]

During the course of the study, two scanning protocols were used. The first protocol dating from 2014 only assessed a subset of joints (MCPs (2nd–3rd), PIPs (2ndd–3rd) and MTPs (2nd–5th). The second protocol was developed to encompass a larger number of joints and included wrists (radiocarpal, ulnocarpal and ulnar styloid), MCPs (1st–5th), IPs, PIPs (2nd–5th), DIPs (2nd–5th) and feet MTPs (2nd–5th). The analysis was done at the joint level only and included the wrists, MCPs (1st–5th), IPs, PIPs (2nd–5th), DIPs (2nd–5th) and feet MTPs (2nd–5th). MTP1 was excluded in both protocols as it is a frequent site of osteoarthritis.[16]

Statistical analysis

Data were first tested for their normality graphically and with the Kolmogorov-Smirnov test. Continuous variables were presented as mean±SD for parametric data and median with IQR for non-parametric data. Parametric data were compared using the independent samples Student's t-test and the Mann-Whitney U test used for non-parametric data. Categorical variables were presented using numbers and percentages. Associations between categorical variables were tested using the χ^2 test, and Fisher's exact test was used when cell count less than 5 was expected. The cut-off for significance was an alpha of 0.05. Agreement between the two modalities (CR and US) on the presence of erosions was calculated in the following joints: wrists, MCPs (1st–5th), IPs, PIPs (2nd–5th) and MTPs (2nd–5th) using Cohen's kappa (Kappa) and prevalence-adjusted bias-adjusted Kappa

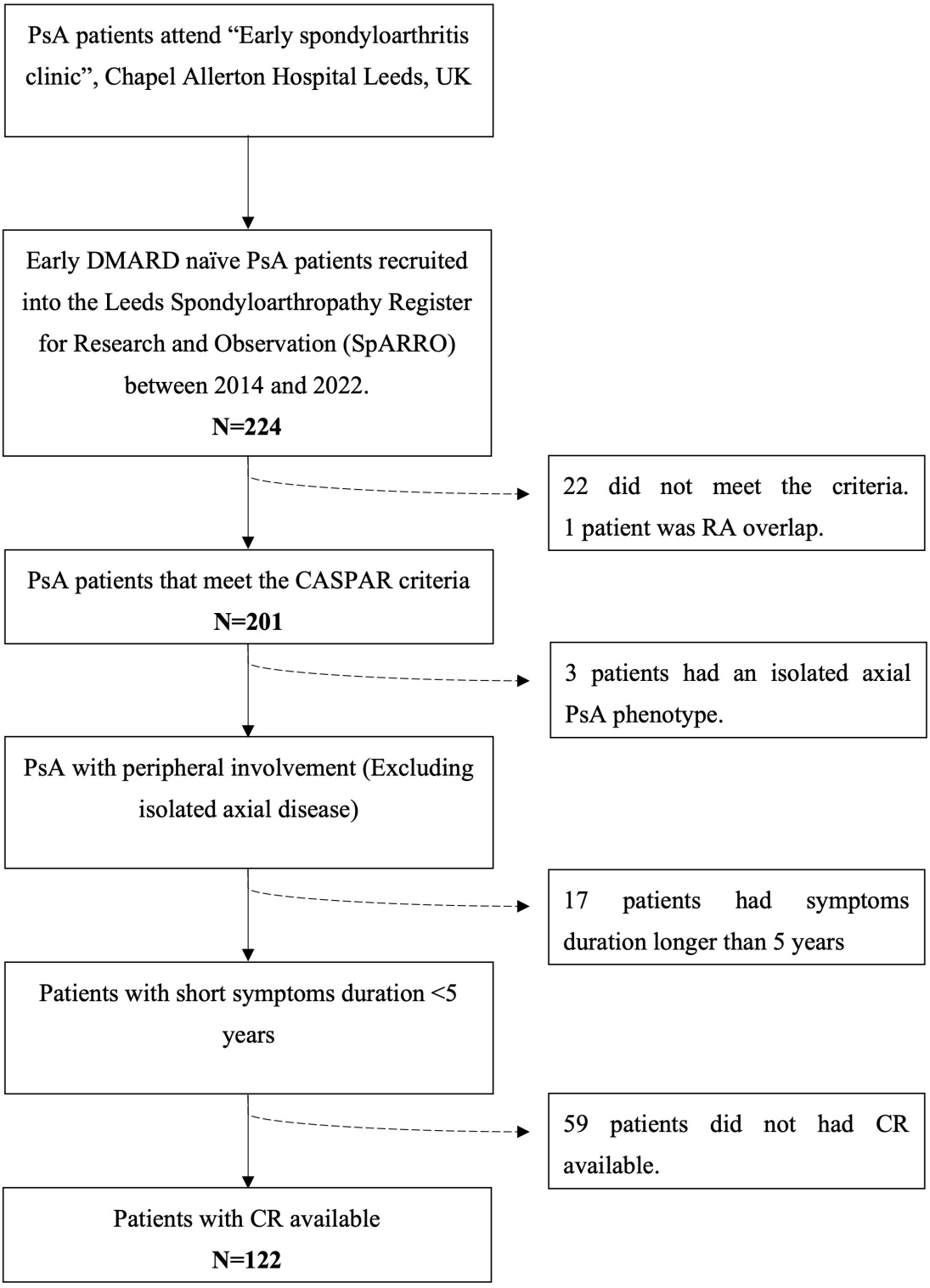

Figure 1 Patient selection flow chart. CR, conventional radiography; CASPAR, ClASsification criteria for Psoriatic ARthritis; PsA, psoriatic arthritis; RA, rheumatoid arthritis.

(PABAk) on dichotomous variables. Kappa typically ranges between 0.0 (random result) to 1.0 (perfect agreement not by chance) but occasionally results in negative values, which implies results worse than random and counts as random as well (could suggest label reversal).[17]

Since the prevalence of events in our study is low, we performed the correction of PABAk.[18]

Results were assessed with the common interpretation of Landis and Koch in which 0.0–0.2=slight agreement, 0.21–0.40=fair agreement, 0.41–0.60=moderate agreement, 0.61–0.80=substantial agreement and 0.81–1.0=almost perfect agreement.

Statistical analysis was performed by IBM SPSS Statistics V.28 version software.

Table 1 Baseline characteristics of study patients

	All patients n=122	Patients with no erosions n=92	Patients with erosions n=30	P value
Age, mean±SD	51±13	51±13	51±12	No
Symptom duration (months, median (IQR))	12 (7–24)	12 (7–24)	12 (8–24)	No
Female, N (%)	53 (43)	38 (41)	15 (50)	No
BMI, median (IQR)	28.6 (25–32)	28.1 (24–32)	28.6 (27–32)	No
Disease phenotype, N (%)		43 (47)	19 (63)	No
Polyarthritis	62 (51)	46 (50)	11 (37)	No
Oligoarthritis	57 (4)	12 (13)	4 (13)	No
DIP-prominent disease	16 (13)	12 (13)	3 (10)	No
Axial involvement	15 (1)	0 (0)	0 (0)	NA
Arthritis mutilans	0 (0)	30 (34)	10 (37)	No
Smoking status, N (%)				
Current	20 (17)	42 (46)	13 (45)	No
Ex-smoker	35 (29)	50 (54)	16 (55)	No
Never smoked	66 (55)			
TJC78, median (IQR)	7 (3–13)	6 (2–11)	9 (4–23)	**0.018**
SJC76, median (IQR)	4 (1–8)	3 (1–7)	7 (2–16)	**0.002**
Psoriasis, n (%)	117 (95.9)			
PASI, median (IQR)	2.6 (0.4–4.3)	1.8 (0.4–4.2)	2.9 (1–5.4)	No
Nail dystrophy, N (%)	61 (51)	2 (2)	0 (0)	No
History of dactylitis, N (%)	40 (35)	47 (51)	19 (63)	No
Dactylitis score positive, N (%)	66 (54)	42 (47)	19 (63)	No
CRP, median (IQR)	<5 (<5–16)	<5 (<5–14)	13 (<5–20)	**0.016**
CRP elevated (>5 mg/L), N (%)	58 (48)	38 (41%)	20 (67)	**0.016**
CRP elevated (>10 mg/L), N (%)	44 (36)	28 (30)	16 (53)	**0.023**
ESR, median (IQR)	12 (5–25)	11 (5–23)	12.5 (6-33)	No
RF positive, N (%)	2 (2)	5 (6)	0 (0)	No
Anti-CCP positive, N (%)	5 (4)	5 (6)	0 (0)	No
DAPSA at baseline, median (IQR)	31 (19–53)	28 (18–49)	39 (26–83)	**0.009**

Bold values represent statistical significance.
BMI, body mass index; CCP, cyclic citrullinated peptide; CRP, C reactive protein; DAPSA, Disease Activity in Psoriatic Arthritis; DIP, distal interphalangeal; ESR, erythrocyte sedimentation rate; NA, not applicable; PASO, psoriasis area and severity index; RF, rheumatoid factor; SJC, swollen joint count; TJC, tender joint count.

RESULTS

Of 224 PsA patients in the SpARRO cohort, 122 (all ≤5 years symptom duration with 85%≤2 from symptom onset) had available CR of the hands and feet at baseline (figure 1) and were included in this analysis. A total of 4655 joints were assessed by CR, including 240 wrists (radial+ulnar), 1200 MCPs (1st–5th), 240 IPs, 960 PIPs (2nd–5th), 960 DIPs (2nd–5th) and 1055 MTPs (1st–5th). The mean age was 51, 43% were females, and the median duration of rheumatologic symptoms was 12 months (IQR (7–24)). Tender and swollen joint counts had a median and IQR of 7 (3–14) and 3 (1–8), respectively. Baseline characteristics and demographics of the cohort are shown in table 1. The majority of patients had skin psoriasis (95.9%), there was history of uveitis in 1, and no inflammatory bowel disease. The median Disease Activity in Psoriatic Arthritis (DAPSA) score was 31 (19–53 IQR) (table 1).

Prevalence of patients with erosions according to CR

Of 122 patients with early PsA, 30 (24.6%) had erosions at baseline. Erosion prevalence showed a declining trend at different symptom duration cut-off points, with the lowest prevalence seen below 8 months of symptoms (17.5%) vs >24 months (24.3%) (table 2). Demographics were similar in those with and without erosions (table 1), both groups had a mean age of 51, close BMI median of 28.6 and 28.1 with a higher percentage of females (50% vs 41%) in the group with erosions. Patients with erosions had higher disease activity features such as higher tender

Table 2 Erosion prevalence at different symptom duration cut-off points

Disease duration in years cut-offs, valid values	Erosions at baseline, N (%)
All valid cases regard disease duration (no cut-off)	28/115 (24.3)
Disease duration ≤24 months	22/98 (22.4)
Disease duration ≤12 months	16/69 (23.2)
Disease duration ≤8 months	7/40 (17.5)
Disease duration ≤6 months	4/19 (17.4)

joint count (TJC) (median, (9 vs 6), p<0.05), higher swollen joint count (SJC) (median, (7 vs 3), p<0.05), higher CRP (median, (13 vs<5), p<0.05) and a higher DAPSA score (median (39 vs 28), p<0.05). A polyarticular pattern was numerically but not statistically more prevalent in patients with erosions (63% vs 47%, p>0.05), whereas patients without erosions (37% vs 50%, p>0.05) had an oligoarticular pattern of joint involvement. No statistical differences were found in the presence or history of dactylitis, psoriatic nail dystrophy or smoking status.

Frequency and distribution of erosions in CR and US

The analysis of erosions at the joint level included an assessment of 4655 joints in total on CR and 3270 on US. The overall number of erosions in all joints was higher on CR (1.35% (63/4655)) compared with the US (1.04% (34/3270)). The most frequent erosion site was the 5th MTP in both CR (5.21% (11/211)) and US (7.14% (15/210)). However, some differences were observed with the 2nd DIP (2.5% (6/240)), 3rd DIP (2.08% (5/240)) and the 4th MTP (1.9% (4/211)), which were more frequently affected on CR and the second MCP (3.33% (7/210)) and wrist (1.9% (4/210)) on US (table 3). The distribution of erosions (among only positive tests, ie, CR and US) was the same in both imaging modalities although different proportions were seen, with the 5th MTP being the most common erosion site but only present in 17% in CR vs 44% in US. Bone erosions in CR were more evenly distributed compared with US where 76.47% of the total number of erosions

Table 3 Frequency and distribution of erosions in CR and US

	Prevalence of erosions				Distribution of erosions			
	CR		US		CR		US	
	Value	%	Value	%	Value	%	Value	%
Wrist	3/240	1.25	4/210	1.90	3/63	4.76	4/34	11.76
McP1	4/240	1.67	2/138	1.45	4/63	6.35	2/34	5.88
McP2	1/240	0.42	7/210	3.33	1/63	1.59	7/34	20.59
McP3	4/240	1.67	2/210	0.95	4/63	6.35	2/34	5.88
McP4	2/240	0.83	2/138	1.45	2/63	3.17	2/34	5.88
McP5	1/240	0.42	0/138	0.00	1/63	1.59	0/34	0.00
IP1	2/240	0.83	0/138	0.00	2/63	3.17	0/34	0.00
PiP2	0/240	0.00	0/210	0.00	0/63	0.00	0/34	0.00
PiP3	4/240	1.67	1/210	0.48	4/63	6.35	1/34	2.94
PiP4	2/240	0.83	0/138	0.00	2/63	3.17	0/34	0.00
PiP5	2/240	0.83	0/138	0.00	2/63	3.17	0/34	0.00
DiP2	6/240	2.50	0/138	0.00	6/63	9.52	0/34	0.00
DiP3	5/240	2.08	0/138	0.00	5/63	7.94	0/34	0.00
DiP4	4/240	1.67	0/138	0.00	4/63	6.35	0/34	0.00
DiP5	1/240	0.42	0/138	0.00	1/63	1.59	0/34	0.00
MtP1	2/211	0.95	NA	NA	2/63	3.17	NA	NA
MtP2	2/211	0.95	0/210	0.00	2/63	3.17	0/34	0.00
MtP3	3/211	1.42	0/210	0.00	3/63	4.76	0/34	0.00
MtP4	4/211	1.90	1/210	0.48	4/63	6.35	1/34	2.94
MtP5	11/211	5.21	15/210	7.14	11/63	17.46	15/34	44.12
Total	63/4655	1.35	34/3270	1.04	63/63	100.00	34/34	100.00

Table 3 shows the analysis of erosions performed at the joint level including 4655 joints on CR and 3270 on US. The distribution of erosions refers to the number of bone erosions related to the total number of bone erosions in the whole study population.
CR, conventional radiography; DiP, distal interphalangeal; IP, interphalangeal; McP, metacarpophalangeal; MtP, metatarsophalangeal; NA, not available; PiP, proximal interphalangeal; US, ultrasound.

Table 4 Erosion agreement between CR and US

	Agreement	PABAk	Kappa
Wrist	96.15%	0.92	0.32
McP1	97.06%	0.92	0.48
McP2	96.15%	0.94	0.32
McP3	94.23%	0.88	−0.03
McP4	95.59%	0.91	−0.02
McP5	98.53%	0.97	0.00
IP1	98.53%	0.97	0.00
PiP2	100.00%	1.00	NE
PiP3	96.15%	0.92	−0.01
PiP4	98.53%	0.97	0.00
PiP5	98.53%	0.97	0.00
DiP2	94.12%	0.88	0.00
DiP3	95.59%	0.91	0.00
DiP4	95.59%	0.91	0.00
DiP5	100.00%	1.00	NE
MtP1	NA	NA	NA
MtP2	98.91%	0.98	0.00
MtP3	97.83%	0.96	0.00
MtP4	97.83%	0.96	0.49
MtP5	91.30%	0.83	0.55

NE refers to no events, that is, no erosions in either group.
CR, conventional radiography; DiP, distal interphalangeal; IP, interphalangeal; McP, metacarpophalangeal; MtP, metatarsophalangeal; NA, not available; PABAk, prevalence-adjusted bias-adjusted kappa; PiP, proximal interphalangeal; US, ultrasound.

were seen in specific joints, such as the wrists, 2nd MCP joints and 5th MTP joints (table 3).

Agreement between US and CR

The inter-rater agreement between CR and US regarding the detection of bone erosions was assessed in wrists, MCPs (1st–5th), IPs, PIPs (2nd–5th), DIPs (2nd–5th) and MTPs (2nd–5th). There was an excellent agreement between these two modalities (ie, above 95%) for all joints except the 3rd MCP, 2nd DIP with 94% and 5th MTP, which was slightly lower at 91%. Most joints had almost perfect PABAκ values ranging from 0.91 to 1. However, the 3rd MCP (PABAκ=0.88), 2nd DIP (PABAκ=0.88) and 5th MTP (PABAκ=0.83) had lower PABAκ than the rest of the joints but still had high scores. The second PIP and fifth DIP did not have any events of erosions either on CR or US. The agreement, Cohen's κ and PABAκ values are shown in table 4.

DISCUSSION

Joint damage characterised by the presence of erosions is associated with ireversible functional impairment and decreased quality of life in PsA. In our study, nearly a quarter (24.6%) of early, DMARD naïve, early PsA patients had erosions according to CR at baseline, confirmed by US. Although this is a lower prevalence than previously described,[19–21] it is not unsubstantial and comparable to that reported in early undifferentiated arthritis.[22] The SwePsA[23] early cohort with equal median symptom duration as ours (12 months), reported 49% of their subjects as having no PsA-related changes, however, they did not specify the changes seen in the other 51% or estimate erosions at the patient level. Touma *et al*[24] reported a higher baseline prevalence (69% erosions) from a cohort with a disease duration longer than 5 years, in agreement with other studies showing disease duration as an important risk factor for radiographic progression, the reason why early treatment is considered crucial for a better prognosis.[2 25] Previous data from our group confirmed the lower prevalence and smaller size of US erosions in PsA when compared with RA, in symptom duration of around 5 years.[26]

All patients included in our report were newly diagnosed with the majority (85%) having a short duration of symptoms of ≤2 years. As expected, symptom duration was shown to be directly related to the presence of erosions: only 17.5% of those who had symptoms for 8 months had erosions, while the prevalence increased to 24.3% among those with a symptom duration ≥2 years. These findings are in agreement with others[2] suggesting that a diagnostic delay of more than 2 years from symptom onset is associated with higher damage progression. These data are highly relevant as underscore the need to improve the time to diagnosis in PsA, and to identify those individuals at risk of disease progression, one of the priority areas of research identified by patients.[27]

Indeed, in our study, PsA patients with erosions at baseline had higher disease activity when compared with the erosion-free group as evidenced by significantly higher TJC, SJC, DAPSA scores and CRP levels. This is consistent with previous reports showing an association between polyarticular phenotype and more severe disease at baseline with a worse prognosis.[25] In addition, although not statistically significant, we found that, numerically, a polyarticular pattern was also associated with the presence of erosions (63% vs 47%, p>0.05). Interestingly, Queiro-Silva *et al*[28] demonstrated that even early (ie, mean arthritis duration ≤10 months) PsA patients with no baseline radiographic changes are more prone to erosion progression if the presentation at disease onset involved more than 5 joints.

In routine practice, most clinicians would perform a baseline CR of hands and feet as a reference to evaluate response to treatment or evolution of disease, while the role of US is still unclear in these clinical scenarios. Overall, our data show that CR is more sensitive to identifying erosions than US in early PsA which appears to be somehow at odds with the data from 'early' RA,[29] including very early individuals 'at-risk' of RA. There may be several reasons for this. When looking at location, the fifth MTP appeared to be the the most common affected

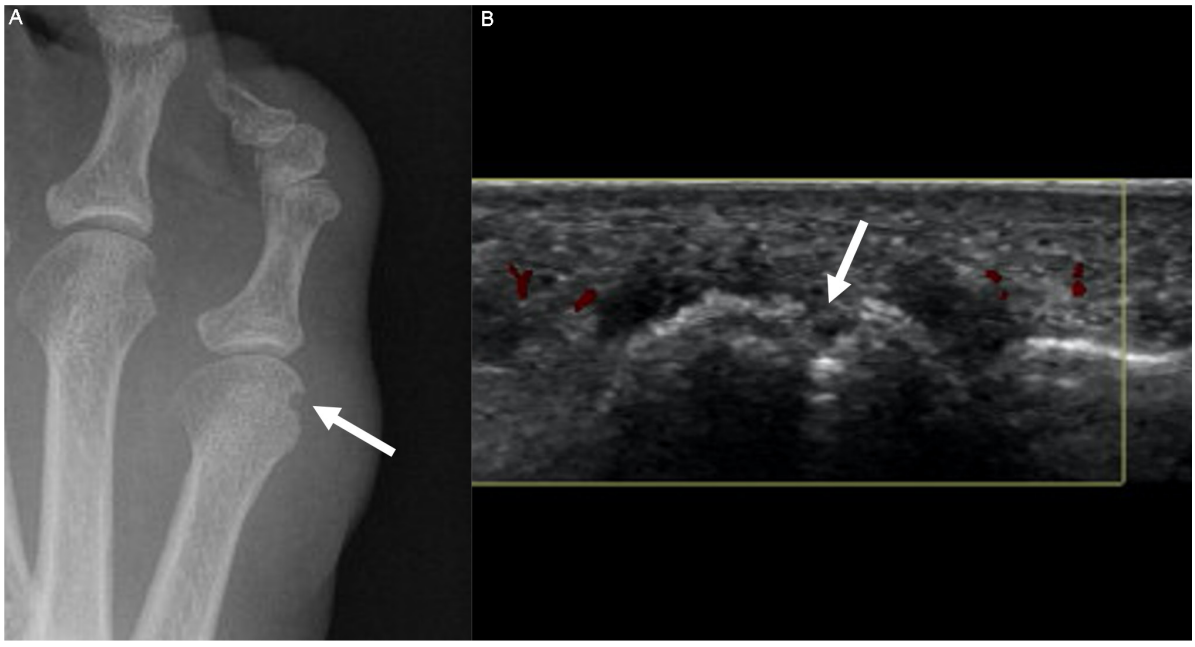

Figure 2 Image of bone erosion on conventional radiography and ultrasound. (A) A conventional posterior–anterior radiographic view of the right forefoot of a 63-year-old female study patient. The white arrow demonstrates a bone erosion of the lateral aspect of the fifth metatarsal head. (B) The corresponding longitudinal US image confirming the erosion (white arrow). US, ultrasound.

site in both US and CR assessments (figure 2). Interestingly, more erosions were detected by CR on second DIP, third DIP and fourth MTP while US identified more lesions on the second MCP and the wrist. These results suggest a lesser sensitivity of US for the evaluation of bone erosions in the DIP joints which are commonly affected in PsA but usually spared in RA. The lower sensitivity of US in the detection of bone erosions in the DIP (or PIP) joints compared with CR could be explained by the fact that bone superimposition (due to concomitant osteoarthritis/osteoproliferation, which are both commonly observed in PsA patients), may impair the correct assessment of bone erosions in these joints.[30] An important observation is that while CR bone erosions were evenly distributed in the joints of the hands and feet, the great majority of US bone erosions were detected in the wrists, second MCP joints and fifth MTP joints (table 3), thus suggesting that an US scan of three joints (ie, wrists, second MCP and fifth MTP) could provide a valuable screening assessment for the presence of bone erosions in new patients with PsA.

On the other hand, the current results confirm the higher sensitivity of US compared with CR for the evaluation of bone erosions in those joints in which US has an optimal 'acoustic window' (and which are also commonly involved in PsA as well as in other rheumatic conditions, such as RA) such as the second MCP joint, ulnar stylod and fifth MTP joints.[31–33] Overall, these data are consistent with previous reports in PsA that showed the higher sensitivity of US to demonstrate erosions at the MCP level, with CR being superior for DIP joint assessment.[34]

Of note, our results show that CR and US are closely related regarding their capacity to detect erosions, with over 94% agreement in the majority of joints examined. Indeed, the PABAK test demonstrated values above 0.91 in most joints, which represents almost perfect agreement. However, lower agreement percentage and PABAk values were seen in joints that had a higher erosions' prevalence, such as the fifth MTP joint, and in joints where US had a lower sensitivity than the CR, like the DIPs. The lower agreement with the higher erosions' prevalence could suggest that the two imaging techniques are not interchangeable and the high agreement scores were actually influenced by the low prevalence of erosions in those joints. It is not clear how US and CR are comparable within a higher erosions environment.

Our study had some limitations. We used two different US protocols, with the main difference being in the number of joints assessed. This protocol switch caused a split in the data and we therefore chose not to present the prevalence of US erosions. Further, this change in protocol could have influenced the frequency of erosions in the joint-level assessment, potentially affecting the study's internal validity but is less likely to have a substantial effect on the erosions' distribution. Nevertheless, this study highlights the need to expand the research agenda for US in early PsA to address the validity of US over CR in the assessment of erosions in peripheral joints in early, untreated PsA; the prognostic value of US erosions in early PsA and the possible impact of therapy on these findings over time.

In summary, this study showed erosions in a quarter of patients with newly diagnosed, DMARD naïve PsA with a declining trend around the 8-month symptom duration cut-off. Although this prevalence appears lower than previous reports, it highlights the need to reduce the

diagnostic delay in PsA in order to improve outcomes. According to both CR and US, the most common site of erosions was the fifth MTP and CR detected more erosions in the DIP joints than US.

Although further data are needed to confirm whether these techniques are interchangeable, at the bedside, a limited US assessment of the wrist, second MCP and fifth MTP may be enough to confirm the presence of erosions in early, untreated PsA.

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Contributors HM-O is the CI of the SpARRO cohort and the study guarantor. HM-O and PH designed the current study. SRD, GDM, ALT, PE, DGM and RJW contributed to patient recruitment. RJW and ADM contributed to US scanning and expertise. PH scored the radiographic data. OH did the statistical analysis and wrote the first version of the manuscript. All authors contributed to the writing and critically appraised the final version of the manuscript.

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REFERENCES

1 Ritchlin CT, Colbert RA, Gladman DD, *et al*. Psoriatic arthritis. *N Engl J Med* 2017;376:957–70. 10.1056/NEJMra1505557 Available: https://pubmed.ncbi.nlm.nih.gov/28273019/
2 Haroon M, Gallagher P, FitzGerald O. Diagnostic delay of more than 6 months contributes to poor radiographic and functional outcome in Psoriatic arthritis. *Ann Rheum Dis* 2015;74:1045–50.
3 Taylor W, Gladman D, Helliwell P, *et al*. Classification criteria for Psoriatic arthritis: development of new criteria from a large international study. *Arthritis Rheum* 2006;54:2665–73. 10.1002/art.21972 Available: https://onlinelibrary.wiley.com/toc/15290131/54/8
4 McInnes IB, Asahina A, Coates LC, *et al*. Bimekizumab in patients with Psoriatic arthritis, naive to biologic treatment: a randomised, double-blind, placebo-controlled, phase 3 trial (BE OPTIMAL). *Lancet* 2023;401:25–37. 10.1016/S0140-6736(22)02302-9 Available: https://pubmed.ncbi.nlm.nih.gov/36493791/
5 Kampylafka E, d'Oliveira I, Linz C, *et al*. Resolution of Synovitis and arrest of Catabolic and anabolic bone changes in patients with Psoriatic arthritis by IL-17A blockade with Secukinumab: results from the prospective PSARTROS study. *Arthritis Res Ther* 2018;20. 10.1186/s13075-018-1653-5 Available: https://pubmed.ncbi.nlm.nih.gov/30053825/
6 Chandran V, van der Heijde D, Fleischmann RM, *et al*. Ixekizumab treatment of biologic-Naïve patients with active Psoriatic arthritis: 3-year results from a phase III clinical trial (SPIRIT-P1). *Rheumatology (Oxford)* 2020;59:2774–84.
7 van der Heijde D, Gladman DD, FitzGerald O, *et al*. Radiographic progression according to baseline C-reactive protein levels and other risk factors in Psoriatic arthritis treated with tofacitinib or Adalimumab. *J Rheumatol* 2019;46:1089–96. 10.3899/jrheum.180971 Available: https://pubmed.ncbi.nlm.nih.gov/30824647/
8 Kane D, Stafford L, Bresnihan B, *et al*. A prospective, clinical and radiological study of early Psoriatic arthritis: an early Synovitis clinic experience. *Rheumatology (Oxford)* 2003;42:1460–8.
9 Gouze H, Backhaus M, Balint P, *et al*. Ultrasound in the management of patients with Psoriatic arthritis: systematic literature review and novel Algorithms for pragmatic use. *J Rheumatol* 2023:jrheum.2023-0091.
10 Gudu T, Ng B, Jethwa H, *et al*. Improving imaging modalities in early Psoriatic arthritis: the role of ultrasound in early diagnosis of Psoriatic arthritis. *Front Med (Lausanne)* 2021;8:804695.
11 Sim J, Wright CC. The Kappa Statistic in reliability studies: use, interpretation, and sample size requirements. *Physical Therapy* 2005;85:257–68. 10.1093/ptj/85.3.257 Available: https://academic.oup.com/ptj/article/85/3/257/2805022
12 Dubash SR, Alabas OA, Michelena X, *et al*. Ultrasound shows swollen joints are the better proxy for Synovitis than tender joints in DMARD-Naïve early Psoriatic arthritis. *Rheumatol Adv Pract* 2021;5.
13 Dubash S, Alabas OA, Michelena X, *et al*. Dactylitis is an indicator of a more severe phenotype independently associated with greater SJC, CRP, ultrasound Synovitis and erosive damage in DMARD-naive early Psoriatic arthritis. *Ann Rheum Dis* 2022;81:490–5.
14 van der Heijde D, Sharp J, Wassenberg S, *et al*. Psoriatic arthritis imaging: a review of scoring methods. *Ann Rheum Dis* 2005;64 Suppl 2:ii61–4.
15 Bruyn GA, Iagnocco A, Naredo E, *et al*. OMERACT ultrasound working group. OMERACT definitions for ultrasonographic Pathologies and elementary lesions of rheumatic disorders 15 years on. *J Rheumatol* 2019;46:1388–93.
16 Iagnocco A, Rizzo C, Gattamelata A, *et al*. Osteoarthritis of the foot: a review of the current state of knowledge. *Med Ultrason* 2013;15:35–40.
17 Byrt T, Bishop J, Carlin JB. Bias, prevalence and Kappa. *J Clin Epidemiol* 1993;46:423–9.
18 Landis JR, Koch GG. The measurement of observer agreement for categorical data. *Biometrics* 1977;33:159. 10.2307/2529310 Available: https://pubmed.ncbi.nlm.nih.gov/843571/
19 Geijer M, Lindqvist U, Husmark T, *et al*. The Swedish early Psoriatic arthritis Registry 5-year followup: substantial radiographic progression mainly in men with high disease activity and development of Dactylitis. *J Rheumatol* 2015;42:2110–7.
20 Polachek A, Furer V, Zureik M, *et al*. Ultrasound, magnetic resonance imaging and radiography of the finger joints in Psoriatic arthritis patients. *Rheumatology* 2022;61:563–71. 10.1093/rheumatology/keab272 Available: https://pubmed.ncbi.nlm.nih.gov/33734348/
21 Ruta S, Jaldin Cespedes R, Cuellar L, *et al*. n.d. Psoriatic arthritis: differential features at the time of clinical presentation in a large cohort of patients with Polyarthralgia. *Eur J Rheumatol*;10:12–7. 10.5152/eurjrheum.2022.22035 Available: https://www.eurjrheumatol.org/EN/january-2023-00236
22 Thabet MM, Huizinga TWJ, van der Heijde DM, *et al*. The Prognostic value of baseline Erosions in undifferentiated arthritis. *Arthritis Res Ther* 2009;11:R155. 10.1186/ar2832 Available: https://doi.org/10.1186/ar2832
23 Theander E, Husmark T, Alenius G-M, *et al*. Early Psoriatic arthritis: short symptom duration, male gender and preserved physical functioning at presentation predict favourable outcome at 5-year follow-up. *Ann Rheum Dis* 2014;73:407–13.
24 Touma Z, Thavaneswaran A, Chandran V, *et al*. Clinical and demographic characteristics of erosion-free and erosion-present status in Psoriatic arthritis in a cohort study. *J Rheumatol* 2016;43:1057–62. 10.3899/jrheum.150466 Available: https://pubmed.ncbi.nlm.nih.gov/27036389/
25 Gladman DD, Thavaneswaran A, Chandran V, *et al*. Do patients with Psoriatic arthritis who present early fare better than those presenting later in the disease? Ann rheum dis. *Ann Rheum Dis* 2011;70:2152–4.

26 Zayat AS, Ellegaard K, Conaghan PG, *et al*. The specificity of ultrasound-detected bone Erosions for rheumatoid arthritis. *Ann Rheum Dis* 2015;74:897–903.
27 Hailey L, Bundy C, Burstow H, *et al*. The top 10 research priorities in Psoriatic arthritis: a James LIND alliance priority setting partnership. *Rheumatology (Oxford)* 2023;62:2716–23.
28 Queiro-Silva R, Torre-Alonso JC, Tinturé-Eguren T, *et al*. A Polyarticular onset predicts erosive and Deforming disease in Psoriatic arthritis. *Ann Rheum Dis* 2003;62:68–70.
29 Szkudlarek M, Terslev L, Wakefield RJ, *et al*. Summary findings of a systematic literature review of the ultrasound assessment of bone Erosions in rheumatoid arthritis. *J Rheumatol* 2016;43:12–21.
30 Zayat AS, Freeston JE, Conaghan PG, *et al*. Does joint position affect US findings in inflammatory arthritis *Rheumatology (Oxford)* 2012;51:921–5.
31 Cipolletta E, Smerilli G, Di Matteo A, *et al*. The Sonographic identification of cortical bone interruptions in rheumatoid arthritis: a morphological approach. *Ther Adv Musculoskelet Dis* 2021;13:1759720X211004326. 10.1177/1759720X211004326 Available: https://pubmed.ncbi.nlm.nih.gov/33948124/
32 T maM-M, Filippucci E, Becciolini A, *et al*. Bone Erosions in rheumatoid arthritis: ultrasound findings in the early stage of the disease. *Rheumatology* 2014;53:1100–7. 10.1093/rheumatology/ket484 Available: https://pubmed.ncbi.nlm.nih.gov/24501246/
33 Di Matteo A, Mankia K, Duquenne L, *et al*. Ultrasound Erosions in the feet best predict progression to inflammatory arthritis in anti-CCP positive at-risk individuals without clinical Synovitis. *Ann Rheum Dis* 2020;79:901–7. 10.1136/annrheumdis-2020-217215 Available: https://pubmed.ncbi.nlm.nih.gov/32366522/
34 Wiell C, Szkudlarek M, Hasselquist M, *et al*. Ultrasonography, magnetic resonance imaging, radiography, and clinical assessment of inflammatory and destructive changes in fingers and toes of patients with Psoriatic arthritis. *Arthritis Res Ther* 2007;9:R119.