Spectrum of Ultrasound Pathologies of Achilles Tendon, Plantar Aponeurosis and Flexor Digiti Brevis Tendon Heel Entheses in Patients with Clinically Suspected Enthesitis

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Summary

Background:
Enthesitis is considered a characteristic presentation of the second most common group of rheumatoid disorders, i.e. spondyloarthropathies (SpAs), particularly peripheral spondyloarthropathies. At the initial stages, enthesitis may be the only symptom of SpA, particularly in patients lacking the HLA-B27 receptor.

Material/Methods:
In light of diagnostic difficulties with detecting enthesitis in clinical examinations and laboratory investigations, many studies point out the high specificity of imaging studies, and particularly ultrasonography.

Results:
A total of 20% Achilles tendon entheses, 45% plantar aponeurosis entheses and 89.5% of flexor digiti brevis tendon entheses were unremarkable. In the remaining cases, the presentation of pathological lesions was not specific to enthesitis and might more likely correspond to degeneration or microinjuries of the entheses, beside the most obvious cases of achillobursitis or Kager’s fat pad inflammation.

Conclusions:
The studies demonstrated that ultrasound scans rarely confirm the clinical diagnosis of enthesitis.

MeSH Keywords:
Achilles Tendon • Rheumatic Diseases • Ultrasonography, Doppler

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Objective

The goal of the study was to use ultrasound scans to prospectively assess the Achilles tendon, plantar aponeurosis, and flexor digiti brevis tendon enthesitis in patients with clinically suspected enthesitis.

Material and Methods

A group of 68 successive patients, including 28 males and 40 females aged 41–93 years (mean age 76 years, median 67.5 years) with clinical suspicion of tuber calcanei enthesis in whom ultrasound examinations of entheses were performed between October through March 2013. The group consisted of 30 patients with pains in the Achilles tendon enthesis and 38 patients with suspected enthesitis of the plantar surface of tuber calcanei (plantar aponeurosis and flexor digiti brevis tendon entheses).

All patients were referred for ultrasound scans by senior rheumatologists to confirm the clinical diagnosis of enthesitis. Heel pain (posterior or inferior) was assessed by rheumatologists on the basis of the presence of at least one of the following findings: a) spontaneous/paroxysmal pain; b) tenderness elicited by pressure, mobilization, or contraction against the resistance of the corresponding tendon or fascia and c) local edema of the enthesis [14]. Heel pain was defined as typical inflammatory SpA pain on the basis of expert opinion, Amor’s criteria and the newest ASAS criteria for SpA [2,12]. The exclusion criteria included: current or previous treatment with tumor necrosis factor alpha (TNFα) blockers, hind foot surgery or trauma, or concomitant endocrinopathies.

Informed consent was obtained from each patient before inclusion in the study. The study was approved by the local ethics committee.

All patients had ultrasound examinations performed with an Esaote MyLab Class C scanner with linear 18 MHz transducer. Achilles tendons, plantar aponeuroses and flexor digiti brevis tendons were assessed along their entire lengths, including their insertions at the calcaneus, in axial and sagittal planes. The following elements were assessed in B-mode and Doppler ultrasound scans. The only cases of hypervascularization were visualized in Doppler ultrasound scans. The only cases of hypervascularization were observed in the Achilles tendon proximal to the enthesis; the tendon was infiltrated by the vessels originating from the inflamed Kager’s fat pad (13%) or Achilles tendon bursa and subcutaneous calcaneal bursa.

Following lesions were considered pathological:

1. Achilles tendon enthesis: thickening, delaminated tears (hypoechoic areas yielding to probe compression), delaminated tear scars, including sclerosing scars (hypoechoic areas not yielding to probe compression) and mineralized scars (enthesophytes, bony spurs), irregularities and erosions within the bony part of enthesis and vascularization of the enthesis;
2. Flexor digiti brevis tendon enthesis – delaminated tears, mineralized scars, erosions within the bony wall of the enthesis, vascularization;
3. Achilles tendon bursa: exudate, thickened synovium, synovial vascularization, erosions within the bony wall of the bursa, delaminated tears and tear scars within the Achilles tendon at bursal level, vascularization of the tendon at bursal level;
4. Subcutaneous calcaneal bursa – exudate, thickened synovium, thickened synovium with hypervascularization; vascularization of the tendon at subcutaneous bursal level;
5. Epitendineum – thickening, exudate, thickened synovium with features of hypervascularization;
6. Kager’s fat pad: edema, vascularization, vessels infiltrating the tendon from the side of the Kager’s fat pad.

Results

The results are presented in Tables 1 and 2.

A total of 20% Achilles tendon entheses, 45% plantar aponeurosis entheses and 89.5% flexor digiti brevis tendon entheses were unremarkable in patients undergoing ultrasound scans.

In patients with preliminary clinical diagnosis of enthesitis:

1. Most common Achilles tendon pathologies included (Table 1): enthesophytes, i.e. upper calcaneal spurs (70%), delaminated tears of the tendon at the level of the Achilles tendon bursa (40%), exudate in the Achilles tendon bursa (27%), bony erosions at the enthesis attachment site (27%), edema of the Kager’s fat pad (20%) and hypervascularization of Kager’s fat pad (20%) (Figures 1–3). No cases of enthesitis vascularization were visualized in Doppler ultrasound scans. The only cases of hypervascularization were observed in the Achilles tendon proximal to the enthesis; the tendon was infiltrated by the vessels originating from the inflamed Kager’s fat pad (13%) or Achilles tendon bursa and subcutaneous calcaneal bursa. Achilles tendon bursa and subcutaneous calcaneal bursa.

2. Achilles tendon enthesitis: thickening, delaminated tears (hypoechoic areas yielding to probe compression), delaminated tear scars, including sclerosing scars (hypoechoic areas not yielding to probe compression) and mineralized scars (enthesophytes, bony spurs), irregularities and erosions within the bony part of enthesis and vascularization of the enthesis;
3. Flexor digiti brevis tendon enthesis – delaminated tears, mineralized scars, erosions within the bony wall of the enthesis, vascularization;
4. Achilles tendon bursa: exudate, thickened synovium, synovial vascularization, erosions within the bony wall of the bursa, delaminated tears and tear scars within the Achilles tendon at bursal level, vascularization of the tendon at bursal level;
5. Subcutaneous calcaneal bursa – exudate, thickened synovium, thickened synovium with hypervascularization; vascularization of the tendon at subcutaneous bursal level;
6. Epitendineum – thickening, exudate, thickened synovium with features of hypervascularization;
7. Kager’s fat pad: edema, vascularization, vessels infiltrating the tendon from the side of the Kager’s fat pad.

Further clinical and laboratory diagnostics revealed spondyloarthropathy (SpA) in 8 out of 30 subjects (26.6%) with preliminary clinical diagnosis of Achilles tendon enthesitis. As many as 12 out of 30 (40%) cases were patients with undifferentiated arthritis, of whom a part would develop the specific form of SpA, with enthesitis being one of the first pathological symptoms. The remaining patients were diagnosed with osteoarthritis (4 cases) and isolated cases of other rheumatoid diseases, such as Sjögren syndrome, diffuse fasciitis with eosinophilia (fibromyalgia), Sapho
syndrome, and granulomatosis with polyangiitis (GPA), previously referred to as Wegener’s granulomatosis.

In case of plantar aponeurosis, SpA was confirmed in 11 out of (28.8%) patients with preliminary diagnosis of enthesitis of plantar aponeurosis or flexor digiti brevis tendon. The remaining cases consisted of undifferentiated arthritis (11 patients), osteoarthritis (5 patients), other isolated cases such as Sjögren syndrome, fibromyalgia, fibromatosis of plantar aponeurosis, Sapho syndrome, and GPA.

Positive results of HLA-B27 screening were observed in 10 out of 30 (33.3%) patients referred with preliminary diagnosis of Achilles tendon enthesitis as well as in 10 out of 38 (26.3%) patients clinically diagnosed with enthesitis of plantar aponeurosis or flexor digiti brevis tendon. The HLA-B27-positive patients included both individuals with ultrasound-detected enthesopathies and individuals with unremarkable ultrasound scan results (ratio of ca. 3:1). No relationship between the intensity of inflammatory lesions (the number of abnormal elements of the ultrasonographic image) and the presence of the HLA-B27 receptor.

**Discussion**

The term “enthesitis” was introduced in 1959 by La Cava, initially to describe enthesopathies observed in the course of mechanical injuries [15]. In 1971, Ball demonstrated that enthesitis is a characteristic feature of ankylosing spondylitis (AS, one of the forms of SpA); later on, in the 1980s,
Enthesitis was ascertained to be a part of clinical presentation of all diseases classified as SpA, as is also confirmed by current ASAS (Assessment in SpondyloArthritis) criteria [5,10,15]. For this reason, enthesitis became a basis for a number of tools for diagnosing SpA and monitoring the efficacy of treatment of different SpA types, such as Mander Enthesitis Index, Maastricht Ankylosing Spondylitis Enthesitis Score, Major Enthesitis Index, Gladman Index, and Psoriasis Area and Severity Index [16].

The diagnostics of enthesitis is based mainly on the results of clinical examinations, which is non-specific in many cases, as are the results of laboratory investigations.

Numerous current publications suggest that ultrasonography is a highly specific method for diagnosing enthesitis [17]. D’Agostino et al. demonstrated that ultrasonographic features of enthesitis are present in 98% SpA patients (with enthesitis being diagnosed for instance only on the

![Figure 1. Achilles tendon enthesis thickening with delaminated tears and mineralized tear scars.](image1)

![Figure 2. Exudate within the Achilles tendon bursa with thickening and vascularization of bursal synovium; delaminated tendon tears infiltrated by the vessels of the inflamed bursa.](image2)

![Figure 3. Edema and hypervascularization of Kager’s fat pad; tendon infiltrated by the vessels of the inflamed adipose tissue.](image3)

![Figure 4. Plantar aponeurosis and enthesis in B-mode (A) and PDUS (B) scans: thickened, hypoechoic, delamination areas, no signs of vascularization.](image4)

![Figure 5. Delaminated tears not yielding to probe compression (sclerosing scars) in the proximal segment of plantar aponeurosis; entheses of plantar aponeurosis and flexor digiti brevis tendon are normal.](image5)
In 2003, D’Agostino et al. [18] published a study analyzing the images of various entheses in patients suffering of enthesitis vascularization as assessed in ultrasound scans. Regardless of their etiology, enthesopathic lesions observed in ultrasound scans may be painful or clinically asymptomatic; in other cases, painful entheses may show no pathological features in ultrasound scans [12,20].

In our study material of clinically painful entheses of tuber calcanei, as much as 20% Achilles tendon entheses, 45% plantar aponeurosis entheses and 69.5% flexor digiti brevis tendon entheses were unremarkable in ultrasound images. No signs of enthesis vascularization, considered to be a crucial and SpA-specific feature of enthesitis, were observed in any of the studied patients [10,11,14,18,20]. First of all, these are indicative of the low specificity of the clinical criteria (interview and palpation). This was suggested e.g. by Sparado et al. [20], in whose study as much as 60% of aponeurosis entheses and 63.1% of Achilles tendon entheses in patients clinically diagnosed with enthesitis were unremarkable. Secondly, our results raise doubts with regard to the sensitivity and specificity of the criterion of enthesis vascularization as assessed in ultrasound scans.

In 2003, D’Agostino et al. [18] published a study analyzing the images of various entheses in patients suffering of SpA, rheumatoid arthritis (RA), and mechanical back pain (MBP). It was shown that power Doppler ultrasonography (PDUS) may be a useful SpA diagnostics and monitoring tool. Vascularization of entheses was observed only in SpA patients (81%), with no cases detected in the control group (RA and MBP). In RA cases, vascularization was observed only within the Achilles tendon bursa (similar to our study). Unfortunately, the authors did not specify which of the studied entheses were associated with vascularization and whether vascularized entheses of the Achilles tendon and the plantar aponeurosis could be observed as they were not observed in our study. In addition, the authors identified no cases of tendon vascularization in SpA cases while our study revealed a total of 10% of Achilles tendons being infiltrated by vessels originating from the inflamed bursa and 15% of Achilles tendons being infiltrated by vessels originating from the Kager’s fat pad.

The most common pathology observed in our study material were enthesophytes, particularly common in entheses of the Achilles tendon (70% of Achilles tendon entheses and 29% and 10.5% of plantar aponeurosis and flexor digiti brevis tendon entheses, respectively). In all research studies, enthesophytes are the leading symptom of enthesopathies within the Achilles tendon while being only occasionally observed in the entheses of plantar aponeurosis [19]. The possible explanation may involve distinct structure of the entheses: ligament – type in plantar aponeurosis, and tendon - type in Achilles and flexor digiti brevis tendons [19].

The second most common pathology in our study material were delaminated tears of Achilles tendon at the bursal level and delaminated tears of the enthesis of plantar aponeurosis (40% and 34% of cases, respectively), which are probably responsible for the literature descriptions of entheses or tendons as being thickened and hypoechoic.

Sparado et al. [20] studied 432 different entheses, both symptomatic and asymptomatic, in AS patients, including entheses of the Achilles tendon and plantar aponeurosis. The most common abnormality within the Achilles tendon were enthesophytes (31.9%), enthesis thickening (27.7%), enthesis vascularization (8.3%) and Achilles tendon bursitis (13.9%). With regard to the enthesis of plantar aponeurosis, the most common abnormality were thickening (13.9%), calcifications (9.7%) and enthesophytes (6.9%) (the authors differentiated enthesophytes and calcifications, the latter probably meaning mineralized scars located proximal to the enthesis?) as well as reduced echogenicity of the enthesis (9.7%). No cases of enthesis vascularization were observed. In the study conducted by these authors, 63.1% of Achilles tendon entheses and 60% of plantar aponeurosis entheses in patients with suspected enthesitis were unremarkable. Out of the remaining entheses, symptomatic and abnormal in B-mode scans, vascularization was observed only in one case of calcaneal enthesis of the Achilles tendon (5.3%) and in none of the cases of plantar aponeurosis enthesis [20]. The results obtained by the authors are similar to that observed in our group and confirm the lack of ultrasonographic features of inflammatory lesions within the entheses with positive clinical examination results.
enthesisopathies within the Achilles tendon and plan-
tar aponeurosis (including echostructure disturbances,
thickening, abnormal bursal vascularization, Achilles ten-
don vascularization, planter aponeurosis vascularization as well as calcifications, erosions and enthesophytes were not SpA-specific and were observed as frequently in control subjects, either healthy or with mechanical back pain, as also reported earlier by other authors [12,13,18]. They confirmed that enthesopathic lesions within the lower limbs, such as enthesis thickening, erosions, and particularly enthesophytes did not permit differentiation of RA patients from AS patients, were as common in healthy individuals and their number increased with age as a manifestation of chronic injuries and degeneration of entheses.

As mentioned before, enthesis vascularization was considered to be the enthesitis-specific symptom [10,11,14,18,20,21]. No such symptom was observed in our study. In the literature, vessels were reported within the Achilles tendon enthesis in isolated cases only. Peydy et al. [12] identified the hypervascular-
ization of the Achilles tendon in as little as 5% SpA patients and 6% control subjects, and only in patients with erosions within the bony part of the enthesis. Most probably, this hypervascularization was due to the processes of repairing delaminated tears within the enthesis [7]. In our study mate-
rial, scars of this type revealed no features of vascularization (underwent complete remodeling).

No cases of hypervascularization of planter aponeuro-
sis were observed in our study. It is possible that it would
become evident in individuals with very active inflamma-
tion [12] or after enthesis injury.

The only cases of vascularization observed in our research were associated with Achilles tendons being infiltrated by vessels originating from the inflamed bursa (10% of cases) or Kager’s fat pad (13% of cases). Such observations were probably also made by other authors, as evidenced by the proposal put forth by Benjamin and McGonagle to extend the definition of enthesis as a synovio-entheseal complex (SEC) [22]. The concept of SEC suggests that entheses form a functional unit with the adjacent synovium, fat tissue and bone. Inflammatory lesions within the bursa are probably triggered by an injury or microinjury of enthesis which, probably in genetically-predisposed individuals, initiate the inflammatory reaction with activation of the immune system within the tendon bursa, or more precisely, within the synovium of the bursal wall and the Kager’s fat pad [11,18,22–24]. The SEC concept is supported by some authors and negated by others who claim that the hypo-
thesis describes bursitis or inflammation of Kager’s fat pad rather than enthesitis [16]. Both the Achilles tendon bursa and Kager’s fat pad are established locations of inflamma-
tion in the course of rheumatoid diseases (particularly RA and OA) [25–28].

Conclusions

As suggested by the results of our studies, clinical suspi-
cion of enthesitis is difficult to confirm by ultrasonogra-
phy. A significant percentage of clinically painful enthes-
es is unremarkable in ultrasound scans. In the remain-
ing cases, ultrasound scan abnormalities are not enthesi-
tis-specific and are more likely to suggest degenerative
lesions or chronic injuries of the entheses, besides isolated cases of tendon bursitis or Kager’s fat pad inflammation. The lack of unambiguous ultrasound image of enthesitis requires that other SPA-specific symptoms and more spe-
cific imaging markers are sought after for possibly fastest
diagnosis.

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