

Ultrasound and MRI Findings in Patients with Planter Fasciitis

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Abstract

planter fasciitis is the most common painful heel condition caused by inflammation at the insertion of the planter fascia on the medial process of the calcaneal tuberosity...it is usually clinically diagnosed but radiological imaging used for confirmation of the diagnosis and exclusion of the other conditions (such as foreign bodies, PF rupture, calcaneal bursitis...etc.) that may have same clinical presentation. The aim of the study is to assess the ultrasonography and MRI findings in patients with planter fasciitis. In across sectional study of 34 patients(16 men and 18 women) with suspected unilateral or bilateral plantar fasciitis, 46 symptomatic heels were examined by both high-resolution ultrasound and magnetic resonance imaging (MRI) protocol to assess the different signs;11 healthy volunteers (22 heels) acted as controls. Results show that in symptomatic feet, the plantar fascia was thickened. The thickness of the plantar fascia in symptomatic feet was (3.5–7.5 mm in range; mean 5.5mm ± 1.3) measured by ultrasound which was significantly thicker than in the control group (2–2.8 mm in range; mean 2.4mm± 0.07); P < 0.05. Other sonographic signs used for the diagnosis of plantar fasciitis in the study were compared to MRI findings. The diagnostic accuracy was 78.2% for abnormal intrinsic echogenicity within the plantar fascia, 73.9% for focal thickening ,60.8% for subcutaneous edema around the plantar fascia, and the lowest diagnostic accuracy of ultrasound was in detection of associated calcaneal spur (56.5%). The findings were compared and discussed in relation to other thesis. Ultrasonographic diagnosis of planter fasciitis is a useful tool compared to MRI and it could be the easy initial imaging modality for confirmation of clinically suspected plantar fasciitis. MRI may be kept for cases where a diagnosis of plantar fasciitis does not confidently explain the clinical presentation and when complex pathology is suspected.

Keywords: plantar fasciitis; ultrasound; MRI.

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1. Introduction

Plantar fasciitis (PFS) is defined as painful heel condition that can affect both sedentary and active individuals, it is most often seen in the adult population it may be associated with a contracture of the gastrocnemius- soleus complex [1]. It is the most common type of planter fascia injury, that occur in men and women in a relatively equivalent ratio as well as in both athletic populations and individuals who live more sedentary lifestyle [2]. PFS estimated to affect 10% of general population during middle age [3] also 8% of foot injuries in runners are related to PFS [4]. The planter fascia stiffens and becomes less pliable with age [5]. The etiology and dysfunction of the planter fascia is multifactorial, but most commonly it is a result of micro-trauma (micro-tears) due to repetitive overload placed on the connective tissue in the plantar region, with time, the micro-tears cause structural fatigue and weakening of the connective tissue, resulted in an inflammatory response, pain and discomfort [6]. Although it is more commonly seen in individuals between the ages of 40-70 years, the most notable medical conditions associated with plantar fasciitis, are sero-negative spondyloarthropathies and rheumatoid arthritis [7]. About 90% to 95% of patients will get improvement within a year regardless of the specific treatment offered [1]. Ultrasound offers an easier, cost effective, faster, and non-invasive approach with better patient tolerance, and enhanced ability to display enthesopathy associated with inflammation [8]. On ultrasound, normal planter fascia shows a fibrillar pattern similarly to ligaments, due to the hyper-echoic appearance of type I collagen fiber bundles embedded within a background of hypo-echoic matrix [9]. Ultrasonographic characteristics of plantar fasciitis include: loss of fibrillar pattern, increased thickness over 4 mm (measured the max. thickness about 15 mm from the calcaneal insertion), peri-fascial fluid collections and calcifications within the planter fascia. Doppler ultrasound can identify hyperaemia in the planter fascia, near its proximal insertion and in the perifascial soft tissue, in patients with plantar fasciitis [10]). Magnetic resonance imaging (MRI) is regarded as the most sensitive imaging modality for diagnosing plantar fasciitis. It enables to determine the exact location and extent of the inflammatory process as well as to detect the signal changes within adjacent soft tissue or bone marrow [2]. The planter fascia is homogeneously hypo-intense on both T1-weighted and fluid-sensitive sequences in healthy individuals. MRI findings of plantar fasciitis include: planter fascia thickening, most commonly at its calcaneal origin, intra-substance areas of intermediate signal on T1-weighted sequences and increased signal on fluid-sensitive sequences, adjacent soft tissue edema and bone marrow edema of the calcaneal attachment of the planter fascia [7].

Aim of the study

To assess the ultrasound and MRI findings in patients with plantar fasciitis.

2. Patients and Methods

This cross sectional analytic study was conducted in the radiology department of Al- Imamain Al-Kadhymain medical city/ Baghdad/ Iraq, between October 2017 and December 2018. The study included 34 patients (16 male and 18 female, age range 27-65 years with mean age of 44.38 ± 8.9 years) suffering from heel pain with high clinical suspicion of plantar fasciitis. An informed oral consent was taken from all patients included in this study

Inclusion criteria: patients complaining from heel pain (acute or chronic) that were worst at the morning with tenderness along the medial calcaneal tuberosity, suggestive of planter fasciitis.

Exclusion Criteria: patients with history of local inflammation, trauma, and heel surgery, presence of any significant deformity or mass lesion that can prevent proper ultrasound or MRI examination and patients with any contraindication to MRI .

The total number of examinations was 68 heels divided into 2 groups: Group 1 (Symptomatic group): include 46 heels with clinical diagnosis of planter fasciitis (22 patients have unilateral complain and 12 patients with bilateral complain) and group 2 (control group): include 11 volunteers (22 heels) with no history of planter fasciitis

Ultrasound examination: all ultrasound examinations were performed by using linear array transducer 11L(11MHz) using sophisticated ultrasound system (Voluson E6,GE, USA). The examination was performed in the prone position with the patient's feet in dorsiflexion position and hanging over the edge of the table. Ultrasound scan was done for both heels with a slight medial inclination toward the attachment of the plantar fascia to the os calcaneum for better visualization of the long axis of the plantar fascia fibers. The focus and gain were adjusted for good penetration of the thick skin of the heel. The US examination was performed for: maximum thickness of the plantar fascia (measured about 1.5-2cm from the calcaneal attachment), presence of focal thickening, echogenicity and homogeneity of the plantar fascia, presence or absence of subcutaneous edema, adjacent fluid collection and/or calcification and incidental pathological findings such as associated calcaneal spur.

MRI examination: all patients were examined by MRI using a 3 Tesla closed superconducting magnet (Achieva, Philips, Netherlands) with a dedicated ankle coil. The patients were examined using the following sequences: Sagittal T1 weighted sequence (TR 500, TE 20, slice thickness 3mm, gap 10%, 20cm field of view, matrix 476x534, flip angle 900), sagittal T1 weighted with fat saturation (SPIR) sequence (TR 500, TE 20, slice thickness 3mm, gap 10%, 20cm field of view, matrix 444x504, flip angle 900, IR delay 400 ms), coronal proton density weighted (PD) sequence (TR 3500, TE 30, slice thickness 4mm , gap 10%, 16cm field of view, matrix 380x224) and coronal proton density weighted fat suppression (PD-fat sat) sequence (TR 2354, TE 30, slice thickness 2.5mm, gap 10%, 15cm field of view, matrix 380x224). All MRI images were interpreted independently by 2 specialist radiologist. The plane of images was slightly inclined medially. Intravenous contrast (gadolinium) injection was not used in the examination. The total number of examinations was 68 heels. In bilateral cases both sides were examined separately using the same protocol (controlled group included in MRI examination). A systematic approach was used: the maximum thickness of the plantar fascia (measured about 1.5-2 cm from the calcaneal insertion), presence or absence of focal thickening, abnormal signal intensity, calcification and adjacent subcutaneous edema

Statistical analysis: Data were analyzed with SPSS v20 statistical package. Mean and standard deviation were used for calculation of normal and abnormal categorical variables such as age, sex, thickness measured by ultrasound and MRI. Kappa statistics were used for determination of agreement for ultrasound and MRI

categorical variables. Paired t-test was used for determination of significant differences in thickness for diseased patients in both ultrasound and MRI. A P – Value of less than 0.05 was considered to be statistically significant.

3. Results

The total number of patients was 34 (16 male and 18 females) with an age ranged from 27 to 65 years (mean 44.38±8.9 years). In symptomatic feet the plantar fascia thickness was (3.5–7.5 mm in range; mean 5.5±1.3) measured by ultrasound and (3.2 –6.9 mm in range; mean 4.95±1.1) measured by MRI. The plantar fascia in symptomatic feet was significantly thicker than in the control group (2–2.8 mm in range; mean 2.4±0.07), (2.2-2.9 mm in range; 2.7±0.05 mm) measured by ultrasound and MRI respectively; P < 0.05 (Table 2).

Table 2: Plantar fascia thickness measured by U/S and MRI in symptomatic and control groups

	Symptomatic group (46 heels)	Control group*(22 heels)	P value	r
Ultrasound	Mean 5.5±1.3mm Range 3.5–7.5mm	Mean 2.4±0.07mm Range 2-2.8 mm	< 0.05	0.854
MRI	Mean 4.95±1.1mm Range 3.2-6.9mm	Mean 2.7±0.05mm Range 2.2-2.9mm	< 0.05	0.798

On ultrasound 41 heels in the symptomatic heel showed abnormal focal low echogenicity in the plantar fascia and 35 of the same group showed abnormal signal intensity within the plantar fascia on MRI examination. Thirty six of the symptomatic heels showed abnormal focal thickening in the plantar fascia and 36 of the same group showed abnormal thickening within the plantar fascia on MRI examination. In symptomatic heels, Edema around the plantar fascia and/or in the adjacent soft tissues was detected by ultrasound in 10 cases and by MRI in 24 cases. Bony calcaneal spurs were detected in 4 cases by ultrasound and 24 by MRI. (Table 3).

Table 3: Incidence of different diagnostic signs in ultrasound and MRI

Diagnostic signs	Ultrasound		MRI		Total
	+ve	-ve	+ve	-ve	
Abnormal signal or echogenicity	41	5	35	11	46
Focal thickening	36	10	36	10	46
Subcutaneous Edema	10	36	24	22	46
Calcaneal spur	4	42	24	22	46

Incidental pathology detected by MRI were: Ankle and/or subtalar joint fluid in 6 heels, Pre-achilles bursitis in 3 heels, coalition of the tarsal bones in 3 heels, Ganglion cyst in 2 heels, stress or occult fracture of talar neck in 1 heel and avascular necrosis of talar dome in 1 heel.



Figure 1: 34-year-old male patient with unilateral right plantar fasciitis.

(A) Sagittal T1-, sagittal T1-SPIR, coronal PD and coronal PD fat-sat MRI showing focal thickening (0.59cm) with abnormal bright signal intensity. (B) Sagittal ultrasound examination showing focal thickening (0.62cm) with abnormal hypo-echoic echogenicity within the plantar fascia Associated subcutaneous edema. Twenty two of our patients were overweight (47.8%), 18 had histories of prolonged weight-bearing (39.1%), 14 were diabetic (30.4%) and 10 were long distant runners (21.7%).

4. Discussion

Not surprisingly, that plantar fasciitis is a common cause of heel pain in athletes and obese patients, apparently due to the trauma of repetitive traction on the plantar fascia [11]. The total number of patients in this study was 34 with slight female predilection (18 female and 16 male) these results were similar to that reported by Ozdemir and his colleagues [12], Cardinal and his colleagues [13], Ashraf and his colleagues [14] and Sabir and his colleagues [15]. Age of the patients ranged from 27 to 65 years with a mean of 44.38 ± 8.9 years. These results were in agreement with previously reported studies [13-15]. By ultrasound, increased thickness of plantar fascia was constant finding in patients with the clinical diagnosis of plantar fasciitis. In this study, the results showed that the range of the proximal planter fascia thickness for patients group was (3.5–7.5 mm; mean $5.5\text{mm} \pm 1.3$), these results were close to that reported by ABDEL WAHAB and his colleagues [11] (3.0 -7.0 mm in range; 4.9 ± 1.3), Cardinal and his colleagues [13] (3.2 – 6.8 mm in range; 5.2 ± 1.13), Ashraf and his colleagues [14] (4.2-8.1 mm in range; 5.6 mean ± 1.2), and Sabir and his colleagues [15] (4.9mm mean $\pm 0.9\text{mm}$). However it was higher than the results of Ozdemir and his colleagues [12] (2.9 mm mean ± 0.6), and Akfirat and his colleagues [16] (4.7 mm mean ± 1.5). This difference might be attributed to the higher percentage of obesity in our patients which was 47.8 % (compared to 27.9% in Ozdemir and his colleagues [12] and 28.4 % in Akfirat and his colleagues [16]) . The proximal planter fascia thickness for control group was (2-2.8mm in range; mean $2.4\text{mm} \pm 0.07$) measured by ultrasound, these results were similar to the results of Ozdemir and his colleagues [12] (2.5mm mean ± 0.6) and Cardinal and his colleagues [13] (mean $2.6\text{mm} \pm 0.48$). However it was lower than Ashraf and his colleagues [14] (mean $3.5\text{mm} \pm 0.22$), Sabir and his colleagues [15]

(mean 3.2 mm \pm 0.4) and Akfirat and his colleagues [16] (mean 3.6 mm \pm 0.6). This difference might be attributed to the younger age in our control group (mean age 24.53 years \pm 3.5). In the current study there was a statistically significant difference ($p < 0.05$) between patients group and the control group regarding proximal planter fascia thickness measured by ultrasound and this difference was similar to that of previously reported studies [11,12,14]. Hypoechoogenicity of the plantar fascia was a frequent sonographic finding. It relates to an underlying process of micro tears or oedema in the plantar fascia [17]. In the current results the percentage of hypoechoogenicity was 78.2%, this finding was close to that reported by Cardinal and his colleagues [13] (84%), Ashraf and his colleagues [14] (84%), and Genic and his colleagues [18] (73%). However this result was higher than that of Ozdemir and his colleagues [12] (41%) and Sabir and his colleagues [15] (38.6%). This difference can be explained by higher percentage of obesity in our patients or due to the difference in the total number of patients between our study and these studies. About 56.5% of current patients have a calcaneal spur, this finding was in agreement with Ashraf and his colleagues [14] (57%), Ozdemir and his colleagues [12] (51%) and ABDEL-WAHAB and his colleagues [11] (55%), however calcaneal spur was not identified by Cardinal and his colleagues [13], this is most probably due to old generation of ultrasound equipment-used in this study. About 60.8% showing subcutaneous edema. This finding was much higher than that reported by Akfirat and his colleagues [16] (10%), Ozdemir and his colleagues [12] (2.5%) and Cardinal and his colleagues [13] (not identified), and this great difference can be explained by low percentage of obesity in their studies, difference in total number of patients and old generation of US equipment used in their studies. In the correct clinical circumstances, MRI is of particular value in differentiating plantar fasciitis from other causes of plantar heel pain that may contribute in the patient complaint. It also has the advantages of larger field of view than ultrasound and has a multi-planar capability useful in the diagnosis of other causes of hind foot pain [19]. In this study, our sonographic examinations were concentrated only on the diagnostic criteria of plantar fasciitis by assessment of the sonographic signs with no attempt made to look for associated causes of hind-foot pain. However, MRI has a wide window and other pathologies were seen in association with plantar fasciitis, including ankle and sub-talar joint effusion (6 cases), a vascular necrosis of the talar dome (1 case), coalition of the tarsal bones (3 cases), pre-Achilles bursitis (3 cases), ganglion cysts (2 cases) and occult fracture of the talar neck (1 case). However, the contribution of these findings to patient complaints could not be evaluated. The development of high-resolution ultrasound technology has enhanced the value of ultrasonography as a diagnostic imaging tool for the assessment of various joint and soft tissue pathologies and often it has a complementary relationship with MRI [15]. Although Ultrasound has a narrower field of view and is more operator-dependent but it is inexpensive, quick, convenient, readily accessible, the greater spatial resolution and, most importantly, the benefit of real-time imaging that assists direct localization of patient symptoms with the ability to palpate, compress and assess dynamically specific structures, also ultrasound offers multi-planar capabilities, the ability to compare easily with the contralateral side at the same time which is possibly of more clinical value in the assessment of plantar fasciitis, particularly in longitudinal parametric studies and in sports medicine. It also has the opportunity for image-guided biopsies, aspirations and injections [20].

5. Conclusions

Ultrasonographic diagnosis of plantar fasciitis is a useful tool compared to MRI and it could be the easy initial imaging modality for confirmation of clinically suspected plantar fasciitis. MRI may be kept for cases where a

diagnosis of plantar fasciitis does not confidently explain the clinical presentation and when complex pathology is suspected.

6. Recommendations

Ultrasound as a first line, straight forward imaging modality in diagnosis of planter fasciitis, MRI study used to evaluate cases with negative or equivocal ultrasound findings.

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