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Sonographic Evaluation of the Plantar Fascia After Treatment with Extra Corporeal Shock Wave Therapy in patients with chronic Plantar Fasciitis in Kuwait

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Abstract

Background and aim: To the best of our knowledge, there have been only a few articles published that discuss the ultrasound appearance of the plantar fascia after treatment with extracorporeal shock wave therapy (ESWT) on plantar fasciitis in Kuwait. Thus, our aim was to study the effect of ESWT on plantar fasciitis, as well as, sonographic evaluation of the plantar fascia thickness after ESWT treatment in patients with chronic plantar fasciitis in Kuwait.

Materials and methods: Thirty Kuwaiti patients with chronic planter fasciitis and twenty-fife healthy individuals as control were included in this study. Sonographic evaluation of the plantar fascia thickness was done at baseline and 1.5 month after ESWT treatment.

Results: A highly statistically significant reduction in VAS from 8.0 ± 1.4 to 1.2 ±1.0 to 1.2 ±1.0 at 1.5 month after ESWT Treatment was noticed ($P < 0.001$) and improvement of functions by assessment of Roles & Maudsley score. Moreover, there was a significant reduction effect of ultrasound measured thickness of the plantar fascia from 5.0 ± 1.2 mm to 4.3±0.3 mm at 1.5 month after ESWT treatment in patients with plantar fasciitis group ($P < 0.001$).

Conclusion: The major therapeutic finding is that ESWT resulted in significant pain relief from plantar fasciitis and improvement of functions, as well as, reduction of ultrasound measured thickness of the plantar fascia at 1.5 month after treatment. ESWT seem to be effective on pain, foot functions, and fascia thickness in chronic plantar fasciitis.

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Key Words: Sonography; Extracorporeal Shock wave therapy (ESWT); visual analogue scale (VAS); the Roles and Maudsley (RM) score; Planter Fasciitis (PF).

1-Introduction

The plantar fascia is a thickened fibrous aponeurosis that originates from the medial tubercle of the calcaneus, runs forward to insert into the deep short transverse ligaments of the metatarsal heads, dividing into 5 digital bands at the metatarsophalangeal joints [1].

Plantar fasciitis (PF) the most common cause of heel pain. PF is the pain caused by degenerative irritation at the insertion of the plantar fascia on the medial process of the calcaneal tuberosity [2]. The cause of degeneration is repetitive microtears of the plantar fascia that overcome the body's capacity to repair itself

[3]. The site most frequently involved is at the medial tuberosity of the calcaneus. The pathological findings include degenerative tissue changes characterized by fibroblastic proliferation and presence of inflammatory tissue [4]. Some experts have deemed this condition "plantar fasciosis," implying that its etiology is a more chronic degenerative process versus acute inflammation [5]. It is now accepted that this fasciopathy should be classified as a type of enteropathy, even though its physiopathology is poorly understood [6].

The presence of enthesitis or perifascial fluid collection eliciting a Doppler signal may suggest spondyloarthropathy. In this case, further investigations in conjunction with a more detailed history and physical examination would assist in making a correct diagnosis [7].

ESWT has been used as an alternative to surgery due to its efficacy, safety, non-invasive nature and association with few side effects. They concluded that ESWT was an effective treatment for evidence-based medicine in the treatment of PF [8]. The ESWT was shown to exert its effects by stimulating neovascularization, increasing the expression of angiogenetic factor, decreasing calcification, reducing the concentrations of inflammatory mediators and substance P in tendinopathies [9].

To the best of our knowledge, there have been only a few articles published that discuss the ultrasound appearance of the plantar fascia and the effect of extracorporeal shock wave therapy (ESWT) on plantar fasciitis in Kuwait. The aim of this study was to study the effect of ESWT on heel pain, and foot functions, as well as, sonographic evaluation of the plantar fascia thickness after ESWT treatment in patients with chronic PF in Kuwait.

2-Materials and Methods

Thirty Kuwaiti patients with chronic planter fasciitis patients (21 females, 9 males and age of 53.77 ± 5.22) and twenty-fife healthy individuals as control (17females, 8 males and age of 50.77 ± 5.22) randomly selected from physical medicine and rehabilitation outpatient clinics Al-Razi hospital subjected to clinical and radiographic examinations on the feet, with weight-bearing, on the side affected by the condition.

Inclusion criteria were included adults over the age of 18 years; History of 6 months of unsuccessful conservative treatment; patients who diagnosed as painful heel syndrome by clinical examination, with the following positive clinical signs of pain in the morning or after sitting a long time, local pain where the fascia attaches to the heel and increasing pain with extended walking or standing. Exclusion criteria were included Age under 18 years, patients had a local infection, or malignancy, pregnant, generalized polyarthritis, seronegative arthropathy, ipsilateral or contralateral vascular or neurological abnormality, recent trauma, fractures, foot deformity and ankle deformity, or active anticoagulation therapy or a bleeding disorder, cardiac arrhythmia, a pace maker or patients had received a corticosteroid injection within the previous six weeks.

The diagnosis of planter fasciitis (PF) is usually clinical and rarely needs to be investigated. The diagnostic criteria of plantar fasciitis were required to fulfill all these prerequisites. Firstly, the patient complains of pain in the medial side of the heel after a period of inactivity during the day, worse following prolonged weight bearing and increase in weight bearing activities. Secondly, tenderness can be elicited over the medial calcaneal tuberosity and may exaggerate on dorsiflexion of the toes or standing tip toe [9]. Imaging studies are typically not necessary for diagnosis of PF [4].

The patients underwent one weekly session of shockwave therapy for six consecutive weeks (1.5 month). The apparatus used in the study was Piezo wave 2, made by German company Richard Wolf. A generator of focused type (head F10/ G4) piezoelectric shock wave was used and 1500-3000shocks/session given in each session with pulse rate (frequency) 4 HZ, gel pad 10-15mm, energy flux density (0.092-0.351 mj/mm2) with intensity level (1-10). The application site for this therapy was the most painful point on the foot, which had been indicated by the patient. The shockwave therapy was applied by a single professional.

The evaluations on the plantar fascia were performed by a single imaging diagnostic professional, using ultrasonography on the plantar region of the feet. The thickness of this anatomical structure was measured at two times: before the treatment and 1.5 month after the treatment. An ultrasound device GE LOGIQ e with a high-frequency transducer (4-13MHz) was used. The measurement of planter fascia is measured in millimeters as the fascia leaves the calcaneum.

Patients who completed four ESWT sessions were evaluated by visual analog scale (VAS) (Figure 1), and Roles & Maudsley score (Table 1). All patients completed a Visual analogue scale (VAS) in which 0 mm was no pain and 10 mm the worst imaginable pain, before the treatment before each session and at 1.5 month after the treatment [11]. Roles & Maudsley score was also completed before the treatment and 1.5 month after the treatment [12].

Statistical Analysis

A statistical analysis was performed using SPSS ver. 12.0 (SPSS Inc., Chicago, IL, VAS), and the statistical significance level was set at $P<0.05$ (significant), $P<0.001$(highly significant). Descriptive analysis was conducted to explore the characteristics of the participants at base line. A student t-test was used for Mean±SD to compare the different total energy influx of the groups (group 1, 2) and the differences in the

treatment effects between the two groups over time. Chi square test for percentage Roles & Maudsley score (Baseline vs after 1.5 month) also was done.

3- Result

The Patient's characteristics and ultrasound-based assessment of plantar fascia in both groups of planter fasciitis group and control healthy group were showed in table (2) .The age ranges from 30 -68 years old with mean age 50.8 ±9.7, females (86%) and males (8.14%) , Right PF(63.2%) , left PF (66.6%) and were accompanied by calcaneal spurs (91.2 %). Prolonged standing was the most Precipitating factor followed by obesity. No statistical difference was observed between the two groups in terms of age, sex, precipitating factors (obesity, prolonged standing) ($P > 0.05$). Ultrasound Measured thickness of the plantar fascia (mm) was 5.4 ± 1.2 mm as compared measured thickness in control group about 2.1±0.3 mm ($P > 0.05$). There were specific findings of hypoechoic pattern in 24(96%) of patients, but no vascularity.

In table (3), it showed comparison of Visual analogue scale (VAS), functions by assessment of Roles & Maudsley score, ultrasound measured thickness of the plantar fascia (mm), before versus after 1.5 month of ESWT treatment in patients with plantar fasciitis group (Baseline versus after 1.5 month) ($p > 0.05$). A highly statistically significant reduction in VAS from 8.0 ± 1.4 to 1.2 ±1.0 was noticed at 1.5 month after ESWT treatment ($p < 0.001$) and improvement of functions by assessment of Roles & Maudsley score. Moreover, there was a significant reduction effect of ultrasound measured thickness of the plantar fascia from 5.0 ± 1.2 mm to 4.3±0.3 mm at 1.5 month after ESWT treatment in patients with plantar fasciitis group ($p < 0.001$).

B Mode US scan with longitudinal view shows measurement of left planter fascia thickness at insertion of the calcaneus of 4.3 mm before and after ESWT treatment in patient with chronic plantar fasciitis. It also appears hypoechoic relative to the subcutaneous fat plane (Fig. 2 and 3). Power Doppler US scan with longitudinal view of right heel shows vascularity and hypoechoic planter fascia in patient with chronic plantar fasciitis (Fig. 4).

4-Discussion

Plantar fasciitis (PFS) is the most common type of PF injury, estimated to affect 10% of the general population during middle age. The main symptom of PF is morning pain or pain at the beginning of activity after rest and the end of the day [13].

In the present study, the major therapeutic finding is that ESWT resulted in significant pain relief from plantar fasciitis and improvement of functions, as well as, reduction of ultrasound measured thickness of the plantar fascia from 5.0 ± 1.2 mm to 4.3±0.3 mm at 1.5 month after treatment. Our study results suggest that ESWT seem to be effective on pain, foot functions, and fascia thickness in the treatment of patients with chronic plantar fasciitis.

Some authors demonstrated similar findings. Some studies suggest pain was found to be significantly better with ESWT up to 3 months post treatment (14). Other study results suggest that ESWT seem to be effective on pain, foot functions, and fascia thickness in the treatment of PF [15]. Ulusoy et al. [8] found a significant decrease in terms of the fascia thickness in all groups of using ESWT, therapeutic ultrasound therapy and laser therapy [16]. Cosentino et al. [17] found a significant reduction in the fascial thickness measurements after one month, compared to the control group.

Furthermore, Ibrahim et al., 2010 [18] found that a significant reducing VAS and improvement of VAS at 1-year follow after ESWT treatment of planter fasciitis. Chen et al., 2001[19] reported significantly improvement of VAS at 24 weeks follow-up treated with high energy shock wave therapy of planter fasciitis [Rompe et al., 2005 [2] found that VAS was decreased in 24 weeks treated by low-energy shock wave therapy in chronic planter fasciitis. Other studies have demonstrated 94% patients had complete resolution of heel pain with ESWT [8].

In contrast to our results, Dorotka et al. [20] have reported that ESWT was not effective when compared to the control group. The explanation of this differences could be due to several reasons such as varied applicator position of ESWT, and the corresponding diverse intensity levels, defined as the energy flow intensity through an area.

The pathogenesis of Planter Fasciitis is still limited, these pathologic changes are more consistent with fasciosis (degenerative process) than fasciitis (inflammatory process) [4]. Also, Planter Fasciitis may be caused by repetitive microtrauma at the origin of medial tuberosity of the calcaneus, traction forces during support lead to inflammatory process that result in fibrosis and degeneration [21]. Heel spurs and can be associated with the inflammatory process [22].

The mechanism of action of shock wave is not fully understood and has been explained by many theories, including direct stimulation of healing, neovascularization, direct suppressive effects on nociceptors, and a hyper-stimulation mechanism that blocks the gate-control mechanism [23]. Takahashi et al., 2006 [24] reported the cumulative effects of repeated shock waves with single and double applications on nerve fibers showed nearly complete degeneration of epidermal nerve fibers until the fourth week of treatment. However, by the end of the sixth week of treatment, a reinnervation of the epidermis was detected. Therefore, they suggest multiple applications of ESWT provide longer-lasting nociceptive effects. The other mechanism of shock wave demonstrated by others authors. Radwan et al, (2012) [25] showed that high-

energy shock waves produce an adequate amount of energy that can produce controlled inflammation, stimulate many mediators, such as transforming growth factor beta 1 and insulin-like growth factor 1 and initiates the healing process [26].

There are some limitations in our research. First, due to the limited number of trials and the measurements of the ultrasound, are subjective, and, depending on the physician's resolution of the grayscale image. Second, an increased thickness of the plantar fascia is not the only criterion for a diagnosis of plantar fasciitis; and the other factors include a decrease in echogenicity and an increase in the blood flow of the fascia, which may cause false negative or false-positive results. We recommend that a longer follow-up would be needed to confirm ESWT long-term efficacy. Further researches are needed to confirm ESWT long-term efficacy,

5- Conclusion

In conclusion, the major therapeutic finding of the present study is that ESWT resulted in significant pain relief from plantar fasciitis and improvement of functions. Another major finding is that ESWT had better therapeutic effect in reduction of ultrasound measured thickness of the plantar fascia (mm) at 1.5 month after treatment in patients with plantar fasciitis group. This study provides important clinical information for selecting therapeutics.

Ultrasonography can be a relatively simple and reliable method for the measurement of plantar fascia thickness. Our study results suggest that ESWT seem to be effective on pain, foot functions, and fascia thickness in the treatment of PF.

Consent for Publication

Oral informed consent was obtained from the patients for publication of this article and any accompanying images.

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Legend of Tables

Table 1: Roles & Maudsley score.
Table 2: Patient's characteristics and ultrasound-based assessment of Plantar Fascia in planter fasciitis group and control healthy group.
Table 3: Comparison of Visual analogue scale (VAS), functional assessment of Roles & Maudsley score, Ultrasound measured thickness of the plantar fascia (mm), baseline versus at 1.5 month after ECSW treatment in30 patients with plantar fasciitis group (Baseline versus after 1.5 month).

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Fig. 1: Visual analogue scale
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Fig. 3: B Mode US scan with longitudinal view shows reduction left planter fascia thickness at insertion of the calcaneus of 3.9 mm at 1.5 month after ECSW treatment in patient with chronic plantar fasciitis. It also appears hypoechoic relative to the subcutaneous fat plane.
Fig.4: Power Doppler (box) US scan with longitudinal view of right heel shows in vascularity and hypoechoic planter fascia in patient with chronic plantar fasciitis.

Table 1: Roles & Maudsley score

	Point	Interpretation
Excellent	1	No pain, full movement and activity
Good	2	Occasional discomfort, full movement and activity
Fair	3	Some discomfort after prolonged activity
Poor	4	Pain limiting activity

Table 2: Patient's characteristics and ultrasound-based assessment of plantar fascia in planter fasciitis group and control healthy group.

Data	Planter fasciitis group(n=30)	Control group (n=25)	p
Age (years) (mean ±SD)	44.9 ±9.3	43.3 ±7.2	NS
BMI (kg/m 2) (mean ±SD)	21.4 ±2 .1	22.1± 1 2.	NS
Sex (n, %)	-	-	-
Female	20(66.5%)	17(78.1 %)	-
Male	10(33.5%)	8(21.9%)	-
Heel pain duration (month) (mean ±SD)	11.2±6 3	-	-
Side of planter fasciitis (n, %)	-	-	-
Right planter fasciitis	17 (56.5%)	-	-
Left planter fasciitis	10 (33.5%)	-	-
Bilateral planter fasciitis	3 (10%)	-	
Calcaneal spur (n, %)	24 (96%)	-	-
Ultrasound-Based Assessment at baseline	-	-	-
Thickness of the plantar fascia, mm (Baseline)	5.4 ± 1.2	2.1±0.3 mm	HS
Hypoechoic pattern (n, %)	-	-	-
Hypervascularity (n, %)	24(96%)	-	
Precipitating factor (n, %)	-	-	-
Obesity	7(28%)	-	-
Prolonged standing	14(56%)	-	-
Pes planus OR pes cavus	6(16%)	-	-

** p< 0.001(HS)= correlation is highly significant; *p<0.05(S)= correlation is significant; p > 0.05 (NS) = correlation is non- significant.

Table 3: Comparison of Visual analogue scale (VAS), functional assessment of Roles & Maudsley score, Ultrasound measured thickness of the plantar fascia (mm), baseline versus at 1.5 month after ESWT treatment in 30 patients with plantar fasciitis group (Baseline versus after 1.5 month).

Data (Mean±SD)	At Baseline before treatment	1.5 month after treatment	P value
1- Visual analogue scale (VAS) (Mean± SD)	8 ±1.4	1.2 ±1.0	HS.
2-Functional assessment of Roles & Maudsley score (n, %):	-	-	-
Poor (n, %)	16 (48%)	0	HS
Fair (n, %)	14 (52%)	0	
Good (n, %)	0	15 (40%)	
Excellent (n, %)	0	17 (60%)	
3-Thickness of the plantar fascia, mm (Mean±SD)	5.0 ± 1.2 mm	4.3±0.3 mm	HS

** p< 0.001(HS)= correlation is highly significant; *p<0.05(S)= correlation is significant; p > 0.05 (NS) = correlation is non- significant.

- ❖ Chi square test for percentage Roles & Maudsley score (Baseline vs after 1.5 month).
- ❖ Student's t test for Mean±SD of VAS and Thickness of the plantar fascia (Baseline vs after 1.5 month).

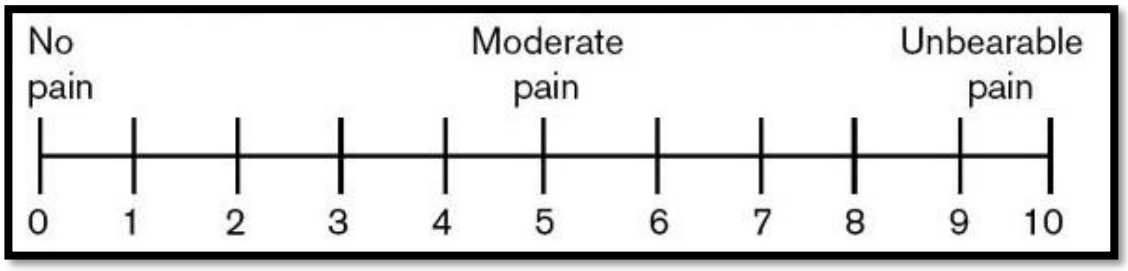

Fig. 1: Visual analogue scale

Fig. 2: B Mode US scan with longitudinal view shows measurement of left planter fascia thickness at insertion of the calcaneus of 4.3 mm before ESWT treatment in patient with chronic plantar fasciitis. It also appears hypoechoic relative to the subcutaneous fat plane.

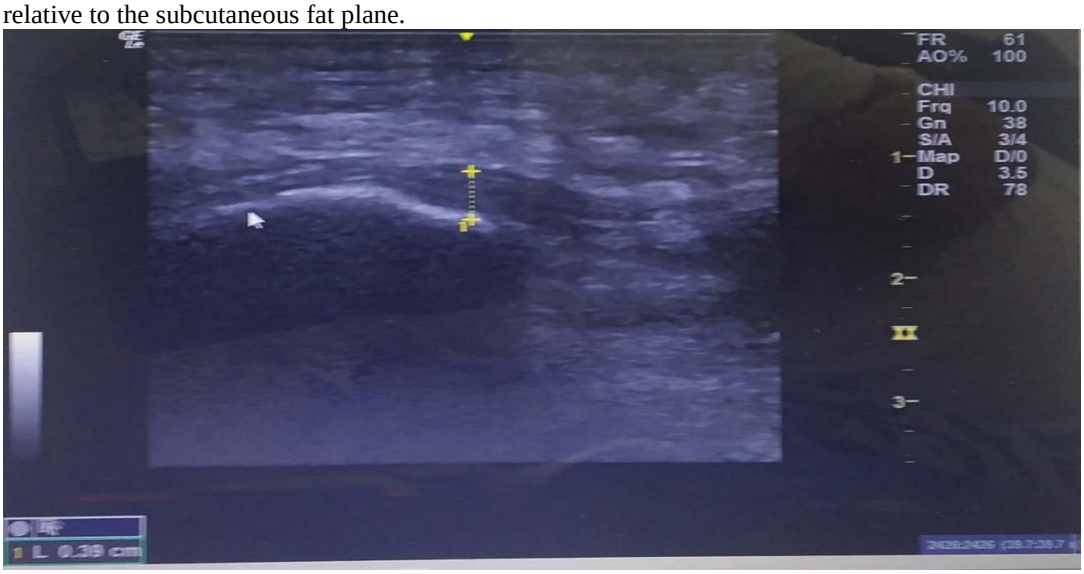

Fig. 3: B Mode US scan with longitudinal view shows reduction left planter fascia thickness at insertion of the calcaneus of 3.9 mm at 1.5 month after ESWT treatment in patient with chronic plantar fasciitis. It also appears hypoechoic relative to the subcutaneous fat plane.

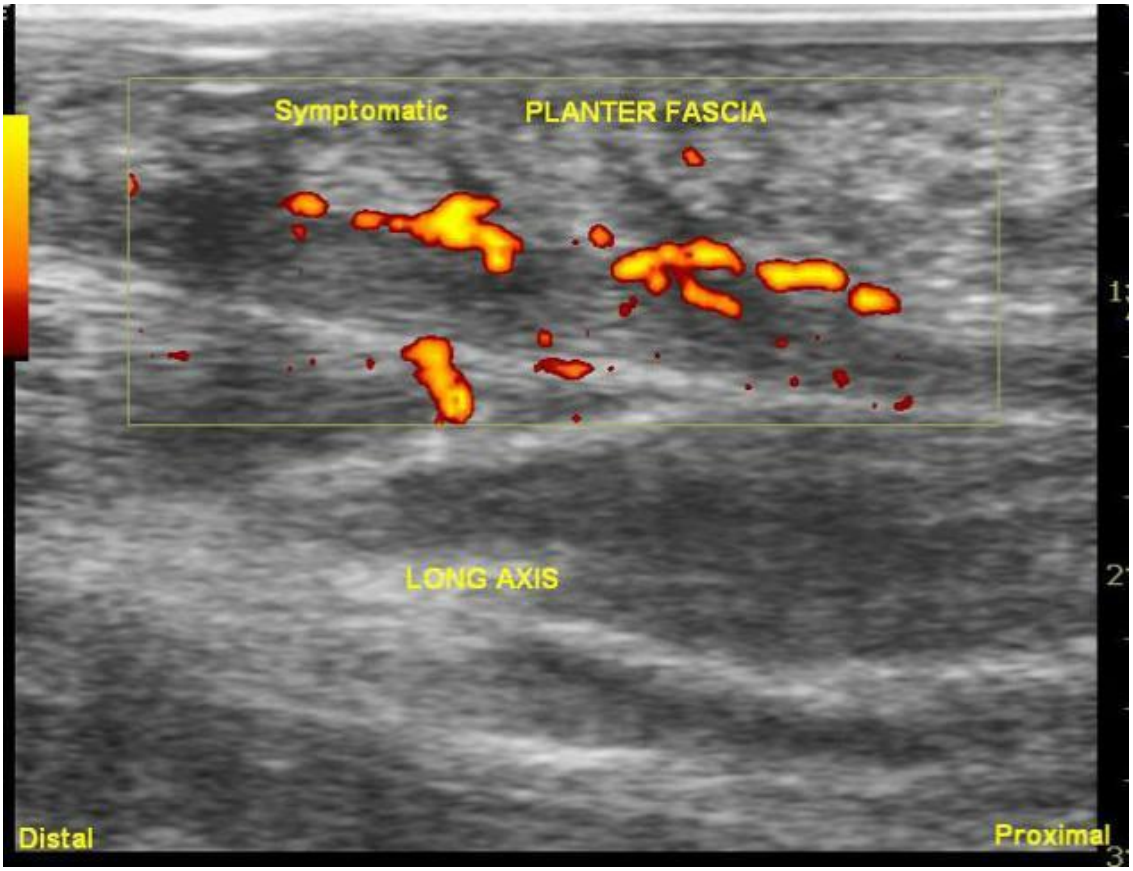

Fig. 4: Power Doppler (box) US scan with longitudinal view of right heel shows in vascularity and hypoechoic planter fascia in patient with chronic plantar fasciitis.

Running head: Sonographic Evaluation after extracorporeal shock wave therapy in patients with chronic Plantar Fasciitis.

Sonographic Evaluation of the Plantar Fascia thickness After Treatment with Extra Corporeal Shock Wave Therapy in patients with chronic Plantar Fasciitis in Kuwait

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