Evaluation of plantar fascia thickness in Egyptian patients with spondyloarthropathy

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Purpose
To measure plantar fascia (PF) thickness in Egyptian patients with spondyloarthropathy (SpA) using high-resolution musculoskeletal ultrasound and to assess its relationship with age, sex, BMI, and clinical and laboratory parameters of disease activity.
Patients and methods
PF thickness was measured in 50 patients with SpA (diagnosis based on Amor criteria), in addition to 100 healthy volunteers as a control group, using 7–13-MHz linear array transducer.
Results
The mean PF thickness in patients with SpA was 5.17±1.25 mm, whereas it was 3.06±0.65 mm in the control group, with significant difference ($P<0.05$); however, there was no statistically significant difference regarding sex. The mean thickness is significant higher in obese and old patients ($P<0.05$). There was a significant correlation between PF thickness and age, BMI, clinical, and laboratory parameters of disease activity in patients with SpA ($P<0.05$).
Conclusion
SpA is frequently associated with plantar fasciitis. Plantar fasciitis in patients with SpA may be clinically asymptomatic and early diagnosed with ultrasonography. PF mean thickness was found to be more than 4 mm in most patients with SpA. Its thickness is associated with disease activity and functional impairment.

Keywords:
plantar fascia, spondyloarthropathy, thickness, ultrasonography

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Introduction

Heel pain has many causes such as plantar fasciitis, tarsal tunnel syndrome, radiculopathy, peripheral neuropathy, infections, tumors, calcaneal stress fracture, and rheumatologic diseases in bilateral cases [1].

Spondyloarthropathy (SpA) is a group of chronic inflammatory diseases characterized by inflammatory back pain, sacroiliitis, and inflammatory manifestations in peripheral joints and entheses [2]. The enthesitis in SpA mostly affects the plantar fascia (PF) attachments with calcaneus. SpA is a risk factor for the development of plantar fasciitis because of mechanical stress and repeated microtrauma [3].

Plantar fasciitis is the most common cause of heel pain [4]. Diagnosis is primarily based on thorough history and clinical examination [5]. The pain regularly starts in the morning and diminishes gradually as the patient walks, with the medial plantar part of the heel the most common painful location [6].

Because the heel is a location for many potential injuries and the diversity of clinical symptoms of plantar fasciitis, the determination of PF thickness is impressive in diagnosing plantar fasciitis [7].

Ultrasonography (US) is an accurate, easy, and quick method for identifying PF thickness. It is important to detect the normal thickness of the PF, as increased PF thickness and hypoechogenicity are sonographic features of plantar fasciitis [8].

In this study, we aimed to measure PF thickness in Egyptian patients with SpA using high-resolution musculoskeletal ultrasound (MSKUS) and to assess its relationship with age, sex, BMI, clinical, and laboratory parameters of disease activity.

Patients and methods

Study design

This study included 50 patients with SpA who fulfilled Amor criteria for SpA [9]. There were 35 (70%) males

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and 15 (30%) females, with a mean age of 37.2±13.2 years (18–55 years). In addition, 100 healthy volunteers of matched age and sex were included, comprising 60 (60%) males and 40 (40%) females, with a mean age of 40.8±11.9 years (22–63 years). The study participants were recruited from the Outpatient Clinic of Rheumatology and Rehabilitation Department, University Hospitals.

Individuals having neuropathic or radicular pain, acute heel trauma, another inflammatory disease, chronic infection, previous heel pain, previous surgery in the heel region, and previous local corticosteroid injection in the PF 6 weeks before the study were excluded.

All patients with SpA were subjected to complete history taking and clinical examination of PF by windlass test [10] (pain with palpation of the medial aspect of the heel and with passive dorsiflexion of the ankle scored on a visual analog scale from 1 to 10). Moreover, the weight, height, and BMI of the patients were assessed. Disease activity was assessed by the Bath Ankylosing Spondylitis Disease Activity Index (BASDAI) [11]. Functional assessment was done by the Bath Ankylosing Spondylitis Functional Index (BASFI) [12]. Laboratory investigations including erythrocyte sedimentation rate (ESR), C-reactive protein (CRP), and human leukocytic antigen B27 were also determined for all patients.

The PF thickness assessment was performed in the Ultrasound Unit of the Rheumatology Department, Tanta University Hospitals (Samsung Medison, UGEO H60 made in Korea) with linear array transducers (7–13 MHz), by an expert rheumatologist (EULAR certified) in MSKUS imaging on the same day of the physical and laboratory evaluation.

The measurements were performed with the patient in the prone position, the hips and knees in extension, and ankles in plantar flexion and slight inversion. The PF thickness was measured at its insertion into the calcaneus. Imaging of PF was conducted by two-dimensional, B-mode scanning. To increase the reliability, the measurement was repeated twice, and the mean of these measurements was taken [13,14]. A perpendicular position was maintained at all times to avoid anisotropy. Sonographic features of PF thickness, echogenicity, and the calcaneal bone surface irregularity were evaluated.

Research ethics standard compliance

The study was approved by the local Ethics Committee of Faculty of Medicine, Tanta University, with Approval Code 34079. The written informed consent from all the patients was obtained, and the trial was conducted according to the Declaration of Helsinki principles.

Statistical analysis

It was performed by SPSS software statistical computer package, version 16 (Levesque R. (2007): SPSS Programming and Data Management: A Guide for SPSS and SAS Users (4th ed.). Chicago, Illinois: SPSS Inc.). Results were expressed for quantitative data as mean±SD, and for descriptive data as number and percentage. Paired *t* test was used in comparing groups for significant differences, and the Pearson correlation was used in measuring the correlation coefficients. Statistical significance was evaluated at the *P* value less than 0.05.

Results

A total of 300 feet in 150 participants were included in this study. A total of 50 patients had SpA, comprising 35 (70%) males and 15 (30%) females, with a mean age of 37.2±13.2 years (18–55 years), and 100 individuals were healthy volunteers, comprising 60 (60%) males and 40 (40%) females, with a mean age of 40.8±11.9 years (22–63 years), with no significant difference between both groups regarding age and sex (Table 1).

Table 1 Demographic, clinical, and laboratory characteristics of the study participants

	Patients with SpA (*N*=50)
Age (years)	37.2±13.2
Sex (male : female)	35 : 15
Disease duration (years)	8.2±3.8
SpA subtype [*n* (%)]	
AS	17 (34)
PsA	22 (44)
ReA	9 (18)
IBD	2 (4)
BASDAI	4.9±2.2
BASFI	4.8±2.7
ESR (mm/h)	29.8±22.7
CRP (mg/l)	18.8±33.2
HLA-B27 +ve [*n* (%)]	24 (48)
Treatment [*n* (%)]	
NSAIDs	45 (90)
Methotrexate	35 (70)
Sulfasalazine	22 (44)
Anti-TNF-α	10 (20)

anti-TNF, antitumor necrosis factor-α; AS, ankylosing spondylitis; BASDAI, Bath Ankylosing Spondylitis Disease Activity Index; BASFI, Bath Ankylosing Spondylitis Functional Index; CRP, C-reactive protein; ESR, erythrocyte sedimentation rate; HLA, human leukocytic antigen; IBD, inflammatory bowel disease; PsA, psoriatic arthritis; ReA, reactive arthritis; SpA, spondyloarthropathy.

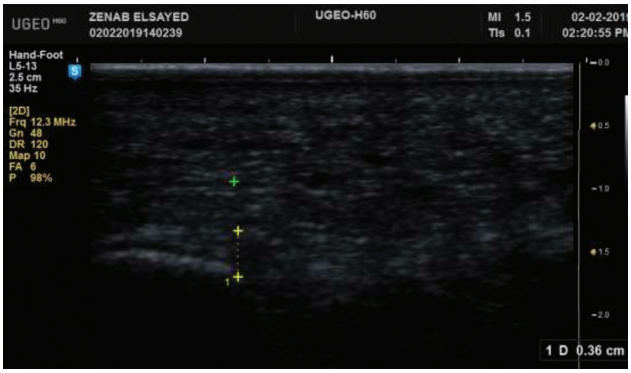
Among our 50 patients with SpA, 23 (46%) patients had clinical pain and tenderness with windlass test, all of them had PF thickening, 27 (54%) patients did not have clinical heel pain, and ~44.4% of them had subclinical PF thickening evaluated by MSKUS (Figs 1–3 and Table 2).

The mean PF thickness for the patients with SpA was 5.17±1.25 mm (3.9–7.4 mm), with 95% confidence interval 5.04–5.30, whereas it was 3.06±0.65 mm (2.0–4.4 mm) in the control group, with 95% confidence interval being 3.03–3.29. The mean PF thickness among male patients was 5.31±1.22 mm (4.4–7.4 mm), with 95% confidence interval being 5.11–5.50, whereas among female patients was 5.09 ±1.26 mm (3.9–7.2 mm), with 95% confidence interval being 4.91–5.26. The mean value of PF thickness on right side was 5.22±1.27 mm (3.9–7.4 mm), with 95% confidence interval being 5.03–5.41, and on left was 5.12±1.23 mm (4.1–7.0 mm), with 95% confidence interval being 4.96–5.30 (Table 3).

The mean value of PF thickness in patients with SpA was significantly higher than controls (P=0.002). There was no significant difference in thickness between male and female patients or between right and left side (P=0.105, 0.444, respectively). On the contrary there was a significant difference in planter fascia thickness between the low and high BMI groups (P=0.005) and in patients older than 40 years old than the younger ones (P<0.001) (Table 4).

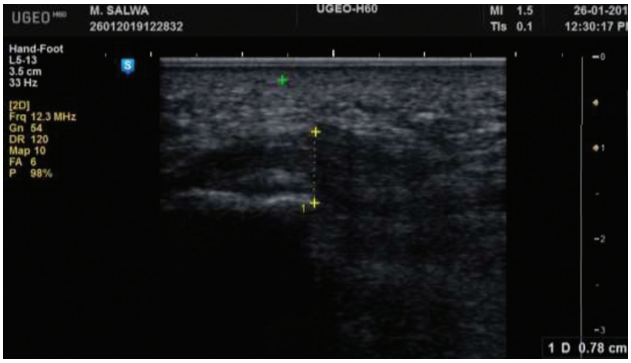
There was a significant positive correlation between age, BMI, Windlass test, BASDAI, BASFI, ESR, and CRP and the mean value of PF thickness in patients with SpA (P<0.05). However, there was no significant correlation between PF thickness and sex difference (Table 5).

Figure 1



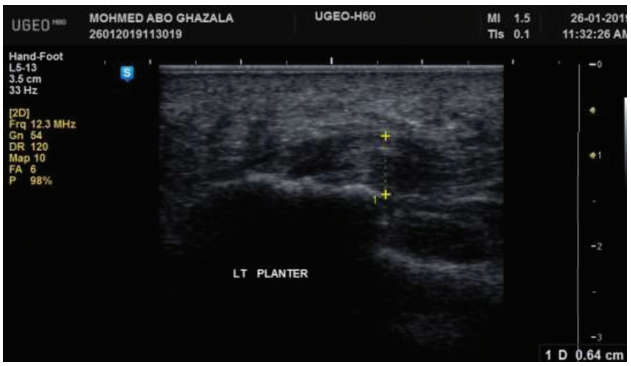
Ultrasonographic plantar fascia thickness at its insertion into the calcaneus in a healthy participant.

Figure 2



Ultrasonographic plantar fascia thickness in a 42-year-old female patient with spondyloarthropathy showing increased thickness with decreased echogenicity.

Figure 3



Ultrasonographic plantar fascia thickness of a 30-year-old male patient with spondyloarthropathy showing increased thickness, decreased echogenicity, and cortical bone irregularity.

Discussion

PF is the strong, fibrous layer of the sole of the foot [15]. It is the major arch support [16]. Many local and systemic conditions may cause acute or chronic heel

Table 2 Ultrasonographic assessment of patients with spondyloarthropathy with and without clinical symptoms

Ultrasound findings	Patients with spondyloarthropathy [*n* (%)]	
	Clinical +ve (*N*=23)	Clinical –ve (*N*=27)
Plantar fascia thickening	23 (100)	12 (44.44)
Hypoechogenicity	12 (52.2)	6 (22.2)
Bone irregularity	16 (70)	10 (37.04)

Table 3 Mean plantar fascia thickness among the study participants

	Mean±SD	95% confidence interval	Range
Patients with SpA (100 feet)	5.17±1.25	5.04–5.30	3.9–7.4
Controls (200 feet)	3.06±0.65	3.03–3.29	2.0–4.4
Male patients (70 feet)	5.31±1.22	5.11–5.50	4.4–7.4
Female patients (30 feet)	5.09±1.26	4.91–5.26	3.9– 7.2
Right side (50 feet)	5.22±1.27	5.03–5.41	3.9–7.4
Left side (50 feet)	5.12±1.23	4.96–5.30	4.1–7.0

SpA, spondyloarthropathy

Table 4 Paired samples test of ultrasonographic plantar fascia thickness values

	Mean difference	Std. error	95% CI		*P* value
			Lower	Upper	
Patients–controls	2.11	0.32	1.85	2.47	0.002*
Male–female	0.21	0.13	–0.05	0.47	0.105
Right–left	0.10	0.13	–0.16	0.36	0.444
<25 BMI (15)					
>25 BMI (35)	–0.40	0.14	–0.67	–0.12	0.005*
<40 years (30)					
>40 years (20)	–0.57	0.12	–0.81	–0.33	< 0.001*

CI, confidence interval; BMI, body mass index..

Table 5 Correlation of ultrasongraphic plantar fascia thickness with demographic, clinical, and laboratory parameters of SpA patients

	Ultrasonographic plantar fascia thickness	
	r	*P* value
Age	0.388	<0.001*
Sex	–0.161	0.109
Windlass test	0.230	0.040*
BASDAI	0.462	<0.001*
BASFI	0.361	<0.001*
BMI (kg/m^2)	0.842	0.009*
ESR (mm/h)	0.199	0.047*
CRP (mg/l)	0.780	0.001*

BASDAI, Bath Ankylosing Spondylitis Disease Activity Index; BASFI, Bath Ankylosing Spondylitis Functional Index; BMI, body mass index; CRP, C-reactive protein; ESR, erythrocyte sedimentation rate; SpA, spondyloarthropathy.

pain. Plantar fasciitis is the commonest cause of heel pain [17].

SpA is a group of inflammatory arthritis that includes ankylosing spondylitis, psoriatic arthritis, reactive arthritis, and enteropathic arthritis associated with inflammatory bowel disease. The shared manifestations of the SpA are positive human leukocytic antigen B27, peripheral joint arthritis, enthesitis, sacroiliitis, dactylitis, spondylitis, and uveitis [18].

Peripheral enthesitis is considered a hallmark in SpA. It distinguishes SpA from other inflammatory rheumatic disorders [19]. Plantar fasciitis is the most commonly affected peripheral entheses in SpA.

Our study included 300 feet in 150 participants. There were 50 patients with SpA and 100 healthy volunteers. In our study, the US evaluation has been done at the calcaneal insertion of PF as a landmark of measurement due to easy and accurate delineation of the PF margins.

Pascual *et al.* [20] reported that PF thickness is quite variable at its proximal part but tends to be more regular distally which could be a good indicator of PF thickness. However, Uzel *et al.* [21] did not find differences in PF thickness at two different locations at its origin and 5 mm distal from origin.

Among our 50 patients with SpA, only 23 (46%) patients had clinical pain and tenderness with windlass test, 27 (54%) patients did not have any clinical heel pain, ~44.4% of them had subclinical PF thickening, 22.2% had hypoechogenicity, and 37.04% had bone irregularities with US evaluation (Table 2).

This was in agreement with other studies assessing PF enthesitis in patients with spondylarthritis, which showed that painful PF on clinical examination ranged from 12 to 67% of the studied enthesis [22,23]. In this study, PF affection was more frequently detected by MSKUS, which is superior to clinical and plain radiograph examinations. They

concluded that US is the modality of choice for PF assessment, in both symptomatic and asymptomatic patients [22].

Another study conducted on 40 patients with SpA assessing Achilles tendon and PF found that 60.2% of them did not show any clinical symptoms of enthesitis, although having subclinical MSKUS abnormalities [24]. They and others confirmed that US assessment of PF was very sensitive in detecting subclinical enthesitis missed during routine clinical assessment [24–26].

The mean PF thickness in our patients with SpA was 5.17±1.25 mm (range, 3.9–7.4 mm) and in controls was 3.06±0.65 mm (range, 2.0–4.4 mm), with significant difference in thickness between patients and controls (P=0.002) (Tables 3 and 4).

Similar results were obtained by a previous US study of Egyptian patients with SpA, which reported that mean US enthesitis score and the mean thickness of the examined PF were significantly higher in patients with SpA than in controls (P<0.0001) [27].

Baccouche *et al*. [24] found that PF involvement in patients with SpA was more frequent and more severe with evidence of subclinical enthesitis.

Moreover, Wearing *et al*. [28] and Akfirat *et al*. [29] found the mean PF thickness within 1 cm of its calcaneal insertion to be 6.1±1.43 and 4.8±1.52 mm in their patients.

In this study, there was no significant difference between the mean value of PF thickness in male and female patients with SpA (P=0.105) or between right and left side. This may be explained by the fact that both feet are used equally in our daily activities unlike upper limbs which could be controlled by handedness (P=0.444) (Tables 3 and 4).

Hassan *et al*. [30] studied peripheral enthesopathy in early SpA and found the number of clinically abnormal entheses was 52 (14%) per 360, whereas the US abnormal entheses was 239 (66.3%) per 360 of the examined enthuses, showing that MSKUS is more important than clinical examination in peripheral enthesopathy assessment. They reported no statistically significant difference between male and female patients with SpA in respect to US score.

Against our results, De Miguel *et al*. [31] and Cobo-Ibáñez *et al*. [32] found a statistically significant difference between US score in male than female patients with SpA (P>0.01 and P>0.07, respectively); this discrepancy may be owing to differences in disease duration.

Wall *et al*. [33] found no significant differences of the PF thickness values between males and females and also between the left and right feet in their patients with plantar fasciitis.

Against our findings, a review about differences between men and women with SpA found that women tend to have greater enthesitis than men do [2]. A significant difference between male and female PF thickness levels (P<0.05) was found in another studies [21,34]. They explained this by possible anatomical difference in sex.

In our study, there was a significant difference in PF thickness according to age and BMI variations (Tables 3 and 4).

This was in agreement with other studies, which found plantar fasciitis to be more common in middle and old age, and increased body weight was reported to play an important role as a risk factor for plantar fasciitis development [35,36].

In that study, a significant positive correlation between age, BMI, Windlass test, BASDAI, BASFI, ESR, and CRP and the mean value of PF thickness in patients with SpA was noticed (P<0.05). There was no significant correlation between planter fascia thickness and sex difference (Table 5).

Maatallah *et al*. [22] and Feydy *et al*. [37] documented a significant association between clinical pain on PF palpation and US findings, with the clinical examination performed on the same day of US examination.

D'Agostino *et al*. [38], Alcalde *et al*. [39], and Ezzat *et al*. [27] found that there was no association between PF clinical and US examinations findings. There was no significant correlation between the mean Glasgow Enthesitis Scoring System and clinical and laboratory variables.

Baccouche *et al*. [24] reported a significant correlation between clinical and US assessment (P=0.01) in patients with SpA, with no significant correlation between US assessment and BASDAI, BASFI, or treatment.

Hassan *et al*. [30] showed that US score was correlated with the disease duration in patients with SpA but no correlation was found with the age, the sex, or BASDAI in the patients.

This was in agreement with Narindra *et al*. [40], who found a positive correlation of PF thickness with age and BMI ($P<0.05$). The variation of the PF thickness with sex was not significant ($P>0.05$). They thought that body weight produced a continuous, long-term biomechanical stress on the PF and that body height had a constitutional effect on its thickness.

Similar to our results, Uzel *et al*. [21], and Huerta *et al*. [41] found a moderate correlation between PF thickness and weight, height, and BMI in healthy, asymptomatic patients.

Amin *et al*. [42] documented a statistically significant ($P<0.05$) correlation between sex, age, weight, BMI, and height and PF thickness in asymptomatic local healthy population.

Dhakal *et al*. [34] evaluated PF thickness of 700 feet among healthy participants as young as 15 years and as old as 86 years. They stated that all five variables, that is, age, sex, weight, height, and BMI were mildly correlated with PF thickness, and all were significant ($P<0.001$).

Balint *et al*. [23] found no significant correlation between acute-phase reactants and US findings in their study to detect entheseal abnormality of the lower limb in patients with SpA.

There is one major limitation in our study that we only use gray-scale imaging in US evaluation of the PF in the patients with SpA, although an increase in the blood flow of the fascia is a major criterion of plantar fasciitis that need to be assessed with power Doppler signals.

Conclusion

MSKUS assessment is better than clinical assessment of plantar fasciitis in patients with SpA, with PF thickness, hypoechogenicity, and bone irregularities being the most common US features of plantar fasciitis.

Main points:

(1) Plantar fasciitis is the most common cause of heel pain.
(2) PF thickness is impressive in diagnosing plantar fasciitis.
(3) US is an accurate, easy and quick method for identifying PF thickness.
(4) Plantar fasciitis is one of the most commonly affected peripheral entheses in SpA, which distinguishes SpA from other inflammatory rheumatic disorders.

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Conflicts of interest

There are no conflicts of interest.

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