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Invited Review

Ultrasound in the Evaluation of Dactylitis and Enthesitis in Psoriatic Arthritis

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Abstract

Dactylitis is a clinical concept that corresponds to the swelling of the whole finger or toe giving a sausage appearance. Although it can be observed in different diseases, it is a distinctive clinical feature of psoriatic arthritis and is associated with a poor prognosis. Ultrasound has made it possible to improve our understanding of the pathogenesis of psoriatic arthritis dactylitis, identifying associated structural alterations, namely, flexor tenosynovitis, subcutaneous tissue edema, pulley inflammation with thickening and intra-pulley Doppler signals, extensor paratenonitis, synovitis, pericapsular bone formation, and flexor enthesitis. Given its complexity, a consensus has yet to be reached on an ultrasound-based definition of dactylitis. In addition, enthesitis is one of the characteristic features of spondyloartritis. Enthesitis, like dactylitis, is among the clinical manifestations in the Assessment of SpondyloArthritis international Society classification criteria for both axial and peripheral spondyloartritis and is a key feature for classifying psoriatic arthritis with the Classification criteria for Psoriatic Arthritis criteria. Ultrasonography is a very useful tool for exploring the enthesis. We have a good sonographic definition, although ultrasound findings do not always allow us to differentiate between mechanical or inflammatory lesions. Elementary lesions that characterize enthesopathy are hypoechogenicity at the enthesis, thickened enthesis, calcification/enthesophyte at enthesis, erosion at enthesis, and Doppler signal at enthesis. Different composite indices have been proposed in order to classify spond yloarthropathies. This article reviews the evaluation of dactylitis and enthesitis from the sonographic perspective.

Keywords: Ultrasound, dactylitis, enthesitis

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Dactylitis

The diagnosis of dactylitis is primarily clinical; the condition is defined as the diffuse uniform swelling of an entire digit, resulting in a sausage-like appearance.

It is a clinical feature that is specific to spondyloarthritis (SpA) and in particular, psoriatic arthritis (PsA). It can, however, occur in other conditions[1] including diseases associated with crystal deposition such as gout, rheumatoid arthritis (RA), sarcoidosis, mycobacterial (tuberculosis) or bacterial (syphilis) infections, and blood disorders such as sickle-cell disease, and even as a paraneoplastic manifestation.[2]

The prevalence of dactylitis in PsA ranges from 16% to 49%,[3] and it may occur as an initial sign or recurrently over the course of the disease. It tends to be asymmetric, is more common in the feet, though may appear in the hands, and can involve several digits at the same time. It may develop with numerous signs of inflammation and cause symptoms, what is called "hot" dactylitis, or be associated with few symptoms, and in this case, it is referred to as "cold" dactylitis. Further, it may be acute or chronic.[4]

Dactylitis has a notable involvement in SpA, being among the Assessment of SpondyloArthritis international Society (ASAS) classification criteria for axial and peripheral SpA (ASpA and PSpA, respectively). In the relation to PsA, it is included in the Classification Criteria for Psoriatic Arthritis (CASPAR).[5] Further, it should be considered a poor prognosis factor, given that it has been associated with radiological progression and greater structural damage,[6] and it is also considered an independent predictor of cardiovascular morbidity.[7] All these factors should be taken into account in our approach to its management and treatment.

The pathogenesis of dactylitis is not fully understood, although our understanding of this condition has advanced considerably thanks to new imaging techniques such as magnetic resonance imaging (MRI) and

ultrasound, which have enabled us to identify the structures involved.

In this study, we will review the structures involved in dactylitis, focusing on ultrasound as the imaging technique.

Clinical and Research Consequences

Technical Characteristics of Ultrasound

Ultrasound imaging, a technique that does not involve exposure to radiation and is easy to perform, allows us to study various different structures involved in PsA (joints, tendons, entheses, nails, and skin) at the same time. Assessments can be performed at rest or while these structures are in motion, which is not possible with other imaging techniques, such as MRI. Ultrasound machines tend to be portable, and the technique is widely available, does not require the use of a contrast agent, and is cost-effective. Further, it can be used to guide minimally invasive interventions for both diagnostic and therapeutic purposes. In contrast, MRI is more expensive, requires a contrast medium (gadolinium), and is less widely available, though it does allow us to assess all soft tissues, and also subchondral bone, which cannot be assessed with ultrasound.

To properly assess dactylitis with ultrasound, the use of 7.5-13.5 MHz[8] probes has been recommended, although recent publications recommend the use of frequencies as high as 22 MHz to improve the resolution for imaging the pulleys.[9] B-mode (greyscale) or power-Doppler images should be obtained from both longitudinal and transverse scans of each structure of interest.

Anatomical Structures Involved in Dactylitis

In the past, before ultrasound and MRI became available, it was believed that sausage digit was the result of arthritis in the same digit in metacarpophalangeal and proximal and distal interphalangeal joints simultaneously (Table 1). With the introduction of ultrasound and MRI, this idea was discarded and the attention turned to the flexor tendon (Figures 1-3).

In 1996, Olivieri *et al*[10] proposed that the structure responsible for dactylitis was the flexor tendon, digital flexor tenosynovitis being observed on greyscale images with or without Doppler signals. The Outcome Measures in Rheumatology (OMERACT) Ultrasound Task Force[11] defined tenosynovitis as "abnormal anechoic and/or hypoechoic (relative to tendon fibers) tendon sheath widening which can be related to both the presence of tenosynovial abnormal fluid and/or hypertrophy." In dactylitis, this was considered to be the key finding, alone or in combination with synovitis in several digital joints.

Table 1. Structures Involved in Dactylitis of Psoriatic Arthritis

Digital flexor tenosynovitis
Soft-tissue edema, pseudotenosynovitis
Thickness of the pulleys A1, A2, A4
Digital extensor paratenonitis
Synovitis
Flexor enthesitis
Pericapsular bone formation

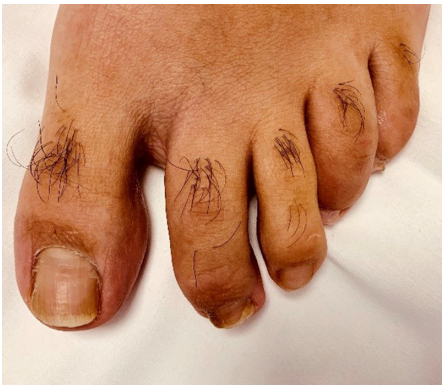

Figure 1. Dactylitis of the second and fourth toe and onycopathy.

On the other hand, digital flexor tenosynovitis had also been observed in RA and it did not have the same appearance. In fact, in 2006, Fournié[12] reported that dactylitis in PsA involves changes in structures other than those altered in RA, including periosteal reactions, capsular enthesophytes, enthesophytes on the distal phalanx, and soft tissue thickening, defining these as extrasynovial ultrasound findings. Later, Tinazzi et al[13] confirmed these results, strengthening the view that extrasynovial findings are characteristic of PsA.

Recently, Tinazzi[14] studied soft-tissue edema in dactylitis, described as peritendinous edema of the flexor tendon and pseudotenosynovitis in other studies, seeking to produce a consensus-based definition and develop a scoring system to quantify it. The final definition agreed upon was "abnormal hypoechoic/anechoic areas, diffused or localized within the subcutaneous tissue between the epidermis and the tendon-related anatomic structures (i.e., flexor tendon sheath, peritenonium, tendon pulleys), with local thickening, with or without local abnormal Doppler signal, visualized in 2 perpendicular planes." These authors also propose scoring systems for grading this condition: a semiquantitative greyscale score considering the edema signal intensity and the phalanges involved and a Doppler score based on the presence of Doppler signals and the phalanges involved, both scores ranging from 0 to 3.

Girolimetto et al[15] investigated the relationship between tenosynovitis and soft-tissue edema involvement and found that symptoms in terms of local pain were associated with flexor tenosynovitis of ≥greyscale grade 2 and subcutaneous power Doppler signal from tissue edema. On the other hand, in asymptomatic dactylitis, there was a higher prevalence of joint synovitis. In another study, the same

Main Points

- Dactylitis is a distinctive clinical feature of psoriatic arthritis (PsA), though not pathognomonic for this type of arthritis, and it has implications for the management and treatment of the condition given that it is associated with a poor prognosis in terms of structural damage and cardiovascular morbidity.
- Ultrasound has made it possible to improve our understanding of the pathogenesis of PsA, identifying associated structural alterations, namely, flexor tenosynovitis, subcutaneous tissue edema with or without a Doppler signal, pulley inflammation with thickening and intra-pulley Doppler signals, extensor paratenonitis, synovitis, pericapsular bone formation, and flexor enthesitis.
- Extracapsular involvement (pulleys, peritendinous edema of the flexor tendon, and extensor paratenonitis) is highly specific for PsA, contributing to its diagnosis. Given its complexity, a consensus has yet to be reached on an ultrasound-based definition of dactylitis.
- Enthesitis is one of the characteristic features of spondyloartritis. The clinical examination of enthesitis is difficult and has a low sensitivity.
- Madrid Sonographic Enthesitis Index (MASEI) is the main validated sonographic score for the evaluation of enthesis. The ultrasound working group of the Catalan Society of Rheumatology group evaluated the interobserver reliability of MASEI. They found a small variability in the results of the validation of the MASEI index when the different observers are well trained.

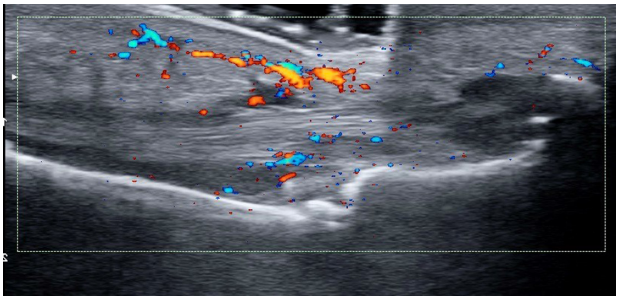

Figure 2. Ultrasound longitudinal view of the second flexor of the toe fluid and synovial thickening within the tendon sheath. There is power Doppler signal inside the sheath and surrounding the soft tissue.

group also related flexor tenosynovitis, peritendinous edema, and subcutaneous power Doppler signal with local pain and dactylitis duration.[16]

There is growing recognition of the importance of digital pulleys in the diagnosis and pathogenesis of PsA, with these structures acquiring a distinctive appearance. Pulleys are fibrocartilaginous structures that keep the flexor tendons close to the bone during flexion and withstand great biomechanical stress. Using MRI, Tan et al[17] demonstrated their relationship with dactylitis, coining the term "digital polyenthesitis." Tinazzi et al[9] focused their ultrasound analysis on pulleys A1, A2, and A4 and found that the thickness of these pulleys is greater in patients with PsA than in those with RA ($P < .001$ and $P = .003$) or healthy controls ($P < .001$); the increase in thickness is mostly marked in A1 and in digits that have or have had dactylitis. A second study by the same research group assessed intra-pulley Doppler signals and found an active involvement of pulley inflammation in the inflammatory process of dactylitis in PsA. Confirming their hypothesis, the authors concluded that clinically active dactylitis, regardless of its duration or the symptoms, is associated with an intra-pulley Doppler signal.[18]

Another potential ultrasound finding, though it does not seem to be so important in the pathogenesis of dactylitis, is extensor paratenonitis, defined as the presence of greyscale hypoechoic swelling around digital extensor tendons, in combination with subcutaneous edema.[19]

In conclusion, dactylitis is a distinctive clinical feature of PsA, though not pathognomonic for this type of arthritis, and it has implications for the management and treatment of the condition given that it is associated with a poor prognosis in terms of structural damage and cardiovascular morbidity. Ultrasound has made it possible to improve our understanding of the pathogenesis of PsaA, identifying associated structural alterations, namely, flexor tenosynovitis, subcutaneous tissue edema with or without a Doppler signal, pulley inflammation with thickening and intra-pulley Doppler signals, extensor paratenonitis, synovitis, pericapsular bone formation, and flexor enthesitis.Extracapsular involvement (pulleys, peritendinous edema of the flexor tendon and extensor paratenonitis) is highly specific for PsA, contributing to its diagnosis. Given its complexity, a consensus has yet to be reached on an ultrasound-based definition of dactylitis. Such a definition would be useful for future research assessing response of this condition to new treatments. On the other hand, the identification of the structures involved already makes it possible to carry out guided interventions for both diagnostic purposes, such as synovial fluid analysis, and therapeutic purposes, such as glucocorticoid injections, earlier and more accurately.

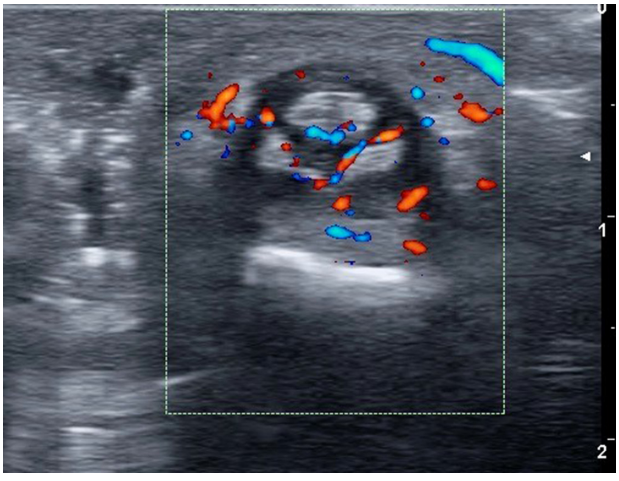

Figure 3. Ultrasound transversal view demonstrates tenosynovitis with power Doppler signal inside the tendon sheath and the surroundings.

Enthesitis

Entheses are sites of attachment of tendons, ligaments, or capsules to bones, and their function is to transmit mechanical stresses from these structures to the bones to which they are attached. Benjamin et al[20] described 2 types of entheses: (a) fibrous entheses, in which fibers attach directly to the bone and (b) fibrocartilaginous entheses, in which there is also a band of fibrocartilage in the region of bone attachment. The latter seems to be targeted by SpA. In 2001, the concept of an "enthesis organ" emerged, based on the fact that these structures are composed of zones of different types of tissue: fibrous tissue, calcified fibrocartilage, uncalcified fibrocartilage, and subchondral bone.[21] In any case, the mechanical stress on these insertion sites involves not only the enthesis itself but also the surrounding tissues. This implies that ultrasound findings of interest are not just those in the tendinous area of the enthesis but also those in the soft tissue and the bone surrounding the junction. Moreover, in some of these, synovial bursae are formed to reduce friction and the inflammatory process also affects these, together with peritendinous fat. This is what has been called the synovio–entheseal complex, and it is a key structure for understanding inflammatory findings in SpA.[22]

There is still no consensus on the definition of enthesitis, with differences depending on whether we consider clinical features or apply imaging criteria.[23,24] We use the term "enthesopathy" when there is structural damage, regardless of whether it is caused by mechanical, metabolic, or inflammatory problems, and the term "enthesitis" exclusively for inflammatory processes.

Enthesitis is one of the characteristic features of SpA. As mentioned earlier, the clinical examination of enthesitis is difficult and has a low sensitivity. For this reason, the reported prevalence

ranges widely from 10% to 60%, depending on the study.[25] Specifically, clinical enthesitis is detected in 35% of patients with PsA, the most common sites are the insertion of the Achilles tendon and the plantar fascia, as well as the lateral epicondyles.[26] Enthesitis, like dactylitis (as noted above), is among the clinical manifestations in the ASAS classification criteria for both ASpA and PSpA and is a key feature for classifying PsA with the CASPAR criteria.[5,27]

Given the challenges in the clinical assessment of enthesitis, imaging studies are essential in research, though there is still debate about this issue. Magnetic resonance imaging and ultrasound are the techniques of choice for assessing enthesitis, the latter being more widely used in clinical practice for both diagnosis and follow-up as it is widely available, easy to use, and harmless.[28] Nonetheless, Helliwell draws our attention, first, to the consistently poor relationship between what is thought of as enthesitis clinically and ultrasound findings and second, to the fact that other conditions with overlapping features, particularly, allodynia, may interfere in the clinical assessment of entheses, except perhaps in the case of the Achilles.[23] Further, inflammatory changes in entheses have been observed on ultrasound in healthy individuals and even in patients with fibromyalgia.[29] This relates to the concept of subclinical enthesopathy, by which we mean ultrasound findings but no clinical manifestations. Various studies have detected changes in clinically asymptomatic entheses on ultrasound in patients with SpA[25,30] or related diseases, such as psoriasis, inflammatory bowel disease, and recurrent anterior uveitis, especially patients with HLAB27 positivity.[31,32]

Clinical and Research Consequences

Ultrasound Examination in Enthesitis

For ultrasound examination of the entheses, 8-18 MHz probes should be used for both B-mode (greyscale) and Doppler imaging. Entheses should be scanned longitudinally and then, after rotating the transducer to 90º, transversely, seeking to examine their entire structure. For studying SpA, the recommended power Doppler settings are a pulse repletion frequency of 500 Hz and a Doppler frequency of 10.1 MHz.[33]

There is agreement that the enthesis corresponds to a region of soft tissue less than 2 mm from the cortical bone. For examining the enthesis, we focus on 3 zones: (a) the cortical bone, looking for signs of bone formation and/or cortical irregularities and erosions; (b) the tendon, assessing ultrasound structure (hypoechogenicity), enthesis thickness, and the presence of calcifications; and (c) the bursa, to detect enlargement, effusion, and/or synovial thickening. In all these structures, it is assessed whether power Doppler signals are present.

The entheses most commonly explored in SpA are (Figures 4-7) (a) at the elbow: the distal insertion of the triceps tendon at the olecranon being examined with the forearm flexed at 90º, and the extensor and flexor insertions at the medial and lateral epicondyles may also be examined, (b) at the knee: distal insertion of the quadriceps and proximal and distal insertion of the patellar tendon being examined with the patient lying face up and the joint in 45º-70º of flexion, though power Doppler of the patellar tendon is better performed with the knee in extension, and (c) at the ankle: the insertion of the Achilles tendon and plantar fascia being examined with the patient lying face down (Figures 8 and 9), with the feet hanging over the edge of the examination table and the ankle in a neutral position (90º).[34,35]

While studying the entheses, we may encounter the following elementary findings: (1) thickening enthesis (Table 1): this being considered a pathological finding if the enthesis under study is >0.1 mm thicker than the standardized measurements as proposed by Balint et al.[33] Otherwise, De Miguel et al[34] for the distal insertion of the triceps established the following cut-off points: quadriceps tendon > 6.1 mm, proximal and distal patellar tendon > 4 mm, Achilles tendon > 5.29 mm, plantar fascia > 4 mm, and triceps tendon > 4.3 mm; (2) changes in ultrasound structure: findings being considered pathological, if there a lack of a fibrillar pattern, a hypoechogenic appearance, or fusiform thickening; (3) calcification/ossification: hyperechoic foci with or without acoustic shadow, depending on their size, that may or may not be linked to the cortical bone; (4) erosion: cortical breakage, with defects detected in both axes (longitudinal and transverse); (5) bursitis: well-defined anechoic or hypoechoic areas, anatomically compatible with the site of a normal bursa, that is compressible with the transducer, and (6) presence of a power Doppler signal: this indicating increased vascularization in the area studied and may be found in bursae and/or the tendinous area of the enthesis (cortical bone, intratenon, or paratenon).[34,36]

Some of the ultrasound signs described above are considered acute inflammatory

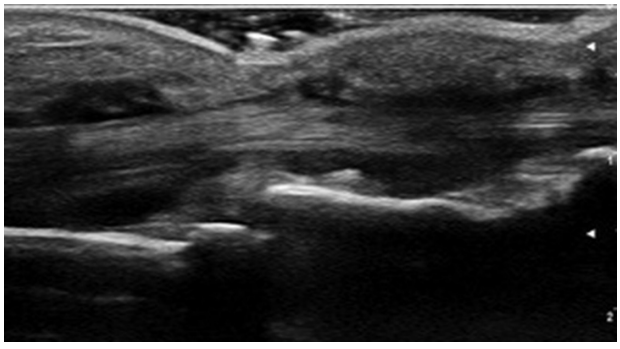

Figure 4. Flexor tendon of the second finger, longitudinal section: centered on the region next to IFP. Gray scale with tenosynovitis without proximal interphalangeal joint (IFP) arthritis.

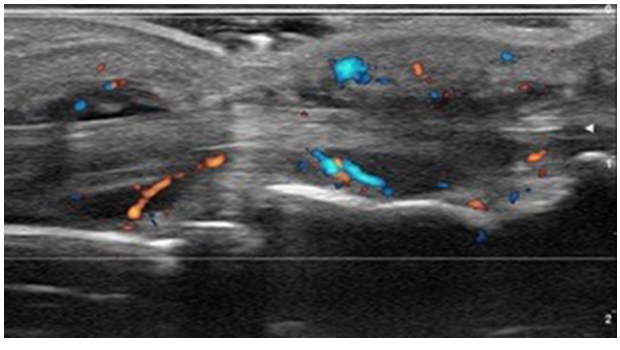

Figure 5. Flexor tendon of the second finger, longitudinal section: centered on the region next to IFP. Doppler signal located peritendinous and subcutaneous cellulose tissue.

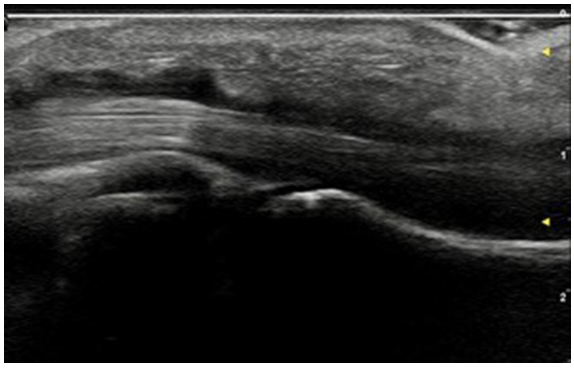

Figure 6. Flexor tendon of the second finger longitudinal section, centered on the proximal region, adjacent to MCF. Gray scale with tenosynovitis without arthritis of metacarpophalangeal joint (MCF).

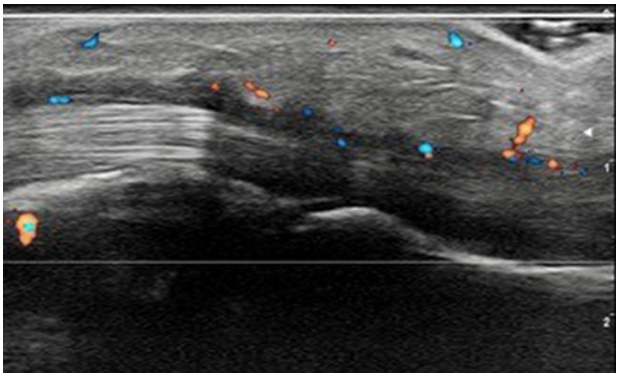

Figure 7. Flexor tendon of the second finger longitudinal section, centered on the proximal region, adjacent to MCF. Doppler signal localized peritendinous and in subcutaneous cellulose tissue.

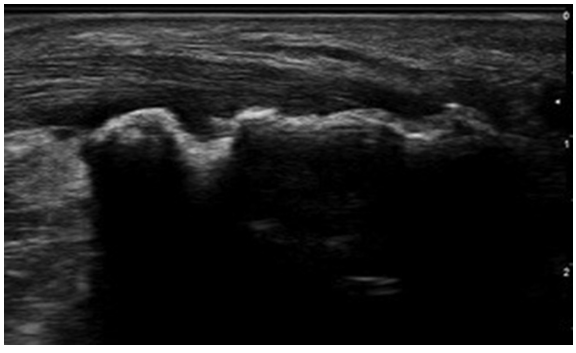

Figure 8. Achilles tendon. Cortical with distal enthesophyte irregularities and erosions.

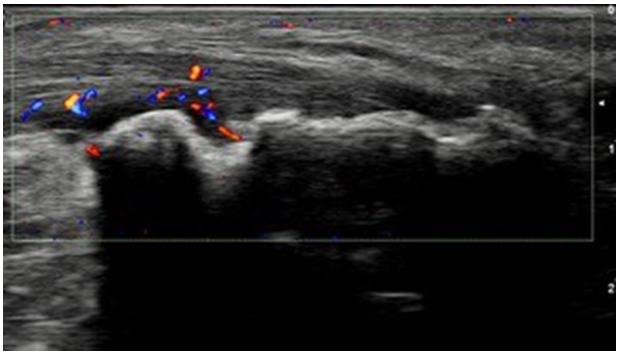

Figure 9. Achilles tendon with cortical and tendon Doppler signal.

changes that would correspond to changes in ultrasound structure, increased thickness and intratenon, or paratenon power Doppler signals, while the other signs such as, calcifications, enthesophytes, and erosions are considered chronic structural changes.[37]

A study by Zabotti et al[38] performed a cross-sectional analysis of clinical and ultrasound abnormalities, including inflammatory and structural lesions and concluded that baseline ultrasound evidence of enthesitis was associated with clinical PsA development in the longitudinal analysis. These findings are relevant for enriching subjects at risk of imminent PsA development.

Differential Diagnosis of Enthesitis

Among other diseases involving the entheses, other diseases involving the entheses are those with a mechanical cause, either trauma (e.g., partial or total rupture) or lesions associated with a degenerative condition (e.g., tendinosis). Other conditions that may affect the entheses are diseases associated with crystal deposition (e.g., gout and chondrocalcinosis), sarcoidosis, and even some systemic diseases such as scleroderma and Sjögren's syndrome or it may appear in the course of cancer treatment after checkpoint inhibitor therapy. On the other hand, there are other metabolic and endocrine conditions in which new bone formation characteristically dominates over inflammatory processes, including diffuse idiopathic skeletal hyperostosis,[39] X-linked hypophosphataemic osteomalacia, acromegaly, and also retinoid therapy.

Quantification and Classification Indices

Quantification and classification measures have been proposed for sonographic enthesitis. Specifically, various scores have been designed for the quantification of enthesitis by ultrasound.[3,33-36,40-43] The OMERACT Scoring System was developed together with the consensus-based definition of enthesis. This scoring system places emphasis on assessing findings in the enthesis, within 2 mm of the cortical bone, and those outside the enthesis, in the tendon or the bursa, classifying them as present or absent.[19] The Group for Research and Assessment of Psoriasis and Psoriatic Arthritis is also working on a scoring system specifically designed for the assessment of enthesitis in PsA for diagnostic purposes.[40] This group has identified 5 lesions and 6 enthesseal sites for identifying patients with PsA. De Miguel et al[34] have proposed an ultrasound-based index with a focus on entheses, the Madrid Sonographic Enthesitis Index (MASEI),

which is able to classify individuals as having axial SpA, validated a cut-off score of 18,[44] and have shown that this score is also valid in juvenile forms of SpA, though with a cut-off score of ≥20.[45] Despite the evidence, the MASEI index has yet to be widely implemented in clinical practice.

Madrid Sonographic Enthesitis Index is the main validated sonographic score for the evaluation of enthesis. The lack of studies is important in reaching an agreement for the interpretation of the MASEI between researchers from different centers in multicenter studies. The ultrasound working group of the Catalan Society of Rheumatology group (EcoCAT) evaluated the interobserver reliability of MASEI. They found a small variability in the results of the validation of the MASEI index when the different observers are well trained.[46]

Other ultrasound-based scoring systems have been used to assess entheses for diagnostic purposes and to evaluate response to treatment of enthesitis. Notably, most of these indices are focused on lower limb entheses, which may be confused with mechanical changes due to aging, overloading, physical activity, or obesity.[47,48]

There are some limitations in the assessment of sonographic enthesitis including the inability of available tools to identify any bone abnormalities associated with active enthesitis[49] and the lack of guidelines or standardized settings for the use of Doppler for assessing enthesitis.

Minimally Invasive Interventions

Ultrasound guidance makes it possible to give injections of corticosteroids or other products into a tendinous sheath, synovial bursa, or joint. In relation to this, one of the main advantages of ultrasound is that it allows diagnosis and treatment to be carried out in a single session.[50,51]

Whenever possible, in all ultrasound-guided procedures involving tendons, the probe is placed such that the needle inserted and the drug given can be visualized at all times, thereby avoiding inadvertent administration of the drug to intra- or peri-tendinous structures.

Corticosteroids are injected into the space around a tendon under ultrasound guidance. If the tendon has a sheath, we should identify the synovial space, while if it is surrounded by a paratenon, the corticosteroid should never be administered to the tendon itself but rather injected at the periphery.[52]

Conclusion

Enthesitis is one of the characteristic features of SpA. As mentioned earlier, the clinical examination of enthesitis is difficult and has a low sensitivity. For this reason, the reported prevalence ranges widely from 10% to 60%, depending on the study. Specifically, clinical enthesitis is detected in 35% of patients with PsA, the most common sites are the insertion of the Achilles tendon and the plantar fascia, as well as the lateral epicondyles.

The entheses most commonly explored in SpA are (a) at the elbow: the distal insertion of the triceps tendon at the olecranon being examined with the forearm flexed at 90º, and the extensor and flexor insertions at the medial and lateral epicondyles may also be examined; (b) at the knee: distal insertion of the quadriceps and proximal and distal insertion of the patellar tendon being examined with the patient lying face up and the joint in 45º-70º of flexion, though power Doppler of the patellar tendon is better performed with the knee in extension; (c) at the ankle: the insertion of the Achilles tendon and plantar fascia being examined with the patient lying face down, with the feet hanging over the edge of the examination table and the ankle in a neutral position (90º).

MASEI is the main validated sonographic score for the evaluation of enthesis.

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References

1. Olivieri I, Scarano E, Padula A, Giasi V, Priolo F. Dactylitis, a term for different digit diseases. *Scand J Rheumatol*. 2006;35(5):333-340. [CrossRef]
2. Eviatar T, Elkayam O. Paraneoplastic dactylitis leading to the diagnosis of ovarian cancer. *Isr Med Assoc J*. 2019;21(5):354-355.
3. Kaeley GS, Eder L, Aydin SZ, Gutierrez M, Bakewell C. Dactylitis: A hallmark of psoriatic arthritis. *Semin Arthritis Rheum*. 2018;48(2):263-273. [CrossRef]
4. Coates LC, Helliwell PS. Disease measuremen t--enthesitis, skin, nails, spine and dactylitis. *Best Pract Res Clin Rheumatol*. 2010;24(5):659-670. [CrossRef]
5. 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(8):2665-2673. [CrossRef]
6. 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(11):2110-2117. [CrossRef]
7. Eder L, Wu Y, Chandran V, Cook R, Gladman DD. Incidence and predictors for cardiovascular events in patients with psoriatic arthritis. *Ann Rheum Dis*. 2016;75(9):1680-1686. [CrossRef]
8. 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(12):1951-1957. [CrossRef]
9. Tinazzi I, McGonagle D, Aydin SZ, Chessa D, Marchetta A, Macchioni P. 'Deep Koebner' phenomenon of the flexor tendon-associated accessory pulleys as a novel factor in tenosynovitis and dactylitis in psoriatic arthritis. *Ann Rheum Dis*. 2018;77(6):922-925. [CrossRef]
10. 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(9):1524-1528. [CrossRef]
11. 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(8):1328-1334. [CrossRef]
12. 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(5):527-531. [CrossRef]
13. Tinazzi I, McGonagle D, Zabotti A, Chessa D, Marchetta A, Macchioni P. 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(5):785-790.
14. Tinazzi I, Idolazzi L, Zabotti A, et al. Ultrasonographic detection, definition and quantification of soft tissue oedema in psoriatic dactylitis. *Med Ultrason*. 2019;21(4):414-421. [CrossRef]
15. 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*. 2020;39(4):1157-1165. [CrossRef]

16. 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(3):903-911. [CrossRef]
17. Tan AL, Fukuba E, Halliday NA, Tanner SF, Emery P, McGonagle D. Highresolution MRI assessment of dactylitis in psoriatic arthritis shows flexor tendon pulley and sheath-related enthesitis. *Ann Rheum Dis*. 2015;74(1):185-189. [CrossRef]
18. Tinazzi I, McGonagle D, Macchioni P, Aydin SZ. Power Doppler enhancement of accessory pulleys confirming disease localization in psoriatic dactylitis. *Rheumatol (Oxf Engl)*. 2020;59(8):2030-2034. [CrossRef]
19. 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(6):1111-1114. [CrossRef]
20. Benjamin M, Toumi H, Ralphs JR, Bydder G, Best TM, Milz S. Where tendons and ligaments meet bone: attachment sites ('entheses') in relation to exercise and/or mechanical load. *J Anatomy*. 2006;208(4):471-490. [CrossRef]
21. Benjamin M, McGonagle D. The anatomical basis for disease localisation in seronegative spondyloarthropathy at entheses and related sites. *J Anat*. 2001;199(5):503-526. [CrossRef]
22. McGonagle D, Lories RJ, Tan AL, Benjamin M. The concept of a "synovio-entheseal complex" and its implications for understanding joint inflammation and damage in psoriatic arthritis and beyond. *Arthritis Rheum*. 2007;56(8):2482-2491. [CrossRef]
23. Helliwell PS. Assessment of enthesitis in psoriatic arthritis. *J Rheumatol*. 2019;46(8):869-870. [CrossRef]
24. Balint PV, Kane D, Wilson H, Mcinnes IB, Sturrock RD. Ultrasonography of entheseal insertions in the lower limb in spondyloarthropathy. *Ann Rheum Dis*. 2002;61(10):905-910. [CrossRef]
25. Mata Arnaiz MC, de Miguel Mendieta E. Utilidad de la ecografia en la evaluación de las entesis periféricas en las espondiloartritis. *Reumatol Clin*. 2014;10(2):113-119. [CrossRef]
26. Polachek A, Li S, Chandran V. Clinical Enthesitis in a Prospective Longitudinal Psoriatic Arthritis Cohort: Incidence, Prevalence, Characteristics, and Outcome. *Arthritis Care Res (Hoboken)*. 2017;69(11):1685-1691. [CrossRef]
27. Rudwaleit M, van der Heijde D, Landewé R, et al. The development of Assessment of SpondyloArthritis international Society classification criteria foraxial spondyloarthritis (part II). *Ann Rheum Dis*. 2009;68(6):777-783. [CrossRef]
28. Mandl P, Navarro-Compán V, Terslev L, et al. EULAR recommendations for the use of imaging in the diagnosis and management of spondyloarthritis in clinical practice. *Ann Rheum Dis*. 2015;74(7):1327-1339. [CrossRef]
29. Marchesoni A, De Marco G, Merashli M, et al. The problem in differentiation between psoriatic-related polyenthesitis and fibromyalgia. *Rheumatology (Oxford)*. 2018;57(1):32-40. [CrossRef]
30. Ruta S, Gutierrez M, Pena C, et al. Prevalence of subclinical enthesopathy in patients with spondyloarthropathy: an ultrasound study. *J Clin Rheumatol*. 2011;17(1):18-22. [CrossRef]
31. Bakirci Ureyen SB, Karacaer C, Toka B, et al. Similar subclinical enthesitis in celiac and inflammatory bowel diseases by ultrasound suggests a gut enthesis axis independent of spondyloarthropathy spectrum. *Rheumatol*. 2018;57(8):1417-1422. [CrossRef]
32. Muñoz-Fernández S, De Miguel E, Cobo-Ibáñez T, et al. Enthesis inflammation in recurrent acute anterior uveitis without spondylarthritis. *Arthritis Rheum*. 2009;60(7):1985-1990. [CrossRef]
33. Balint PV, Terslev L, Aegerter 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(12):1730-1735. [CrossRef]
34. De Miguel E, Cobo T, Muñoz-Fernández S, et al. Validity of enthesis ultrasound assessment in spondyloarthropathy. *Ann Rheum Dis*. 2009;68(2):169-174. [CrossRef]
35. D'Agostino MA, Said-Nahal R, Hacquard-Bouder C, Brasseur JL, Dougados M, Breban M. Assessment of peripheral enthesitis in the spondylarthropathies by ultrasonography combined with power Doppler: a cross-sectional study. *Arthritis Rheum*. 2003;48(2):523-533. [CrossRef]
36. Balint PV, Kane D, Wilson H, Mcinnes IB, Sturrock RD. Ultrasonography of entheseal insertions in the lower limb in spondyloarthropathy. *Ann Rheum Dis*. 2002;61(10):905-910. [CrossRef]
37. Polachek A, Cook R, Chandran V, Gladman DD, Eder L. The association between sonographic enthesitis and radiographic damage in psoriatic arthritis. *Arthritis Res Ther*. 2017;19(1):189. [CrossRef]
38. Zabotti A, McGonagle DG, Giovannini I, et al. Transition phase towards psoriatic arthritis: clinical and ultrasonographic characterisation of psoriatic arthralgia. *RMD Open*. 2019;5(2):e001067. [CrossRef]
39. Mader R, Novofastovski I, Iervolino S, et al. Ultrasonography of peripheral entheses in the diagnosis and understanding of diffuse idiopathic skeletal hyperostosis (DISH). *Rheumatol Int*. 2015;35(3):493-497. [CrossRef]
40. Tom S, Zhong Y, Cook RJ, Aydin SZ, Kaeley GS, Eder L. Development of a preliminary ultrasonographic enthesitis score in psoriatic arthritis - GRAPPA Ultrasound Working Group. *J Rheumatol*. 2019;46(4):384-390. [CrossRef]
41. Delle Sedie A, Riente L. Psoriatic arthritis: what ultrasound can provide us. *Clin Exp Rheumatol*. 2015;33(5):S60-S65.
42. Eder L, Aydin SZ, Kaeley GS, Maksymowych WP, Østergaard M. Options for assessing joints and entheses in psoriatic arthritis by ultrasonography and magnetic resonance imaging: how to move forward. *J Rheumatol Suppl*. 2018;94:44-47. [CrossRef]
43. Alcalde M, Acebes JC, Cruz M, González-Hombrado L, Herrero-Beaumont G, Sánchez-Pernaute O. A sonographic enthesitic index of lower limbs is a valuable tool in the assessment of ankylosing spondylitis. *Ann Rheum Dis*. 2007;66(8):1015-1019. [CrossRef]
44. Mathew AJ, Krabbe S, Eshed I, et al. The OMERACT MRI in enthesitis Initiative: definitions of key pathologies, suggested MRI sequences, and a novel Heel enthesitis Scoring System. *J Rheumatol*. 2019;46(9):1232-1238. [CrossRef]
45. Weckbach S, Schewe S, Michaely HJ, Steffinger D, Reiser MF, Glaser C. Whole-body MR imaging in psoriatic arthritis: additional value for therapeutic decision making. *Eur J Radiol*. 2011;77(1):149-155. [CrossRef]
46. Moya Alvarado P, de Agustín de Oro JJ, Aparicio Espinar M, et al. Interobserver reliability of Masei index validation by a multicenter collaborative group of rheumatologists. *Rheumatol Int*. 2022;42(3):441-448. [CrossRef]
47. Elalouf O, Bakirci Ureyen S, Touma Z, et al. Psoriatic arthritis sonographic enthesitis instruments: a systematic review of the literature. *J Rheumatol*. 2019;46(1):43-56. [CrossRef]
48. Østergaard M, Eder L, Christiansen SN, Kaeley GS. Imaging in the diagnosis and management of peripheral psoriatic arthritis-The clinical utility of magnetic resonance imaging and ultrasonography. *Best Pract Res Clin Rheumatol*. 2016;30(4):624-637. [CrossRef]
49. Eshed I, Bollow M, McGonagle DG, et al. MRI of enthesitis of the appendicular skeleton in spondyloarthritis. *Ann Rheum Dis*. 2007;66(12):1553-1559. [CrossRef]
50. Adler RS, Finzel KC..The complementary roles of MR imaging and ultrasound of tendons. *Radiol Clin N Am*. 2005;43(4):771-807. [CrossRef]
51. Royall NA, Farrin E, Bahner DP, et al. Ultrasound assisted musculosketal procedures: a practical overview of corrent literatura. *World J Orthop*;2011;2(7):57-66.
52. Kaeley GS, Eder L, Aydin SZ, Gutierrez M, Bakewell C. Enthesitis: a hallmark of psoriatic arthritis. *Semin Arthritis Rheum*. 2018;48(1):35-43. [CrossRef]