Association between Leeds Dactylitis Index and ultrasonographic features: a multicentre study on psoriatic hand dactylitis

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Abstract

Objective

The aim of this study was to explore the link between specific sonographic findings and Leeds Dactylitis Index basic (LDI-b) score in psoriatic arthritis (PsA) patients with hand dactylitis.

Methods

Ninety-one hand dactylitis were evaluated in a multicentre study for the presence of pain, functional limitation and tenderness (2-point scale) and LDI-b score. Dactylitic fingers were investigated using high-frequency US in grey scale (GS) and power Doppler (PD). According to median LDI-b score value of 12, fingers were then divided into two groups and categorised into quartiles on the basis of the value of ratio of circumference.

Results

Dactylitic fingers with a LDI-b score >12 showed a significantly higher prevalence of GS flexor tenosynovitis (p=0.015), PD flexor tenosynovitis (p=0.001) and soft tissue oedema (p=0.004), when compared with those with those with LDI-b score <12. GS synovitis at proximal interphalangeal (PIP) level (p=0.003) showed more frequent in dactylitic fingers with a LDI-b score <12, than those with a higher LDI-b value. Fingers in the fourth quartile showed a significantly higher prevalence of GS flexor tenosynovitis of grade ≥2 (p=0.046) and joint synovitis of grade ≥2 at PIP level (p=0.028).

Conclusions

We found that high values of LDI are associated with US flexor tenosynovitis and soft tissue oedema in PsA dactylitis. Results suggest a potential role of PIP joint synovitis in the genesis of hand digital swelling and of extra-articular structures alterations in determining the LDI score

Key words

dactylitis, ultrasound, psoriatic arthritis, tenosynovitis, oedema, joint synovitis, Leeds Dactylitis Index

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Received on September 28, 2019; accepted in revised form on January 17, 2020.

Competing interests: none declared.

Introduction

Psoriatic arthritis (PsA) is a chronic inflammatory disease that may be present in near 30% of patients affected by psoriasis, clinically characterised by inflammation of periarticular and articular structures (1, 2). Dactylitis, also defined as sausage-digit, is characterised by a diffuse and uniform swelling of a whole digit and it is considered a clinical marker of disease severity in PsA (3, 4). Dactylitis may occur in up to 50% of PsA patients (5-7), representing a clinical characteristic of PsA (8, 9). This may occur as an acute/tender form characterised by pronounced swelling or as a chronic/non-tender form, also called "cold dactylitis" (10-11).

Several ultrasound (US) and magnetic resonance imaging (MRI) studies have shown that dactylitis includes different inflammatory lesions such as tenosynovitis (12-15), adjacent soft tissue thickening/oedema (16-17), synovitis of metacarpophalangeal (MCP), proximal interphalangeal (PIP) and distal interphalangeal (DIP) joints (15, 18-19) and extensor paratenonitis and enthesitis. (20-23).

Different scores are used for defining dactylitis activity; these are represented by a dichotomic "yes or no" score, the Leeds Dactylitis Index (LDI) and a simplified version, the LDI basic (LDI-b) (25-26). Further, some authors recommend the use of dactylometer and LDI as tools for evaluating both swelling and tenderness (25-27).

Until today, no studies have focused on possible associations between the dactylitis activity score, LDI, and related-ultrasound aspects in PsA hand dactylitis. However, the characterisation of US aspects of hand dactylitis and its correlation with LDI could be useful for differentiating the underlying mechanisms and involved structures of acute/tender and chronic/non-tender forms.

Hence, we conducted a multicentre, cross-sectional study in order to explore possible associations between specific US findings and the LDI-b score in PsA patients with clinically evident hand dactylitis.

Patients and methods

Patients

Consecutive adult patients with PsA, classified on the basis of CASPAR Criteria, showing acute or chronic hand dactylitis were enrolled for this study. The study was approved by the local ethical committees (ethical approval code: 5/12) and was conducted in conformity with the Declaration of Helsinki and its later amendments.

The exclusion criteria were represented by: (1) current and past manual work, (2) recent and past hand trauma, (3) current use of biologic synthetic disease modifying antirheumatic drugs (bDMARDs) and (4) previous treatment with corticosteroid injections.

The presence of hand dactylitis (diffuse swelling of a digit, associated or less with tenderness) was evaluated through physical examination by three Rheumatologists (AM, CS, RS) and measured using the dactylometer and the related LDI-b (25). In particular, the LDI was used in order to measure the ratio of the circumference of the involved digit to the circumference of the contralateral, non-affected digit; the minimal difference of 10% was necessary to define the presence of hand dactylitis. Digit circumference was measured at the level of the proximal base of the proximal phalanx using the dactylometer. The ratio of circumference was multiplied using the tenderness binary score (0 for no tender, 1 for tender) to obtain LDI-b score (26).

Ultrasound protocol

Hand dactylitic fingers US examination was performed by three rheumatologists (NG, PM, IT), trained in musculoskeletal US examination, blinded to clinical and laboratory data. All of the US scans were performed using a MyLab 70XVG machine equipped with a 6–18 MHz linear transducer (Esaote SpA, Genova, Italy).

The US grey-scale (GS) imaging parameters were optimised for maximal image resolution. Power Doppler (PD) settings were standardised at the following values: 500 Hz for pulse repetition frequency, 3 for wall filter, 4 for persistence, and colour gain between 45–55%.

Flexor and extensor tendons, MCP, PIP and DIP joints of the affected hand fingers were assessed by GS and PD US evaluation in longitudinal and transverse scanning views, in accordance with the 2017 EULAR standardised procedures for ultrasound imaging in rheumatology (28). Joints were examined from both dorsal and volar sides. We investigated for the presence and the evaluation of the following dactylitis related US findings: flexor tenosynovitis (both in GS and in PD mode), soft tissue oedema, subcutaneous PD signal (PDS), extensor tendon involvement (including paratenonitis and enthesitis of extensor tendon at proximal-interphalangeal joint), synovitis (both in GS and in PD mode).

Tenosynovitis was defined in GS according to the Outcome Measures in Rheumatology (OMERACT) consensus-based ultrasound score (29). Soft tissue oedema was defined as a diffuse hypo/isoechoic thickening of the extratendinous soft tissues around flexor tendon (pseudotenosynovitis) with positive PD signal in the subcutaneous tissue, which was seen in 2 perpendicular planes (16-17). Paratenonitis was defined as a hypoechoic area surrounding a tendon without synovial sheath, with or without peri-tendinous PDS (30-31). Enthesitis of extensor tendon at PIP joint was defined by the presence of hypoechoic and/or increased thickness of the tendon insertion close to the bone (within 2 mm from the bony cortex), which exhibits Doppler signal if active (32-33).

According to the EULAR-OMERACT standardised consensus-based scoring, synovitis was defined as a hypoechoic synovial hypertrophy (SH) regardless of the presence of effusion and any grade of PD signal (34). Tenosynovitis was assessed using the four-grade semi-quantitative scoring scale in GS and Doppler mode, as proposed by the OMERACT US group (35). Synovitis was scored using a semi-quantitatively score (0–3) both for GS and Doppler mode, according to recent studies (36-37).

Statistical analysis

The statistical analysis was performed using SPSS, version 23. Quantitative variables were expressed in terms of mean ± SD or median and range in case of strong violation of normality, while qualitative variables were expressed as percentages. Intra-observer and inter-observer reliabilities were obtained in two measurements (at basal and at 3 months from the first US evaluation) using 20 static images of 20 patients and these covered all the different degree of the findings. Cohen's kappa coefficient ($\varkappa$) was used for each sonographic lesion and values >0.8 were considered as excellent. Continuous variables were compared using t-test or non-parametric tests when appropriate. Non-continuous variables were compared using Chi-square test. Statistical tests were performed at a significance level of α=0.05. For the purposes of analysis, we divided all fingers into two groups according to LDI score (higher or lower than the median, 12). Fingers were categorised into quartiles based on the value of ratio of circumference (expressed as percentage; %).

To evaluate the capacity of LDI value to discriminate between acute and chronic forms of dactylitis, receiver operating characteristic (ROC) curves with corresponding areas under the curve (AUC) were calculated.

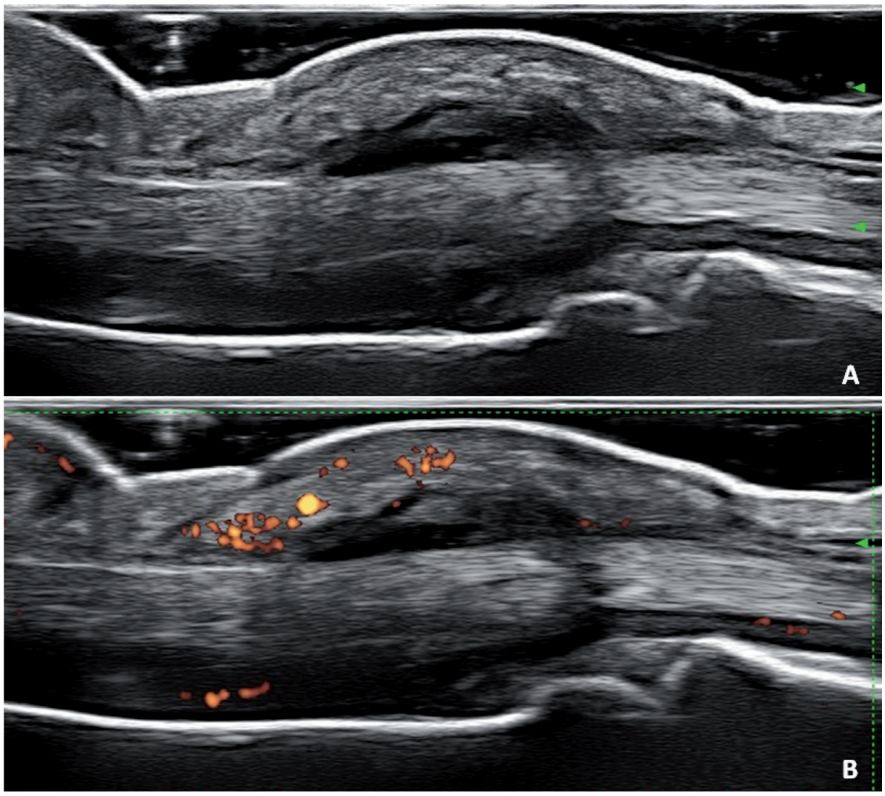

Fig. 1. Longitudinal ultrasound views of dactylitis.
A: Flexor tenosynovitis of grade 2 with soft tissue oedema.
B: Presence of power Doppler signal (PDS) around the tendon fibres and at the level of the subdermal tissue.

Results

Characteristics of patients

Sixty-four PsA patients (25 female and 39 male; mean age 51.5±13.5 years, range 18–72 years, PsA duration disease 54.9±48.6 months), with a total of 91 hand dactylitic fingers, were enrolled in the study. No significant difference was found in the comparison between patients on therapy with nonsteroidal anti-inflammatory drugs (NSAIDs) and patients on csDMARDs.

At the clinical examination, twenty-two fingers showed absence of tenderness and absence of pain as evaluated by the visual analogue scale (VAS) (asymptomatic dactylitis). Four fingers showed absence of tenderness and presence of pain <2 as evaluated by VAS (paucisymptomatic dactylitis). Sixty-five fingers showed presence of tenderness and presence of pain >2 as evaluated by the VAS (symptomatic dactylitis).

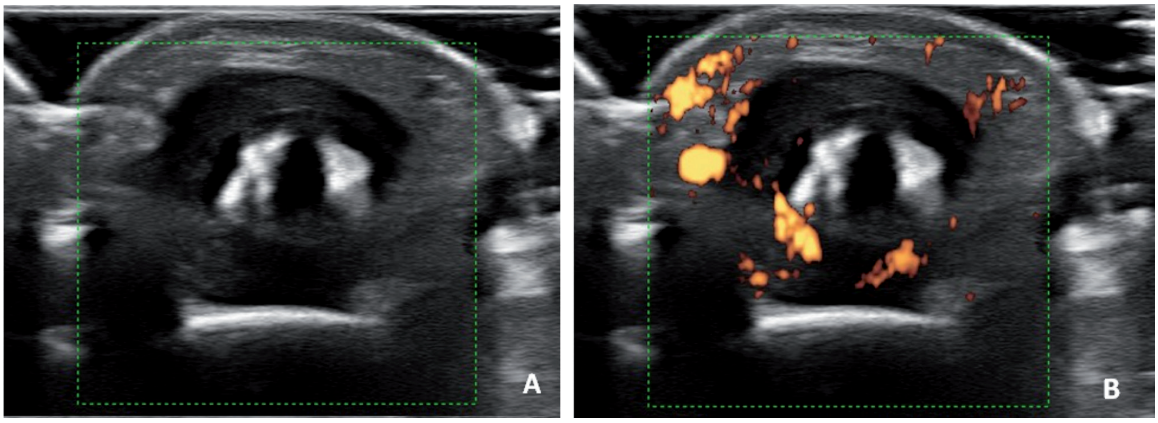

Fig. 2. Transverse ultrasound views of dactylitis.
A: Distension of the flexor tendon sheath and soft tissue oedema. (power Doppler (PD) box off).
B: Presence of PD signal around the tendon fibres and at the level of the subdermal tissue.

The symptomatic dactylitis had a significantly lower digit involvement duration compared to asymptomatic/paucisymptomatic ones (15.5±16.7 *vs.* 49.6±31.2 weeks, p=0.01).

Sonographic intra-observer reliability

The value of the intra-observer reliability for all three operators was between 0.85 and 0.92. Further, for the three sonographers, the intra-observer reliability was excellent for all parameters (κ>0.8). For the three sonographers, the intra-observer reliability was excellent for all parameters (κ>0.8). The inter-observer reliability depicted by k coefficient was 0.87 (95%CI: 0.81–0.93) for GS flexor tenosynovitis, 0.83 (95% CI: 0.75–0.90) for PD flexor tenosynovitis, 0.89 (95%CI: 0.85–0.93) for soft tissue oedema, 0.86 (95% CI: 0.74–0.97) for subcutaneous PDS, 0.88 (95%CI: 0.84–0.92) for extensor tendon involvement, 0.84 (95%CI: 0.76–0.93) for GS synovitis and 0.91 (95% CI: 0.85–0.96) for PD synovitis.

Sonographic findings

All the hand dactylitis showed at least one US abnormality. Flexor tenosynovitis was evident in GS in 88% of dactylitis, and related PD flexor tenosynovitis was observed in 74% of dactylitic fingers.
Soft tissue oedema and subcutaneous PD signal were present in 74% and 92% of cases, respectively. Extensor tendon involvement was observed in 13% of the dactylitic fingers. GS synovitis involving at least one joint was seen in 43% of cases; synovitis of PIP joint was founded in 29% of cases, followed by MCP (14%) and DIP synovitis (12%).
An increased PD synovial tissue signal of at least one digit joint was showed in 26% of cases. This was more frequently detected at PIP level (17%). MCP and DIP joints showed an increased PD signal in 6% and 5% of cases, respectively. Flexor tenosynovitis and soft tissue oedema were found in 83% of cases; flexor tenosynovitis and joint synovitis were observed in 35% of cases while all three US lesions were found in 29% of cases.
US characteristics of a finger dactylitis of our study are described in Figures 1 and 2.

Association between LDI and US abnormalities

The group of patients with LDI-b score over the sample median value of 12 showed a significant higher prevalence of GS flexor tenosynovitis (p=0.015), PD flexor tenosynovitis (p=0.001) and soft tissue oedema (p=0.004) (Table I). GS synovitis at PIP level was found more frequent in fingers with a lower LDI-b score, when compared with those with LDI-b >12 (p=0.003). No difference in the prevalence of the joint synovitis at MCP and DIP level and other evaluated US abnormalities was found.
Twenty-two fingers with coexistent GS flexor tenosynovitis of grade >2, PD flexor tenosynovitis and soft tissue oedema had significantly higher values of LDI compared to fingers showing just one US abnormality (5.25±6.42 *vs.* 14.11±6.04, p<0.001).

Association between ratio of circumference and US abnormalities

In order to evaluate the ratio of circumference, we compared the circumference of the dactylitic finger with the value of the contralateral one. The mean value ± Standard Deviation (SD) was 13.29%±4.2. The median value was 12%, and minimum, maximum and the interquartile ranges were 11%, 14% and 16%, respectively. Then, we compared US findings of hand fingers included in the first quartile (ratio ≥11%, 25 fingers) with those of the fourth quartile (ratio >16%, 24 fingers). As shown in Table II, fingers belonging to the fourth quartile had a significantly higher prevalence of GS flexor tenosynovitis of grade ≥2 and joint synovitis of grade ≥2 at PIP level (p=0.046 and p=0.028, respectively). No significant differences were found for soft tissue oedema and joint synovitis at MCP and DIP level.

Discussion

This study represents the first to evaluate a possible association between US abnormalities and the dactylitis activity, as evaluated by the LDI score, in PsA hand dactylitis. Our results show that high values of LDI-b are associated with flexor tenosynovitis and soft tissue oedema. Further, findings from this study suggest the potential role of flexor tenosynovitis and soft tissue oedema in triggering and sustaining the symptoms of dactylitis.
Our results are in line with previous studies in which digital tenderness and pain in course of PsA hand dactylitis have been reported strongly associated with flexor tenosynovitis of grade ≥2, soft tissue oedema and subcutaneous PD signal (38-40). In line with our results, previous studies have also reported significantly higher values of LDI-b, patient VAS-pain and VAS-functional score in fingers with symptomatic dac-

Table I. Prevalence of ultrasound abnormalities observed in 91 fingers dactylitis from sixty-four Psoriatic Arthritis patients in according to Leeds Dactylitis Index basic (LDI-b) score (higher or lower than the median, 12).

Variable	LDI-b <12 (47 cases)	LDI-b ≥12 (44 cases)	*p*-value
GS Flexor tenosynovitis	37 (82%)	45 (98%)	0.015
GS Flexor tenosynovitis grade ≥2	17 (38%)	33 (72%)	0.001
PD Flexor tenosynovitis	28 (62%)	42 (91%)	0.001
PD Flexor tenosynovitis grade ≥2	24 (53%)	35 (76%)	0.023
Soft tissue oedema	35 (78%)	45 (98%)	0.004
Subcutaneous PDS	37 (82%)	42 (91%)	ns
GS Extensor tendon involvement	4 (9%)	5 (11%)	ns
PD Extensor tendon involvement	3 (7%)	4 (9%)	ns
MCP GS Synovitis	9 (20%)	5 (11%)	ns
MCP PD Synovitis	4 (9%)	4 (9%)	ns
PIP GS Synovitis	21 (47%)	8 (17%)	0.003
PIP GS Synovitis grade ≥2	17 (38%)	8 (18%)	0.029
PIP PD Synovitis	12 (27%)	6 (13%)	ns
DIP GS Synovitis	6 (13%)	4 (9%)	ns
DIP PD Synovitis	2 (4%)	2 (4%)	ns

DIP: distal interphalangeal; GS: grey-scale; MCP: metacarpophalangeal; PD: power Doppler; PDS: power Doppler signal; PIP: proximal interphalangeal.

Table II. Fingers were split into quartiles based on the ratio of circumference (expressed as percentage; %). Comparison of the prevalence of ultrasound abnormalities between the 1st and 4th quartiles.

Variable	Quartile 1 (<11%) 25 fingers	Quartile 4 (>16%) 24 fingers	*p*-value
GS Flexor tenosynovitis	24 (96%)	23 (96%)	ns
GS Flexor tenosynovitis grade ≥2	13 (52%)	19 (79%)	0.046
PD Flexor tenosynovitis	20 (80%)	21 (88%)	ns
PD Flexor tenosynovitis grade ≥2	19 (76%)	21 (88%)	ns
Soft tissue oedema	21 (84%)	22 (92%)	ns
Subcutaneous PDS	23 (92%)	20 (83%)	ns
GS Extensor tendon involvement	1 (4%)	3 (13%)	ns
PD Extensor tendon involvement	1 (4%)	2 (8%)	ns
MCP GS Synovitis	5 (20%)	5 (21%)	ns
MCP PD Synovitis	3 (12%)	5 (21%)	ns
PIP GS Synovitis	6 (24%)	8 (33%)	ns
PIP GS Synovitis grade ≥2	2 (8%)	8 (33%)	0.028
PIP PD Synovitis	3 (12%)	6 (25%)	ns
PIP PD Synovitis grade ≥2	0	4 (17%)	0.033
DIP GS Synovitis	4 (16%)	3 (13%)	ns
DIP PD Synovitis	1 (4%)	2 (8%)	ns

DIP: distal interphalangeal; GS: graes-cale; MCP: metacarpophalangeal; PD: Power Doppler; PDS: power Doppler signal; PIP: proximal interphalangeal.

tylitis than the asymptomatic ones (40). LDI represents a rapid, objective and easy-to-complete scoring system for quantifying dactylitis based on digital circumference, as measured by dactylometer, and tenderness (25, 41-43). It is often used in clinical trials to measure response to therapy and it is useful to distinguish tender and non-tender dactylitis (44-47). In our study, tenderness appears to be related to extra synovial inflammatory changes and not to joint synovitis. These findings are in line with results from our previous study in which tenosynovitis and oedema showed frequent in early dactylitis phases, and synovitis showed frequent in the late ones (40).

In line with other studies in which high values of LDI score were associated with short dactylitis duration (38, 39), we also found that the highest prevalence of joint synovitis at PIP level in patients with lower LDI correlated to a long standing dactylitis phase.

With regard to digital swelling, we observed an association between increased digital circumference and presence of GS flexor tenosynovitis of grade ≥2 and joint synovitis of grade ≥2 at PIP level. Our data are also consistent with previous US (15, 18, 19) and MRI (12-14) studies in which flexor tenosynovitis has been hypothesised as a key determinant of the digital swelling, while synovitis could represent a coexisting feature.

The current study has several limitations, the major one being its cross-sectional nature. Another possible limitation is the fact that we have enrolled patients with different disease duration. We cannot exclude that in some patients the different time of evolution may have influenced the ultrasound characteristics, both in GS and in PD. Further, concerning the US examination, we have considered only the most commonly recorded abnormalities in dactylitis without considering other elements possibly involved in the genesis of symptoms, such as the lesions of volar plate, the pulleys and the extensor tendons at distal phalanx insertion. However, the study of these articular and peri-articular structures should be performed with a high frequency probe (22-24 MHz), and all of the US study scans were performed using a 6–18 MHz linear transducer.

In conclusion, this is the first report showing that high values of LDI-b score are associated with US flexor tenosynovitis and soft tissue oedema. Further, we found that the ratio of circumference is linked with flexor tenosynovitis of grade ≥2 and joint synovitis of grade ≥2 at PIP level. These findings seem to support the central role of extra-articular structures in determining the LDI value in symptomatic dactylitis.

References

1. CHIMENTI MS, CASO F, ALIVERNINI S *et al*.: Amplifying the concept of psoriatic arthritis: The role of autoimmunity in systemic psoriatic disease. *Autoimmun Rev* 2019; 18: 565-75.
2. SCARPA R, CASO F, COSTA L, PELUSO R, DEL PUENTE A, OLIVIERI I: Psoriatic disease 10 years later. *J Rheumatol* 2017; 44: 1298-1301.
3. OLIVIERI I, SCARANO E, PADULA A, GIASI V: Dactylitis involving most of the fingers. *Clin Exp Rheumatol* 2003; 21: 406.
4. BROCKBANK JE, STEIN M, SCHENTAG CT, GLADMAN DD: Dactylitis in psoriatic arthritis: a marker for disease severity? *Ann Rheum Dis* 2005; 64: 188-90.
5. GLADMAN DD, ZIOUZINA O, THAVANE-

SWARAN A, CHANDRAN V: Dactylitis in psoriatic arthritis: prevalence and response to therapy in the biologic era. *J Rheumatol* 2013; 40: 1357-9.
6. GLADMAN DD, CHANDRANV: Observational color studies: lessons learnt from the University of Toronto Psoriatic Arthritis Program. *Rheumatology* (Oxford) 2011; 50: 25-31.
7. CASO F, COSTA L, ATTENO M *et al*.: Simple clinical indicators for early psoriatic arthritis detection. *Springerplus* 2014; 3: 759.
8. TAYLOR W, GLADMAN D, HELLIWELL P, MARCHESONI A, MEASE P, MIELANTS H; CASPAR STUDY GROUP: Classification criteria for psoriatic arthritis: development of new criteria from a large international study. *Arthritis Rheum* 2006; 54: 2665-73.
9. TILLETT W, COSTA L, JADON D *et al*.: The ClASsification for Psoriatic ARthritis (CASPAR) criteria - a retrospective feasibility, sensitivity, and specificity study. *J Rheumatol* 2012; 39: 154-6.
10. GLADMAN DD: Clinical features and diagnostic considerations in psoriatic arthritis. *Rheum Dis Clin North Am* 2015; 41: 569-79.
11. GLADMAN DD, HELLIWELL P, MEASE PJ, NASH P, RITCHLIN C, TAYLOR W: Assessment of patients with psoriatic arthritis: a review of currently available measures. *Arthritis Rheum* 2004; 50: 24-35
12. OLIVIERI I, BAROZZI L, PIERRO A, DE MATTEIS M, PADULA A, PAVLICA P: Toe dactylitis in patients with spondyloarthropathy: assessment by magnetic resonance imaging. *J Rheumatol* 1997; 24: 926-30.
13. OLIVIERI I, SCARANO E, PADULA A *et al*.: Fast spin echo-T2-weighted sequences with fat saturation in toe dactylitis of spondyloarthritis. *Clin Rheumatol* 2008; 27: 1141-5.
14. HEALY PJ, GROVES C, CHANDRAMOHAN M, HELLIWELL PS: MRI changes in psoriatic dactylitis-extent of pathology, relationship to tenderness and correlation with clinical indices. *Rheumatology* (Oxford) 2008; 47: 92-5
15. OLIVIERI I, BAROZZI L, FAVARO L *et al*.: Dactylitis in patients with seronegative spondylarthropathy. Assessment by ultrasonography and magnetic resonance imaging. *Arthritis Rheum* 1996; 39: 1524-8.
16. FOURNIÉ B, MARGARIT-COLL N, CHAMPETIER DE RIBES TL *et al*.: Extrasynovial ultrasound abnormalities in the psoriatic finger. Prospective comparative power-doppler study versus rheumatoid arthritis. *Joint Bone Spine* 2006; 73: 527-31.
17. TINAZZI I, MCGONAGLE D, ZABOTTI A, CHESSA D, MARCHETTA A, MACCHIONI P: Comprehensive Comprehensive evaluation of finger flexor tendon entheseal soft tissue and bone changes by ultrasound can differentiate psoriatic arthritis and rheumatoid arthritis. *Clin Exp Rheumatol* 2018; 36: 785-90.
18. KANE D, GREANEY T, BRESNIHAN B, GIBNEY R, FITZGERALD O: Ultrasonography in the diagnosis and management of psoriatic dactylitis. *J Rheumatol* 1999; 26: 1746-51.
19. WAKEFIELD RJ, EMERY P, VEALE D: Ultrasonography and psoriatic arthritis. *J Rheumatol* 2000; 27: 1564-5.
20. ESHED I, BOLLOW M, MCGONAGLE DG *et al*.: MRI of enthesitis of the appendicular skeleton in spondyloarthritis. *Ann Rheum Dis* 2007; 66: 1553-9.
21. BAKEWELL CJ, OLIVIERI I, AYDIN SZ *et al*.: Ultrasound and magnetic resonance imaging in the evaluation of psoriatic dactylitis: status and perspectives. *J Rheumatol* 2013; 40: 1951-7.
22. TAN AL, FUKUBA E, HALLIDAY NA, TANNER SF, EMERY P, MCGONAGLE D: High-resolution MRI assessment of dactylitis in psoriatic arthritis shows flexor tendon pulley and sheath-related enthesitis. *Ann Rheum Dis* 2015; 74: 185-9.
23. WATAD A, ESHED I, MCGONAGLE D: Lessons learned from imaging on enthesitis in psoriatic arthritis. *Isr Med Assoc J* 2017; 19: 708-11.
24. RAMIRO S, SMOLEN JS, LANDEWÉ R, VAN DER HEIJDE D, GOSSEC L: How are enthesitis, dactylitis and nail involvement measured and reported in recent clinical trials of psoriatic arthritis? A systematic literature review. *Ann Rheum Dis* 2018; 77: 782-83.
25. HELLIWELL PS, FIRTH J, IBRAHIM GH, MELSOM RD, SHAH I, TURNER DE: Development of an assessment tool for dactylitis in patients with psoriatic arthritis. *J Rheumatol* 2005; 32: 1745-50.
26. HEALY PJ, HELLIWELL PS: Measuring dactylitis in clinical trials: which is the best instrument to use? *J Rheumatol* 2007; 34: 1302-6.
27. COATES L: Outcome measures in psoriatic arthritis. *Rheum Dis Clin North Am* 2015; 41: 699-710.
28. MÖLLER I, JANTA I, BACKHAUS M *et al*.: The 2017 EULAR standardised procedures for ultrasound imaging in rheumatology. *Ann Rheum Dis* 2017; 76: 1974-79.
29. NAREDO E, D'AGOSTINO MA, WAKEFIELD RJ *et al*.: Reliability of a consensus-based ultrasound score for tenosynovitis in rheumatoid arthritis. *Ann Rheum Dis* 2013; 72: 1328-34.
30. GUTIERREZ M, FILIPPUCCI E, SALAFFI F, DI GESO L, GRASSI W: Differential diagnosis between rheumatoid arthritis and psoriatic arthritis: the value of ultrasound findings at metacarpophalangeal joints level. *Ann Rheum Dis* 2011; 70: 1111-4.
31. WAKEFIELD RJ, O'CONNOR PJ, CONAGHAN PG *et al*.: Finger tendon disease in untreated early rheumatoid arthritis: a comparison of ultrasound and magnetic resonance imaging. *Arthritis Rheum* 2007; 57: 1158-64.
32. BALINT P, TERSLEV L, AERGERTER P *et al*.: Reliability of a consensus-based ultrasound definition and scoring for enthesitis in spondyloarthritis and psoriatic arthritis: an OMERACT US initiative. *Ann Rheum Dis* 2018; 77: 1730-35.
33. FILIPPOU G, DI SABATINO V, ADINOLFI A *et al*.: No enthesis should be overlooked when psoriatic arthritis is suspected: enthesitis of the extensor digitorum tendons. *J Rheumatol* 2013; 40: 335.
34. TERSLEV L, NAREDO E, AEGERTER P *et al*.: Scoring ultrasound synovitis in rheumatoid arthritis: a EULAR-OMERACT ultrasound taskforce-Part 2: reliability and application to multiple joints of a standardised consensus-based scoring system. *RMD Open* 2017; 3: e000427.
35. NAREDO E, D'AGOSTINO MA, WAKEFIELD RJ *et al*.: Reliability of a consensus-based ultrasound score for tenosynovitis in rheumatoid arthritis. *Ann Rheum Dis* 2013; 72: 1328-34.
36. D'AGOSTINO MA, TERSLEV L, AEGERTER P *et al*.: Scoring ultrasound synovitis in rheumatoid arthritis: a EULAR-OMERACT ultrasound taskforce-Part 1: definition and development of a standardised, consensus-based scoring system. *RMD Open* 2017; 3: e000428.
37. TERSLEV L, NAREDO E, AEGERTER P *et al*.: Scoring ultrasound synovitis in rheumatoid arthritis: a EULAR-OMERACT ultrasound taskforce-Part 2: reliability and application to multiple joints of a standardised consensus-based scoring system. *RMD Open* 2017; 3: e000427
38. GIROLIMETTO N, COSTA L, MANCARELLA L *et al*.: Symptomatic psoriatic dactylitis is associated with ultrasound determined extra-synovial inflammatory features and shorter disease duration. *Clin Rheumatol* 2019; 38: 903-11.
39. GIROLIMETTO N, MACCHIONI P, TINAZZI I *et al*.: Ultrasonographic evidence of predominance of acute extracapsular and chronic intrasynovial patterns in 100 cases of psoriatic hand dactylitis. *J Rheumatol* 2019 May 15 [Epub ahead of print].
40. GIROLIMETTO N, MACCHIONI P, TINAZZI I *et al*.: Predominant ultrasonographic extracapsular changes in symptomatic psoriatic dactylitis: results from a multicenter cross-sectional study comparing symptomatic and asymptomatic hand dactylitis. *Clin Rheumatol* 2019 Jul 13 [Epub ahead of print].
41. FERGUSON EG, COATES LC: Optimisation of rheumatology indices: dactylitis and enthesitis in psoriatic arthritis. *Clin Exp Rheumatol* 2014; 32: 113-7.
42. MEASE PJ: Measures of psoriatic arthritis: Tender and Swollen Joint Assessment, Psoriasis Area and Severity Index (PASI), Nail Psoriasis Severity Index (NAPSI), Modified Nail Psoriasis Severity Index (mNAPSI), Mander/Newcastle Enthesitis Index (MEI), Leeds Enthesitis Index (LEI), Spondyloarthritis Research Consortium of Canada (SPARCC), Maastricht Ankylosing Spondylitis Enthesis Score (MASES), Leeds Dactylitis Index (LDI), Patient Global for Psoriatic Arthritis, Dermatology Life Quality Index (DLQI), Psoriatic Arthritis Quality of Life (PsAQOL), Functional Assessment of Chronic Illness Therapy-Fatigue (FACIT-F), Psoriatic Arthritis Response Criteria (PsARC), Psoriatic Arthritis Joint Activity Index (PsAJAI), Disease Activity in Psoriatic Arthritis (DAPSA), and Composite Psoriatic Disease Activity Index (CPDAI). *Arthritis Res Ther* (Hoboken) 2011; 63: S64-85.
43. LEUNG YY, OGDIE A, ORBAI AM *et al*.: Classification and outcome measures for psoriatic arthritis. Fr*ont Med* (Lausanne) 2018; 5: 246.
44. GLADMAN DD, ORBAI AM, KLITZ U *et al*.: Ixekizumab and complete resolution of enthesitis and dactylitis: integrated analysis of two phase 3 randomized trials in psoriatic arthritis. *Arthritis Res Ther* 2019; 21: 38.
45. WALSH JA, GOTTLIEB AB, HOEPKEN B, NURMINEN T, MEASE PJ: Efficacy of certolizumab pegol with and without concomitant use of disease-modifying anti-rheumatic drugs over 4 years in psoriatic arthritis patients: results from the RAPID-PsA randomized controlled trial. *Clin Rheumatol* 2018; 37: 3285-96.
46. COATES LC, HELLIWELL PS: Methotrexate efficacy in the Tight Control in Psoriatic Arthritis Study. *J Rheumatol* 2016; 43: 356-61.
47. SCARPA R, CASO F: Spondyloarthritis: which composite measures to use in psoriatic arthritis? *Nat Rev Rheumatol* 2018; 14: 125-26.