Signature: © Pol J Radiol, 2014; 79: 402-408
DOI: 10.12659/PJR.890803

Polish Journal of Radiology
www.PolRadiol.com
ORIGINAL ARTICLE

Received: 2014.04.03
Accepted: 2014.05.27
Published: 2014.11.09

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

Iwona Sudoł-Szopińska[1,2ABCDEF], **Katarzyna Zaniewicz-Kaniewska**[1ABCDEF], **Brygida Kwiatkowska**[3ABCDEF]

[1] Department of Radiology, Institute of Rheumatology, Warsaw, Poland
[2] Department of Diagnostic Imaging, Second Faculty of Medicine, Medical University of Warsaw, Warsaw, Poland
[3] Early Arthritis Clinic, Institute of Rheumatology, Warsaw, Poland

Author's address: Iwona Sudoł-Szopińska, Department of Radiology, Institute of Rheumatology, Warsaw, Poland, e-mail: sudolszopinska@gmail.com

Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
D Data Interpretation
E Manuscript Preparation
F Literature Search
G Funds Collection

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

PDF file: http://www.polradiol.com/abstract/index/idArt/890803

Background

Entheses are the attachments of ligaments, tendons, fascia and joint capsules to the bone, reducing the mechanical stress at the interface of tissues of different strengths (i.e. fibrous connective tissue and bone). Pathologies occurring in entheses are referred to as enthesopathies. Enthesitis is one of the types of enthesopathies and is considered a characteristic feature of spondyloarthropathies, particularly peripheral spondyloarthropathies, which constitute the second most common group of rheumatic diseases [1,2].

Rheumatologists base the diagnosis of enthesitis on the patient's complaints (pain at the attachment site, experienced particularly at the morning, resolving after exercise) and the result of physical examination (pain and edema at the enthesis site) [3]. Laboratory investigations (CRP, ESR) are non-specific while the spondyloarthropathy (SpA)-specific receptor HLA-B27 is detected in only 30–70% of cases of the peripheral form of the disease [4]. Therefore, particularly in HLA-B27-negative patients, clinical presentation may not be different from enthesopathies occurring in the course of endocrine or metabolic diseases, or as a result of injuries or degenerative lesions [1,5–8].

As suggested by numerous literature publications, imaging examinations, particularly ultrasonography facilitate differentiation of enthesitis from other enthesopathies [3,5,9–11], although opinions to the contrary were also published [12,13].

Objective

The goal of the study was to by use ultrasound scans to prospectively assess the Achilles tendon, plantar aponeurosis and flexor digiti brevis tendon entheses 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 enthesitis 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 continuity, echogenicity, echostructure, and vascularization of the entheses, the outlines of tuber calcanei (i.e. the bony part of the enthesis), echogenicity and vascularization of Kager's fat pad, Achilles tendon bursa and subcutaneous calcaneal bursa.

Following lesions were considered pathological:

1. Achilles tendon enthesis: thickening, delaminated tears (hypoechogenic areas yielding to probe compression), delaminated tear scars, including sclerosing scars (hypoechogenic 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. Calcaneal enthesis of plantar aponeurosis: thickening, delaminated tears (hypoechogenic areas yielding to probe compression), delaminated tear scars, including sclerosing scars (hypoechogenic 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.

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 enthesis vascularization were visualized in Doppler ultrasound scans. The only cases of hypervascularization were observed in the Achilles tendon proximally to the enthesis; the tendon was infiltrated by the vessels originating from the inflamed Kager's fat pad (13%) or achillobursitis calcanei (10%) (Figures 2 and 3);
2. Most common plantar aponeurosis pathologies included (Table 2): delaminated tears of the aponeurosis distally from the enthesis (34%), mineralized scars (enthesophytes) (29%). No cases of hypervascularization of aponeurosis or enthesis was observed (Figures 4–6);
3. Pathologies of the flexor digiti brevis tendon enthesis were diagnosed in 4 out of 38 cases suspected of plantar enthesitis (10.5%). The pathologies consisted of mineralized scars (enthesophytes, lower calcaneal spur). All these were concomitant with plantar aponeurosis enthesopathies (Figure 7).

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

Table 1. Spectrum of abnormalities observed in Achilles tendon entheses and the surrounding tissues.

No.	Achilles tendon (N=30)	Number	Percentage
1	Enthesis – no pathologies	6	20
2	Enthesis – enthesophytes	21	70
3	Enthesis – thickening	0	0
4	Enthesis – delaminated tears	4	13
5	Bone enthesis – erosions	8	27
6	Enthesis – vascularization	0	0
8	Achilles tendon – delaminated tears at the Kager's fat pad level	12	40
9	Tendon – thickening	1	3
10	Achilles tendon bursa – exudate	8	27
11	Achilles tendon bursa – thickened synovium	5	17
12	Achilles tendon bursa – vascularized synovium	3	10
13	Calcaneal bursal wall – erosions	1	3
14	Bursal vessels infiltrating the tendon	3	10
15	Kager's fat pad – edema	6	20
16	Kager's fat pad – vascularization	6	20
17	Kager's fat pad's vessels infiltrating the tendon	4	13

Table 2. The spectrum of abnormalities observed in the ultrasound scans of entheses and proximal segments of plantar aponeurosis and flexor digiti brevis tendon.

No.	Plantar aponeurosis (N=38)	Number	Percentage
1	Enthesis – no pathologies	17	45
2	Enthesis – enthesophytes	11	29
3	Enthesis – thickening	6	16
4	Enthesis – delaminated tears	2	5
5	Enthesis – erosions	6	16
6	Enthesis – vascularization	0	0
7	Plantar aponeurosis – degeneration, microtears	13	34
8	Flexor digiti brevis tendon enthesis – enthesophytes	4	10.5

syndrome, and granulomatosis with polyangitis (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,

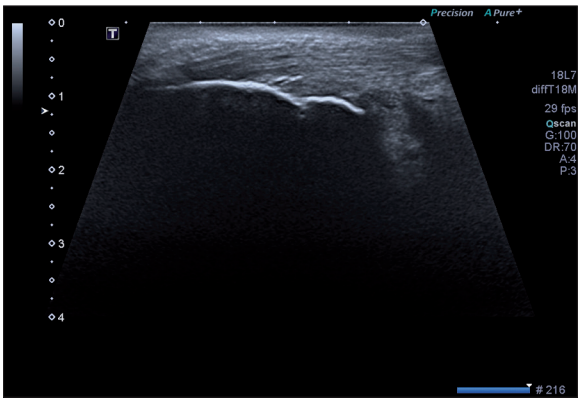

Figure 1. Achilles tendon enthesis thickening with delaminated tears and mineralized tear scars.

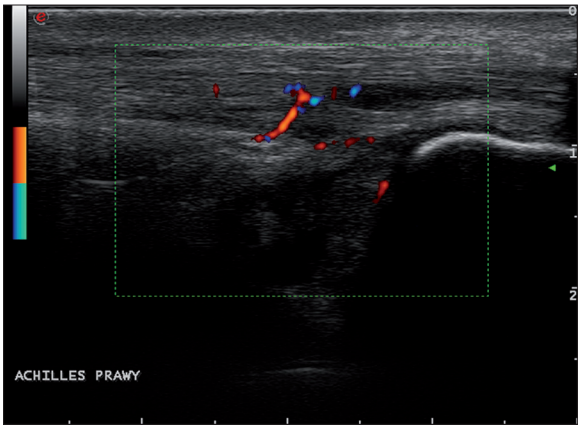

Figure 2. Exudate within the Achilles tendon bursa with thickening and vascularization of bursal synovium; delaminated tendon tears infiltrated by the vessels of the inflamed bursa.

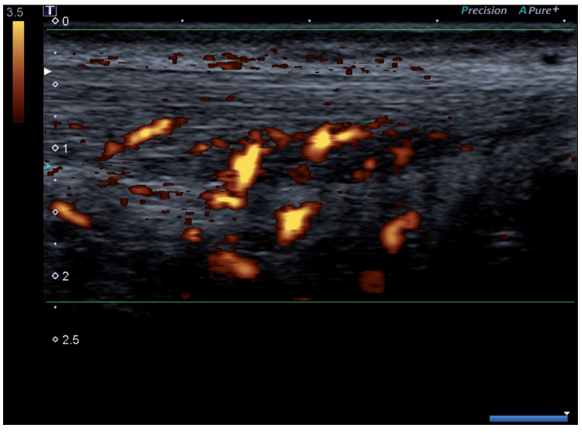

Figure 3. Edema and hypervascularization of Kager's fat pad; tendon infiltrated by the vessels of the inflamed adipose tissue.

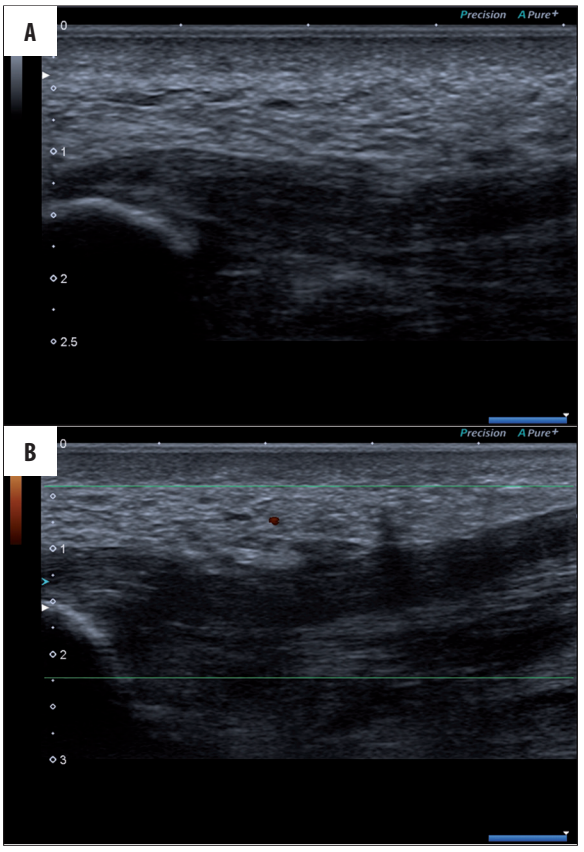

Figure 4. Plantar aponeurosis and enthesis in B-mode (**A**) and PDUS (**B**) scans: thickened, hypoechogenic, delamination areas, no signs of vascularization.

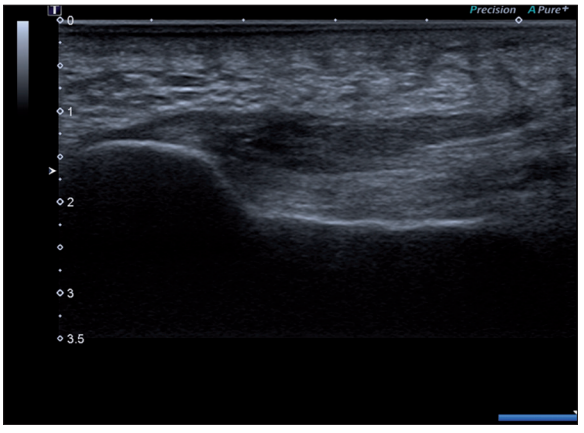

Figure 5. Delaminated tears not yielding to probe compression (sclerosing scars) in the proximal segment of plantar aponeurosis; entheses of plantar aponeurosis and flexor digiti brevis tendon are normal.

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 Entesitis 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

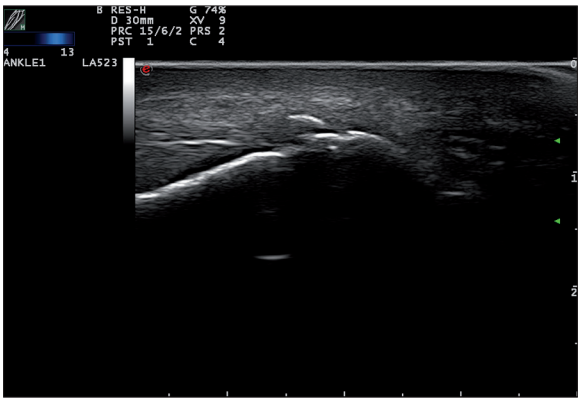

Figure 6. Mineralized scars and erosion within the enthesis of plantar aponeurosis.

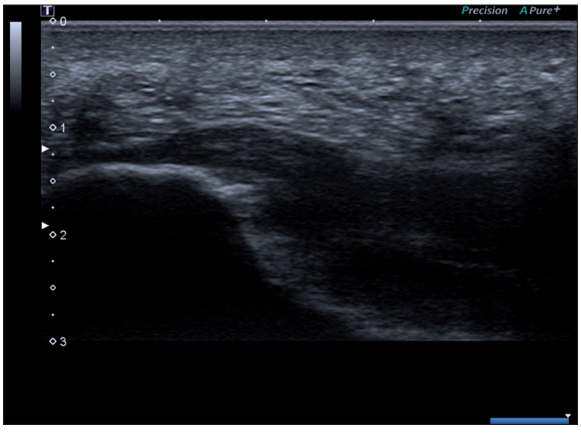

Figure 7. Enthesophytes within the flexor digiti brevis tendon enthesis concomitant to enthesopathy within the plantar aponeurosis.

basis of the presence of enthesophytes) [18]. Other authors point out that spectrum of lesions observed in ultrasound scans of enthesitis is identical as that in other degenerative enthesopathies and chronic (micro)injuries [7–9,12,13,19]. 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 89.5% 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 hypoechogenic.

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.

PDUS and magnetic resonance imaging (MRI) studies conducted by Feydy et al. in 2011 [12] revealed that

enthesopathic lesions within the Achilles tendon and plantar aponeurosis (including echostructure disturbances, thickening, abnormal bursal vascularization, Achilles tendon vascularization, plantar 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. Feydy et al. [12] identified the hypervascularization 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 material, scars of this type revealed no features of vascularization (underwent complete remodeling).

No cases of hypervascularization of plantar aponeurosis were observed in our study. It is possible that it would become evident in individuals with very active inflammation [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 hypothesis 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 inflammation in the course of rheumatoid diseases (particularly RA and OA) [25–28].

Conclusions

As suggested by the results of our studies, clinical suspicion of enthesitis is difficult to confirm by ultrasonography. A significant percentage of clinically painful entheses is unremarkable in ultrasound scans. In the remaining cases, ultrasound scan abnormalities are not enthesitis-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 specific imaging markers are sought after for possibly fastest diagnosis.

References:

1. Eshed I, Bollow M, McGonagle D et al: MRI of enthesitis of the appendicular skeleton in spondyloarthritis. Ann Rheum Dis, 2007; 66: 1553–59
2. Sudoł-Szopińska I, Urbanik A: Diagnostic imaging of sacroiliac joints and the spine in the course of spondyloarthropathies. Pol J Radiol, 2013; 78(2): 43–49
3. Balint PV, Kane D, Wilson H et al: Ultrasonography of entheseal insertions in the lower limb in spondyloarthropathy. Ann Rheum, 2002; 61: 905–10
4. McMichael A, Bowness P: HLA-B27: natural function and pathogenic role in spondyloarthritis. Arthritis Res, 2002; 4(Suppl.3): 153–58
5. Maffulli N, Kader D: Tendinopathy of tendo Achillis. J Bone Joint Surg, 2002; 84: 1–8
6. O'Connor P: Crystal deposition disease and proriatic arthritis. Semin Musculoskelet Radiol, 2013; 17: 74–79
7. Czyrny Z: Diagnostic anatomy and diagnostics of enthesal pathologies of the rotator cuff. J Ultrason, 2012; 12: 178–87
8. Dębek A, Nowicki P, Czyrny Z: Ultrasonographic diagnostics of pain in the lateran cubital compartment and proximal forearm. J Ultrason, 2012; 12: 188–201
9. D'Agostino MA, Aegerter P, Bechara K et al: How to diagnose spondyloarthritis early? Accuracy of peripheral enthesitis detection by power Doppler ultrasonography. Ann Rheum, 2011; 70: 1433–40
10. Natvig BN, Picavet HSJ: The epidemiology of soft tissue rheumatism. Best Pract Res Clin Rheumatol, 2002; 16(5): 777–93
10. D'Agostino MA, Aegerter P, Jousse-Joulin S et al: How to evaluate and improve reliability of power Doppler ultrasonography for assessing enthesitis in spondyloarthritis. Arthritis Rheum, 2009; 61: 61–69
11. D'Agostino MA: Enthesitis. Best Pract Res Clin Rheumatol, 2006; 20: 473–86
12. Feydy A, Lavie-Brion MC, Gossec L et al: Comparative study of MRI and power doppler ultrasonography of the heel in patients with spondyloarthritis with and without heel pain and in controls. Ann Rheum, 2012; 71: 498–503
13. Genc H, Cakit BD, Tuncbilek I et al: Ultrasonographic evaluation of tendons and entheseal sites in rheumatoid arthritis: comparison with ankylosing spondylitis and healthy subjects. Clin Rheumatology, 2005; 24: 272–77
14. Francois RJ, Braun J, Khan MA: Entheses and enthesitis: a histopathological review and relevance to spondyloarthrides. Curr Opin Rheumatol, 2001; 13: 255–64
15. Healy PJ, Helliwell PS: Measuring enthesitis in psoriatic arthritis: assessment of existing measures and development of an instrument specific to psoriatc arthritis. Arthritis Rheum, 2008; 59: 686–91
16. Eder L, Barzilai M, Peled N et al: The use of ultrasound for the assessment of enthesitis in patients with spondyloarthritis. Clinical Radiology, 2013; 68: 219–23
17. D'Agostino MA, Said-Nahal R, Hacquard-Bouder C et al: Assessment of peripheral enthesitis in the spondyloarthropathies by ultrasonography combined with power Doppler. Arthritis Rheum, 2003; 48(2): 523–33
18. D'Agostino MA, Aegerter P, Jousse-Joulin S et al: How to evaluate and improve the reliability of power Doppler ultrasonography for assessing enthesitis in spondyloarthritis. Arthritis Rheum, 2009; 61: 61–69

19. Czyrny Z: Sonographic and histological appearance of heel enthesopathy, what the „heel spurs" really are and what their consequencies. J Ortop Trauma Surg Rel Res, 2010; 2(18) 23–36
20. Sparado A, Iagnocco A, Perrotta FM et al: Clinical and ultrasonography assessment of peripheral enthesitis in ankylosing spondylitis. Rheumatology, 2011; 50: 2080–86
21. de Miguel E, Cobo T, Munoz-Fernandez S et al: Validity of enthesis ultrasound assessment in spondyloartropathy. Ann Rheum Dis, 2009; 68: 169–74
22. Benjamin M, McGonagle D: The enthesis organ concept and its relevance to the spondyloarthropathies. In: Lopez-Larrea C, Diaz-Pena R (eds.): Molecular mechanisms of spondyloarthropathies. (ed.) Springer-Science + Business Media LLC, New York, 2009; 57–70
23. D'Agostino MA, Palazzi C, Olivieri I: Entheseal involvment. Clin Exp Rheumatol, 2009; 27(Suppl.55): S50–55
24. Benjamin M, McGonagle D: Histopathologic changes at "synovio-entheseal complex" suggesting a novel mechanism for synovitis in osteoarthritis and spondylitis. Arthritis Rheum, 2007; 56(11): 3601–9
25. Sudoł-Szopińska I, Kontny E, Maśliński W et al: The pathogenesis of rheumatoid arthritis in radiological studies. Part I: Formation of inflammatory infiltrates within synovial membrane. J Ultrason, 2012; 12(48): 202–13
26. Sudoł-Szopińska I, Zaniewicz-Kaniewska K, Warczyńska A et al: The pathogenesis of rheumatoid arthritis in radiological s Part II: Imaging studies in rheumatoid artritis. J Ultrason, 2012; 12(49): 319–28
27. Sudoł-Szopińska I, Kontny E, Zaniewicz-Kaniewska K et al: Role of inflammatory factors and adipose tissue in pathogenesis of rheumatoid arthritis and osteoarthritis. Part I: Rheumatoid adipose tissue. J Ultrason, 2013; 13(53): 192–201
28. Sudoł-Szopińska I, Kontny E, Zaniewicz-Kaniewska K et al: Role of inflammatory factors and adipose tissue in pathogenesis of rheumatoid arthritis and osteoarthritis. Part II: Inflammatory background of osteoarthritis. J Ultrason, 2013; 13(54): 319–28