

Ultrasound and Magnetic Resonance Imaging in the Evaluation of Psoriatic Dactylitis: Status and Perspectives

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ABSTRACT. Objective. Dactylitis, a characteristic feature of the spondyloarthropathies, occurs in up to 48% of patients with psoriatic arthritis (PsA). No clear consensus on the underlying components and pathogenesis of dactylitis exists in the literature. We undertook a systematic review of ultrasound (US) and magnetic resonance imaging (MRI) literature to better define imaging elements that contribute to the dactylitic digit seen in PsA. Our objectives were to determine first the level of homogeneity of each imaging modality's definition of the components of dactylitis, and second, to evaluate the metric properties of each imaging modality according to the Outcome Measures in Rheumatology Clinical Trials (OMERACT) filter.

Methods. Searches were performed in PUBMED and EMBASE for articles pertaining to MRI, US, and dactylitis. Data regarding the reported features of dactylitis were collected and categorized, and the metrological qualities of the studies were assessed.

Results. The most commonly described features of dactylitis were flexor tendon tenosynovitis and joint synovitis (90%). Extratendinous soft tissue thickening and extensor tendonitis were described nearly equally as being present and absent. Discrepancy exists as to whether entheses proper contribute to the etiology of dactylitis. An increasing number of studies categorize abnormalities in several tissue compartments including the soft tissue, tendon sheaths, and joints, as well as ligaments.

Conclusion. The understanding of which tissues contribute to dactylitic inflammation has evolved. However, there is a lack of literature regarding the natural history of these abnormalities. This systematic review provides guidance in defining elementary lesions that may discriminate dactylitic digits from normal digits, leading to development of a composite measure of activity and severity of dactylitis. (J Rheumatol First Release Nov 1 2013; doi:10.3899/jrheum.130643)

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Psoriatic arthritis (PsA) affects up to one-third of patients with psoriasis, and can be associated with significant joint destruction, decreased quality of life, and disability^{1,2,3}. Apart from axial and peripheral joint involvement, the musculoskeletal lesions in PsA consist of enthesitis, including the nail entheses complex at the distal interphalangeal joint, tendons, and ligaments; as well as soft tissue thickening, as seen in dactylitis, or "sausage"-shaped digit. To date, PsA is classified in the spondyloarthritis (SpA) complex together with primary ankylosing spondylitis, reactive arthritis, arthritis associated with inflammatory bowel disease, and forms that fail to meet criteria for definite categories, which are designated as undifferentiated SpA^{4,5}.

Dactylitis is a characteristic feature of SpA^{4,5}. It can present as a painful digit or as a relatively asymptomatic

chronically swollen digit. It occurs in 16% to 48% of subjects with PsA and can be the sole manifestation^{6,7}. Clinically, it may be defined as uniform diffuse swelling of the soft tissues of a digit so that actual joint swelling could no longer be independently recognized⁸.

Dactylitis is one of the elements of the CIASsification for Psoriatic ARthritis (CASPAR) criteria for the diagnosis of PsA⁷, underscoring the importance of dactylitis as a key feature in PsA. The feature has also been associated with the presence of erosive articular changes⁹.

The soft tissue components of dactylitis have traditionally been evaluated by clinical examination while radiographs were used to evaluate for underlying bony abnormality. Clinical evaluation and conventional radiography, however, cannot accurately define which tissue compartments are involved in a dactylitic digit. Histologic sampling of digits is not feasible, and hence new imaging techniques such as ultrasound (US) and magnetic resonance imaging (MRI) are used to examine multiple soft tissue compartments, as well as their vascularity¹⁰. MRI sheds light on the pathogenesis of dactylitis by visualizing both soft tissue and bone marrow edema using multiplanar views. However, its use is limited by high cost as well as the risks associated with the use of gadolinium contrast in patients with impaired renal function. US is an imaging technique that uses nonionizing radiation and allows for multiple target assessment in real time. It is highly portable and cost effective¹¹. It offers a higher lateral resolution than MRI¹² and has the additional benefit of examining blood flow using Doppler techniques, avoiding the use of contrast. The use of US and MRI in daily practice and clinical trials may be evaluated by using the metric qualities of the Outcome Measures in Rheumatology Clinical Trials (OMERACT) filter¹³.

The objective of our study was to systematically review the literature regarding the use of US and MRI to define imaging elements that contribute to the dactylitic digit seen in PsA. Our review will first determine the level of homogeneity of each imaging modality's definition of the components of dactylitis, and second, evaluate the metric properties of each imaging modality according to the OMERACT filter.

MATERIALS AND METHODS

Search strategy and study selection. We searched for original articles concerning humans, published between January 1985 and December 2012, and referring to the use of MRI and/or ultrasonography in the evaluation of PsA dactylitis using PUBMED and EMBASE databases. For ultrasonography, the following search terms were used: "sonography and psoriatic arthritis", "ultrasound and arthritis and psoriasis", "sonography and dactylitis", "sonography and enthesitis and psoriasis", "ultrasound and dactylitis and psoriasis", "ultrasound and enthesitis and psoriasis", "ultrasound and dactylitis", and "Olivieri and dactylitis". A separate search for Doppler was performed with the following search terms: "doppler and psoriatic arthritis", "doppler and dactylitis", and "doppler and dactylitis and psoriatic arthritis". For MRI, all articles were assessed that appeared using

the search terms "psoriasis and digit", "psoriasis and digit and magnetic resonance imaging", "psoriatic arthritis and digit and magnetic resonance imaging", "magnetic resonance imaging and dactylitis", and "psoriatic arthritis and magnetic resonance imaging and dactylitis". Hand search by 1 author (GK) yielded 1 more article selected for review in the MRI category¹⁴.

Only references with abstracts available in English were included. Titles, abstracts, and full reports of articles identified were systematically screened by 2 authors (CB and GK) with regard to inclusion and exclusion criteria. The final results, number of articles selected for review, and numbers excluded by category are available from the authors.

Data extraction. All data were extracted from the selected articles using a standardized spreadsheet, based upon a template previously developed and validated for systematic reviews^{15,16}. Only original literature was included. All selected articles were assessed for definitions of dactylitis and its elementary components as evidenced by US or MRI modalities, and the validity and reliability of the studies was evaluated according to the OMERACT filter. Particular attention was paid to the following: (1) Was the definition of dactylitis clearly stated, as well as the definition of each elementary component? (2) Was there an adequate description of the US or MRI technique? (3) Were data regarding the components of dactylitis gathered in a quantitative or qualitative manner? (4) Was there an attempted blinding of observers? (5) Was there any assessment of interreader or intrareader reliability? (6) What was the comparator to the findings of the imaging technique?

Evaluation methods. Face validity, construct validity, criterion validity, reliability, and responsiveness of each article were evaluated according to the OMERACT filter¹³. Face validity was defined as the overall credibility of the article; i.e., whether a measure appears to measure what it is supposed to. The studies were evaluated for alterations in digital tissue compartments that could be affected in dactylitis. If available, images were also reviewed for consistency and quality. Construct validity was defined as the consistency of a measure with theoretical concepts, e.g., US or MRI measures of dactylitis as related to other clinical subjective or objective measures of dactylitis. Criterion validity was determined based upon whether the measure truly reflected a gold standard, e.g., tissue pathology or another imaging modality, such as MRI to US. Reliability was defined based upon whether the measure was reliable across occasions. Responsiveness was evaluated by the ability of the tool to detect change, usually in response to an intervention. Descriptive statistics were then applied to the results, reported as frequencies and percentages for categorical variables. Each study was evaluated independently by GK and CB and consensus scoring was reached.

RESULTS

US study characteristics. Of the 204 articles produced by PUBMED searches, only 4 met the criteria for inclusion in our study as being relevant to the ultrasonographic evaluation of psoriatic dactylitis^{17,18,19,20}, excluding case reports and reviews (data available from the authors)¹⁴. All 4 were case series, 2 comparing psoriatic and rheumatoid patient populations, and 2 focusing solely on the dactylitis seen in PsA. Sample sizes ranged from 10 to 20 patients and 12 to 25 digits, with lesion frequency reporting at the digital rather than patient level (Table 1).

MRI study characteristics. Of the 50 articles produced by PUBMED searches, only 5 met criteria for inclusion in our study as being relevant to the MRI evaluation of psoriatic dactylitis^{14,20,21,22,23,24}, excluding case reports and reviews. One article was located by hand search by (GK) and included for review (data available from the authors)¹⁴. Of

Table 1. Characteristics of the reviewed articles.

Year	Authors	Type of Article	Sample Size (Patients)	Sample Size (Digits)	Population of Interest	Face Validity
Ultrasound						
2006	Fournie	Case series	20	25*	PsA vs RA	Y
2006	Ribes	Case series	17	20*	PsA vs RA	Y
1999	Kane	Case series	17	25*	PsA with dactylitis	N
1996	Olivieri	Case series	10	12*	PsA with dactylitis	Y
MRI						
2008	Healy	Case series	17	23*	PsA with dactylitis	Y
2008	Olivieri	Case series	10	12*	SpA with dactylitis	P
2002	Olivieri	Case series	6	11*	SpA with dactylitis	N
1997	Olivieri	Case series	7	12*	SpA with dactylitis	P
1996	Olivieri	Case series	10	12*	PsA with dactylitis	Y
1995	Jevtic	Case series	2	2	PsA, RA, reactive arthritis	Y

* Denotes level of analysis. P: partial; PsA: psoriatic arthritis; SpA: spondyloarthritis; MRI: magnetic resonance imaging; RA: rheumatoid arthritis.

the 6 selected articles, all were case series with sample sizes ranging from 2 to 17 patients or 2 to 23 digits, with lesion frequency reporting at the digital rather than patient level (Table 1). Two studies focused specifically on dactylitis of the toe^{22,24}, while the remaining focused either on a combination of toes and fingers, or fingers exclusively¹⁹.

US measures and setting. All of the included studies described the US machine and transducer frequency used, and these ranged from 7.5 to 13.5 MHz, with 2 more recent studies using the higher frequency probe (more appropriate for imaging superficial structures at higher resolution)^{17,19}. Only 50% of the articles examined were felt to have adequately described their methods based upon presence of both longitudinal and transaxial imaging^{18,20}. There was limited technical information regarding Doppler settings, such as pulse repetition frequency or gain settings in either greyscale or Doppler mode^{17,18,19,20}.

MRI measures. All of the studies included described the MRI machine and magnet strength. Machines ranged from a 0.5 Tesla magnet to 2.35 T, the most powerful magnet strength being used only in the earliest MRI paper from 1995¹⁴. Slice thickness ranged between 3 and 7 mm. Only 33% of studies analyzed included adequate information on patient positioning^{20,23}. Oliveri, *et al* controlled for patient position by using a foam block placed in between the hands in prayer position^{20,23}. Other studies did not use any strategies to ensure consistent patient position, which is important because the apparent digital thickness can be affected by the degree of flexion of the digit.

Description of elementary lesions found in dactylitis. With the exception of the article by Jevtic, *et al*¹⁴, the initial MRI and sonographic studies seemed to report mainly flexor tenosynovitis and synovitis in digits with dactylitis. However, later studies reported involvement of an expanded number of tissue compartments^{17,19,21,22,23}.

Table 2 summarizes involvement of elementary tissue compartments in both US and MRI techniques. In both

imaging modalities, the most commonly described features of dactylitis were flexor tendon tenosynovitis and joint synovitis (90%). One study using both MRI and US modalities specifically commented on the absence of synovitis in their examined cohort on US, since it failed to reveal the 1 distended joint capsule visualized on MRI^{20,25}. Jevtic, *et al*¹⁴ did not comment on the presence or absence of flexor tenosynovitis on MRI examination of the 2 dactylitic fingers they describe in detail. Soft tissue thickening (extra-tendinous) was described equally frequently as being present (30%) and absent (30%), although it should be noted specifically that the earlier studies by Olivieri found a lack of soft tissue thickening, and the author has subsequently conceded this may be due to the limitations of US and MRI at that time²⁵. Nearly equal numbers also reported on the presence (30%) and absence (20%) of extensor tendon thickening or inflammation. Bone edema, which can only be seen on MRI, was also found to be present and absent in equal numbers of studies (33.3%). Less commonly described features included collateral ligament inflammation (20%) and plantar/palmar plate enhancement (10%), only seen in the MRI studies. Sesamoid abnormalities (consisting of bone unevenness or irregularity) were described in 2 US studies^{17,20} and sesamoiditis was described in 1 MRI study²¹.

Only 50% of the US studies used the Doppler mode to evaluate for hyperemia or tissue inflammation, and only 33.3% of MRI studies used gadolinium (Table 3). Of these, the most commonly identified abnormalities include soft tissue edema and joint synovitis (75% each), followed by increased signal at the site of extraarticular osteoproliferation (50%). One study each commented on the presence of increased signal at the flexor tendons (US)¹⁹, nail matrix (US)¹⁷, intraarticular osteoproliferation (US)¹⁹, collateral ligaments, and bone edema (MRI)¹⁴. None of the studies commented on increased signal in erosions or in the adjoining tissue.

Table 2. Ultrasound/MRI definition of dactylitis or of its elementary components demonstrated by study.

	Ultrasound					MRI				
	2006	2006	1999	1996	2008	2008	2002	1997	1996	1995
Year	2006	2006	1999	1996	2008	2008	2002	1997	1996	1995
Author	Fournie	Ribes	Kane	Olivieri	Healy	Olivieri	Olivieri	Olivieri	Olivieri	Jevtic
Definition or description of dactylitis	NA	Y [†]	Y	Y	Y	Y	Y	Y	Y	NA
Probe frequency (MHz)/slice thickness	13.5	13.5	7–10	7.5	NA	3–5 mm	3–5 mm	3–7 mm	3–7 mm	3 mm
Elementary components										
Soft tissue thickening	Desc	NA	Desc	Meas*	NA	NA	NA	Meas*	Meas*	Desc
Soft tissue edema	Desc	NA	NA	NA	Desc	Desc	Desc	Desc	NA	NS
Flexor tendon tenosynovitis	Desc	Desc	Meas	Meas	Desc	Desc	Desc	Meas	Meas	NA
Extensor tendon inflammation, thickening	NA	NA	NA	Meas*	Desc	Desc	NA	Meas	Meas*	NA
Nail plate abnormalities	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nail bed/matrix abnormalities	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Joint synovitis	Desc	Desc	Desc	Desc*	Desc	Desc	Desc	Desc	Desc	Desc
Bone-extraarticular osteoproliferation	Desc	Desc	NA ⁺	NA	NA	NA	NA	NA	NA	NA
Bone-intraarticular osteoproliferation	Desc	Desc	NA	NA	NA	NA	NA	NA	NA	NA
Erosions	Desc	Desc	NA [‡]	NA	Desc	NA	NA	NA	NA	NA
Collateral ligament abnormalities	NA	NA	NA	NA	Desc	NA	NA	NA	NA	Desc
Bone edema	NA ^{††}	NA ^{††}	NA ^{††}	NA ^{††}	Desc	Desc*	Desc	NA	NA	Desc*
Sesamoid abnormalities/sesamoiditis	Desc	Desc	NA	NA	Desc	NA	NA	NA	NA	NA
Plantar/palmar plate abnormalities	NA	NA	NA	NA	Desc	NA	NA	NA	NA	NA

* Feature not found, but specifically searched for and absence mentioned in article. [†] Dactylitis defined by synovitis, although authors later comment on presence of sausage morphology in each PsA patient. ⁺ Comment of bone periostitis on radiograph only. [‡] Erosions examined/quantified on radiograph only. ^{††} Ultrasound unable to assess changes beneath the bone cortex. Desc: qualitatively described; Meas: measured/quantified; NA: not available; MRI: magnetic resonance imaging.

Table 3. Reporting of tissue-specific vascularity in Doppler-mode or post-gadolinium. Elementary components of dactylitis in Doppler-mode or post-contrast demonstrated by study.

	Ultrasound					MRI				
	2006	2006	1999	1996	2008	2008	2002	1997	1996	1995
Year	2006	2006	1999	1996	2008	2008	2002	1997	1996	1995
Author	Fournie	Ribes	Kane	Olivieri	Healy	Olivieri	Olivieri	Olivieri	Olivieri	Jevtic
Doppler measures	NA	NA*	NA	NA	—	—	—	—	—	—
Elementary components										
Soft tissue edema	Desc	Desc	NA	NA	Desc	NA	NA	NA	NA	NS
Flexor tendon tenosynovitis	NA	Desc	NA	NA	NS	NA	NA	NA	NA	NA
Extensor tendon inflammation, thickening	NA	NA	NA	NA	NS	NA	NA	NA	NA	NA
Nail plate abnormalities	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nail bed/matrix abnormalities	Desc	NA	NA	NA	NA	NA	NA	NA	NA	NA
Joint synovitis	Desc	Desc	NA	NA	NS	NA	NA	NA	NA	Desc
Bone-extraarticular osteoproliferation	Desc	Desc	NA	NA	NA	NA	NA	NA	NA	NA
Bone-intraarticular osteoproliferation	NA	Desc	NA	NA	NA	NA	NA	NA	NA	NA
Erosions	NA	NA	NA	NA	NS	NA	NA	NA	NA	NA
Collateral ligament abnormalities	NA	NA	NA	NA	NS	NA	NA	NA	NA	Desc
Bone edema	NA [†]	NA [†]	NA [†]	NA [†]	NS	NA	NA	NA	NA	Desc
Sesamoiditis	NA	NA	NA	NA	NS	NA	NA	NA	NA	NA
Plantar/palmar plate abnormalities	NA	NA	NA	NA	NS	NA	NA	NA	NA	NA

* Did specify that PRF was constant, and that the room was kept at a constant temperature. No gain or PRF number given. [†] Ultrasound unable to assess changes beneath the bone cortex. Desc: qualitatively described; Meas: measured/quantified; NA: not available; NS: not specified (STIR vs gadolinium); MRI: magnetic resonance imaging.

Evaluation of studies according to the OMERACT filter. Table 4 summarizes the characteristics of the selected studies according to the OMERACT filter.

Truth. The only article found to have adequately reported the face, construct, and criterion validity of its conclusions

was by Olivieri, *et al*²⁰. However, because of technological advancements since that time, some of the conclusions may no longer be valid.

Of the US-focused body of literature, 3 of the papers had face validity^{17,19,20}; however, 1 article had equivocal face

Table 4. Analysis of each article according to the metrics of the OMERACT filter.

Year	Authors	Blinded Design	Reliability	Construct Validity	Criterion Validity	Comparator	Responsiveness
Ultrasound							
2006	Fournie	N	NA	Y	NA	Radiographs, clinical	NA
2006	Ribes	N	NA	Y	NA	Radiographs, clinical	NA
1999	Kane	N	NA	Y	NA	Radiographs, clinical	NA
1996	Olivieri	Partial	NA	Y	Y	MRI, clinical	NA
MRI							
2008	Healy	Partial	NA	Y	NA	Clinical	NA
2008	Olivieri	Partial	NA	Y	NA	Clinical	NA
2002	Olivieri	Partial	NA	Y	NA	Clinical	NA
1997	Olivieri	Partial	NA	Y	NA	Clinical	NA
1996	Olivieri	Partial	NA	Y	Y	Clinical, US	NA
1995	Jevtic	N	NA	NA	NA	NA	NA

NA: not available; US: ultrasound; OMERACT: Outcome Measures in Rheumatology Clinical Trials; MRI: magnetic resonance imaging.

validity¹⁸. Kane, *et al*¹⁸ reported measurements of flexor tenosynovitis (defined as a hypoechoic zone encircling the tendon) at the level of the metacarpophalangeal, where inadvertent inclusion of the A1 pulley would be likely, and this was not addressed in the body of the paper. However, US technology has advanced significantly since 1999, and likely discernment of that fine of a structure would have been difficult at that time. It is also worth mentioning that the figures included in the paper clearly demonstrated flexor tenosynovitis and we found the remainder of the methods/conclusions to be valid.

Of the body of literature focusing on MRI, 3 of the 6 had unequivocal face validity^{14,20,21}. Earlier studies may have been limited by the available technology, such as the Olivieri articles^{20,24}. Slice thickness was reported to be as high as 7 mm, which for a digit, can exclude a considerable amount of important data. The authors do comment on this limitation in their discussion²³. A unique measurement technique was used: to subtract tendinous sheath distance from the bone-to-skin distance to give a measurement of extratendinous soft tissue thickness. This was found to be less in the dactylitic digit, perhaps because of compression caused by the tenosynovitis. However, extensor tendon synovial sheath thickness was measured²⁴, but current anatomical understanding is that the extensor tendons of the hand have no synovial sheath. Therefore, it may be that abnormal soft tissue was misinterpreted as tenosynovitis. Lastly, although all patients were diagnosed with SpA by Amor criteria, their distinct subsets were not described (e.g., psoriatic vs reactive arthritis). Olivieri, *et al*²⁴ do, however, comment that the majority of the patients were diagnosed with PsA, but discrimination for the purpose of analysis would have been desirable. Owing to the paucity of data available in this field, they were included for the purposes of our study and do contribute considerably to our understanding of the phenomenon of dactylitis.

Discrimination. No studies available evaluated the reliability or responsiveness of their imaging techniques.

Feasibility. None of the papers analyzed reported information about feasibility of examining dactylitis using MRI or US. Specifically, data regarding the amount of time and expense necessary to complete the evaluation is lacking.

DISCUSSION

This systematic review of dactylitis included both US and MRI modalities to comprehensively evaluate published evidence of the extent of inflammation or tissue alteration in digits. However, we note that there is a significant body of work by McQueen, *et al*²⁶ and Ostergaard, *et al*²⁷ (in conjunction with the OMERACT MRI in inflammatory arthritis group) focusing on the development of a scoring system for MRI evaluation of peripheral psoriatic arthritis, which was not included in our review. These studies did not specifically evaluate patients with dactylitis, but rather included them in the data gathered on patients with peripheral PsA manifestations, including those with clinically isolated synovitis. The PsA MRI score (PsAMRIS) is an excellent model for the development of a composite scoring system, with emphasis on interreader and intrareader reliability data, and should be emulated in the study of dactylitis by both MRI and US modalities^{26,27,28}.

Early MRI and US studies suggested that the physical appearance of dactylitis was due to flexor tenosynovitis^{20,29,30}. Olivieri, *et al* demonstrated increased bone-to-skin distance at the midpoint of the palmar surface of the proximal phalanx by MRI and US²⁰. However, in that early study of dactylitic fingers, it was noted that the flexor tendon tenosynovitis contributed the most to this soft tissue expansion. These studies did not use Doppler in the sonographic examinations or gadolinium contrast in the MRI examinations. In addition, the dactylitic fingers were not classified as being tender or nontender. These studies also reported coexisting joint synovitis, the frequency of which varied from 16% to 52%^{18,20,30}, leading the authors to conclude that synovitis was not a necessary component of the clinical appearance of dactylitis. Thus, the early reports

of studies using advanced imaging to study dactylitis suggested that flexor tenosynovitis was a major contributor to the physical appearance of dactylitis.

The view that flexor tenosynovitis is a major contributor to the clinical phenomenon of dactylitis was challenged in an early hypothesis paper by McGonagle, *et al* in which they argued that flexor tendon tenosynovitis occurs frequently in rheumatoid arthritis (RA), but dactylitis is not seen³¹. They further proposed that the diffuse circumferential thickening of dactylitis could be related to inflammatory epicenters located at several digital enthesal insertions, not only resulting in synovitis and tenosynovitis, but extensive soft-tissue swelling outside the joint capsule. This was later formalized as a “functional enthesis” concept³².

Jevtic, *et al* first reported extracapsular inflammation detected in 2 PsA subjects with dactylitis when examined with MRI using gadolinium contrast¹⁴. There have been several imaging studies lending support to the altered view of dactylitis. Olivieri, *et al*²³ studied subjects with dactylitis secondary to SpA with fast spin echo T2-weighted sequences. No evidence of enthesal involvement of the flexor digitorum tendons was seen. However, the MRI slices may have been too thick²³. In a prospective sonographic study of fingers of 25 subjects with RA and 25 subjects with PsA, Fournie, *et al* demonstrated extrasynovial abnormalities solely in subjects with PsA¹⁷. Both groups revealed evidence of synovitis and tenosynovitis. Soft tissue changes reported by subjects with PsA included diffuse soft tissue thickening in the digit and, in a minority, finger pad thickening. Doppler signal was documented in 2 of 3 fingers with digital pad inflammation. Pseudotenosynovitis, defined as diffuse digit swelling in the absence of sonographic signs of tenosynovitis, was also reported in a small number of subjects. Extraarticular bone changes were also found only in the PsA group. Juxtaarticular periosteal reaction was seen in 12 fingers, 5 of which also had concurrent Doppler signal. Fine capsular bony spicules were also seen in 5 fingers of PsA subjects, as well as sesamoid bone unevenness in 2 fingers. Finally, sonographic signs of enthesitis were seen at the attachment of the flexor profundus tendon, in contrast to the MRI studies by Olivieri, *et al*^{20,22}. In a later MRI study of dactylitic toes by Olivieri, *et al*, flexor tendon enthesitis was again not seen, but diffuse peritendinous edema was noted frequently²². Another study demonstrated several features of enthesopathy in dactylitis, including joint capsule calcification, hypoechogenicity at the insertion of the flexor profundus tendon with associated calcium deposit, and irregular bony contour at this site of insertion (referred to by the authors as “ghost” aspect, since the cortex was difficult to visualize)¹⁹. Further support to viewing dactylitis as enthesitis came from a 1.5T gadolinium-enhanced MRI study of dactylitic digits of 17 subjects with PsA²¹. This was the only study that differentiated imaging findings based upon whether the affected

digit was tender. Widespread circumferential soft tissue edema was demonstrated in dactylitic fingers. These changes, in a milder fashion were also noted in subjects without tender dactylitis. Although synovitis and tenosynovitis occurred in subjects with and without tenderness, bone edema especially after contrast was reported to be more frequent in digits that were tender.

There is mounting evidence that dactylitis may be caused by inflammation of multiple structures in the fingers and not just by flexor tenosynovitis and synovitis^{17,19,21,22,23}.

Although dactylitis is a key feature of PsA, a great deal still needs to be learned about its pathophysiology. There are relatively few studies examining dactylitis, and there appear to be no longitudinal data available. It remains unclear whether nontender dactylitis represents a burned-out phase of the disease process. It is also not clear as to which therapeutic agents are the most effective for dactylitis. Our systematic review identifies several candidate elementary digital tissue areas that may be involved in dactylitis, and which may be used for further imaging studies of dactylitis (Table 2). We conclude that significant work still needs to be done in the field of dactylitis imaging to better understand its elementary components, to develop a core set of elementary lesions that can discriminate dactylitic from normal digits, and to develop a composite measure of activity and severity. Because dactylitis is not only a defining aspect of PsA (CASPAR criteria)⁷, but can be its sole manifestation as well^{6,7}, the development of an imaging composite measure would have significant implications for clinical trials as well as patient care in the diagnosis and monitoring of treatment of patients having this disease.

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