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Comparison between Therapeutic Ultrasound and Laser Therapy in Treatment of Plantar Fasciitis Diagnosed by Ultrasonography

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ABSTRACT

Background: The majority of people who experience pain in the plantar surface of their heel have plantar fasciitis (PF). Patients who suffer from chronic plantar fasciitis have access to a variety of additional treatment options, such as extracorporeal shockwave therapy, ultrasound (US) therapy, low-level laser therapy, and surgical plantar fasciotomy.

Objective: This study aimed to evaluate the efficacy of therapeutic US in comparison with laser therapy in plantar fasciitis treatment.

Methods: This prospective randomized clinical study included 56 patients diagnosed as plantar fasciitis. The patients were divided into two groups according to the treatment they received. Group (1) had 28 patients who were treated by laser therapy (scanning method), with 808 nm wavelength. The area is irradiated in 3 points over 3 cm^2 three times weekly for 2 weeks and group (2) had 28 patients who were treated by ultrasound therapy at a frequency of 3 MHZ in a pulsed mode (1;4) for eight minutes (min) at an intensity of 0.5W/cm^2 three times weekly for 4 weeks. Hamstrings and calf muscles were stretched.

Results: The Mayo score, the foot and ankle ability and the foot function index pain subscale (FFI-P) thad significantly improved in both groups four and eight weeks after treatment in comparison with the baseline and at 8 weeks compared to 4 weeks. The improvement was significantly higher in the laser therapy at 8 weeks after treatment. The plantar fascia thickness (PFT) decreased significantly in both groups 4 and 8 weeks after treatment compared to the baseline and at 8 weeks compared to 4 weeks.

Conclusion: When it comes to the treatment of PF, it has been demonstrated that laser therapy, specifically the scanning method, when combined with stretching exercises, is more effective than traditional ultrasound.

Keywords: Therapeutic ultrasound, Laser therapy, Plantar fasciitis.

INTRODUCTION

The human foot is a terminal portion of the limb that supports the body's weight and enables movement. It is a strong and complicated mechanical structure [(1)]. It is a dense, fibrous, connective tissue structure that originates from the medial tuberosity of the calcaneus, and it is known as the plantar fascia. It is divided into three parts: the medial, lateral, and central parts [(2)].

Plantar fasciitis (PF) is a degenerative state, which happens when the plantar fascia is subjected to compressive forces as a result of repeated trauma. This causes the foot's longitudinal arch to become flattened. The gait on support phase is characterized by traction forces, which, when combined with inflammation, can lead to fibrosis and degeneration. Plantar fasciitis is the most frequent cause of heel pain, representing eighty percent of all instances. People between the ages of 40 and 60 are the ones who are most likely to be affected by it [(3)].

Overuse of the plantar fascia, activities such as ballet jumping, long distance running, long periods of standing, overweight, pregnancy, and athletes are all predisposing factors for plantar fasciitis, but the exact cause of plantar fasciitis is still unknown. On the other hand, the predisposing factors that lead to plantar fasciitis include those things. The patient typically suffers from pain on the medial side of the plantar heel, and this pain is typically worse during the patient's initial few steps after waking up [(4)]. Near the origin of the central band of plantar aponeurosis at the medial plantar tubercle is the typical location of pain in plantar fasciitis [(5)]. Ultrasonography (US) is an accurate, easy, and quick method for identifying plantar fascia thickness (PFT). It is of great importance to detect the normal thickness of the planter fascia, as increased PFT and hypoechogenicity are sonographic features of plantar fasciitis [(6)].

Ultrasound (US), is a mechanical form of energy, which has been used to hasten the rate at which the injured tissue heal and improve the overall quality of that healing. The most common form of conventional therapeutic ultrasound is characterized by low energy, pulses of long duration, and diffuse form. This type of ultrasound warms the soft tissue that is located under the ultrasonic beam [(7)]. Plantar fasciitis can also be treated with laser therapy, which is a non-invasive treatment that does not cause any discomfort. Low level laser therapy is assumed to hasten the healing process of wounds, along with reducing pain and alleviating inflammation [(8)].

The aim of the current study was to evaluate the efficacy of therapeutic US in comparison with laser therapy in PF treatment that has been clinically diagnosed as well as confirmed by ultrasonography.

PATIENTS AND METHODS

This prospective randomized clinical study comprised 56 cases with plantar fasciitis recruited from Rheumatology and Rehabilitation Outpatient Clinic at Mansoura University Hospitals, Egypt. Patients were clinically diagnosed as plantar fasciitis according to Clinical Practice Guidelines for Heel Pain and Plantar Fasciitis [(9)] .

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The included patients had heel pain localized to the proximal insertion of planter fascia without radiation, tenderness on palpation, pain at the back of the heel caused by a recent increase in weight-bearing exercise, and pain diminished primarily after the first few steps, but returned with an increase in activity.

Exclusion criteria: Patients with history of local steroid injection for Plantar Fasciitis treatment, history of foot surgery, lumbar disc herniation, any rheumatic disease, radiculopathy and neuropathy, coagulopathy, lower extremity fracture sequelae, congenital or acquired deformity, cancer, cardiac pacemaker, and metal implant at the application site.

Methods

Entire cases were subjected to complete history taking including analysis of heel pain (character of pain, time, aggravating factors, and radiation), history of arthritis or systemic features and past history of local trauma, surgery and interventional procedures.

The physical examination included general examination in form of vital signs, weight, height, BMI, gait and systemic examination. While, local examination included assessment of the tenderness and/or swelling at the medial calcaneal tuberosity. Every patient had plain radiograph in the form of lateral view of calcaneus.

Treatment regimen:

Group 1 (28 patient) had laser therapy. The painful area was treated with laser for two weeks, three times weekly. The treatment time was 9 minutes, and an 808 nm wavelength was used. The irradiation area is 3 points over 3 cm^2 and lasts for 14 days [(2)]. The potential for laser light to damage the eyes has been mitigated by the implementation of safety measures.

Group 2 (28 patient) had ultrasound therapy. The painful area was subjected to ultrasound therapy three times weekly for four weeks at a frequency of 3 MHZ in a pulsed mode (1;4) for 8 min at an intensity of $0.5W/cm^2$ [(2)].

Stretching of hamstrings and the plantar flexors of the ankles and strengthening exercises of ankle muscles [(10)] were done for both groups. Self-stretching of the plantar fascia was done when the patient passively extended their metatarsophalangeal joints by crossing the affected foot over the opposite thigh while seated.

Clinical assessment:

All patients were assessed at 0, 4, and 8 weeks as follow:

- Mayo clinical scoring system evaluated the effects of discomfort on mobility, footwear needs, and gait. There are six factors that add up to a total of 100 points; (degree of pain, activity limitation, plantar heel tenderness, neuropathy, and antalgic gait). Results are ranked as excellent (90–100 points), good (80–89), fair (70–79), or poor (60–69) [(11)].
- Foot function index pain subscale (FFI-P) comprised twenty three questions, covering 3 subscales of foot function: Pain, disability, and activity limitation.
- Foot and ankle ability measure (FAAM) that is composed of an activities of daily living subscale (twenty one scored parameters) and a sports subscale (seven scored parameters).

Ultrasonography Assessment:

Scans were taken with a Phillips HD11 XE (Best, Netherlands) ultrasound system equipped with a linear transducer operating at 3-12 MHz. Two separate radiologists evaluated the sonograms in a blinded fashion.

The PFT was measured at the anatomical landmark formed by the plantar fascia's anterior crossing of the inferior border of the calcaneus. An abnormal plantar fascia thickness was defined as anything over 4 mm with diminished echogenicity. Perifascial edema and bony calcaneal spurs have also been reported as coexisting symptoms of plantar fasciitis. Maximum thickness, abnormal signal, subcutaneous edema, and plantar fascia fluid collection were noted. Treatment reactions and side effects were documented at every appointment and again two to three days later.

Ethical approval: Medical Ethics Committee of Mansoura Faculty of Medicine gave its approval to this study. All participants gave written consents after receiving all information. The Helsinki Declaration was followed throughout the study's conduct.

Statistical analysis:

Data analysis was conducted by using SPSS software, version 18 (SPSS Inc., PASW statistics. Chicago: SPSS Inc.). Qualitative data were described by utilizing number and percent. Quantitative data were defined by utilizing mean ± SD for normally distributed data following assessing normality by utilizing Kolmogorov-Smirnov test. Chi-Square and Monte Carlo tests were utilized to compare qualitative data between groups. Post Hoc Tukey test was utilized to detect pair-wise comparison. Paired t test was utilized to compare pre-treatment and post-treatment values. Significance of the obtained results was judged at ≤ 0.05 level.

RESULTS

Table **(1)** showed the demographic data, main presentation and disease duration in the two studied groups. There were no significant differences regarding age (p=0.170), sex distribution (p=0.415), mean BMI (p= 0.170), main presentation (P= 0.919,) and disease duration (P=0.394)

Table (1): Demographic data, main presentation and disease duration in the studied groups

		Groups				Test of significance	P value
		Group 1 (Laser therapy) (N=28)		Group 1 (Ultrasound therapy) (N=28)			
Age (years)		50.57 ± 6.85		49.43 ± 7.01		t= 1.392	0.170
Gender	Male	10	35.7 %	13	46.4 %	χ^2= 0.664	0.415
	Female	18	64.3 %	15	53.6 %		
BMI (Kg/m^2)		28.74 ± 3.20		29.38 ± 2.35		t= -0.852	0.398
Main Presentation							
Sharp heel pain in the morning		10	35.7 %	11	39.3 %	MC = 0.936	0.919
Foot stiffness		5	17.9 %	3	10.7 %		
Localized swelling		7	25%	6	21.4%		
Limping gait		2	7.1%	3	10.7 %		
Dull aching pain at night		4	14.3%	5	17.9%		
Disease Duration (months)		1.27 (0.40-2.97)		1.58 (0.57-2.83)		z= -0.852	0.394

Table (2) showed Mayo clinical scoring system in the studied groups along the study period. There were no significant differences of Mayo score between the studied groups at the baseline (P= 0.190) and at 4 weeks after treatment (p=0.502), but it was higher in laser group compared to US group at 8 weeks (P=0.002). There was a statistically significant improvement in the Mayo score at 8 weeks after treatment in both groups, in comparison with the score at the baseline and at 4 weeks after treatment (P<0.001).

Table (2): Mayo clinical scoring system in the studied groups along the study period

	Group 1 (Laser therapy) (N=28)	Group 1 (Ultrasound therapy) (N=28)	Test of significance	P value
Baseline	51.57 ± 11.13	55.57 ± 11.41	t= - 1.328	0.190
At 4 weeks after treatment	67.18 ± 10.31	69.04 ± 10.26	t = - 0.676	0.502
At 8 weeks after treatment	87.57 ± 8.58	79.79 ± 9.60	t = 3.199	0.002*
Interclass significance	p1 <0.001* p2 <0.001* p3 <0.001*	p1 <0.001* p2 <0.001* p3 <0.001*		

P1: Significance between level at baseline and at 4 weeks after treatment P2: Significance between level at baseline and at 8 weeks after treatment P3: Significance between level at 4 weeks after treatment and at 8 weeks after treatment

Table (3) showed FFI-P in the studied groups along the study period. There were no significant differences of FFI-P between the studied groups at the baseline (P= 0.166) and at 4 weeks after treatment (p=0.116), but it was lower in laser group compared to US group at 8 weeks (P<0.001). FFI-P was significantly lower at 8 weeks following treatment in both groups, in comparison with FFI-P at the baseline and at 4 weeks after treatment (P<0.001).

Table (3): FFI-P in the studied groups along the study period

	Groups		Test of significance	P value
	Group 1 (Laser therapy) (N=28)	Group 1 (Ultrasound therapy) (N=28)		
Baseline	78.54 ± 3.47	79.82 ± 3.38	t= - 1.405	0.166
At 4 weeks after treatment	62.43 ± 3.35	63.93 ± 3.66	t = -1.600	0.116
At 8 weeks after treatment	45.46 ± 4.08	52.14 ± 3.56	t = -6.532	< 0.001*
Interclass significance	p1 <0.00-1* p2 <0.001* p3 <0.001*	p1 <0.001* p2 <0.001* p3 <0.001*		

P1: Significance between level at baseline and at 4 weeks after treatment P2: Significance between level at baseline and at 8 weeks after treatment P3: Significance between level at 4 weeks after treatment and at 8 weeks after treatment

Table (4) showed FAAM in the studied groups along the study period. There were no significant differences of FAAM between the studied groups at the baseline (P= 0.619) and at 4 weeks after treatment (p=0.391), but it was greater in Laser Group in comparison with US group at 8 weeks (P<0.001). FFI-P was significantly higher at 8 weeks after treatment in both groups, in comparison with FAAM at the baseline and at 4 weeks after treatment (P<0.001).

Table (4): FAAM in the studied groups along the study period

	Groups		**Test of significance**	**P value**
	Group 1 (Laser therapy) (N=28)	**Group 1 (Ultrasound therapy) (N=28)**		
Baseline	31.25 ± 6.23	30.36 ± 7.10	t= 0.500	0.619
At 4 weeks after treatment	48.39 ± 6.06	46.96 ± 6.29	t = 0.865	0.391
At 8 weeks after treatment	64.96 ± 6.31	58.21 ± 6.16	t = 4.050	< 0.001*
Interclass significance	p1 <0.001* p2 <0.001* p3 <0.001*	p1 <0.001* p2 <0.001* p3 <0.001*		

P1: Significance between level at baseline and at 4 weeks after treatment P2: Significance between level at baseline and at 8 weeks after treatment P3: Significance between level at 4 weeks after treatment and at 8 weeks after treatment

Table (5) showed thickness of planter fascia by ultrasonography (in sagittal plan) in the studied groups along the study period. There were no statistically significant differences between both groups as regards thickness of plantar fascia at baseline and at 4 weeks after treatment (P=0.549 and 0.212 respectively), but the thickness was significantly lower in the laser group at 8 weeks after treatment (p=0.002). Both groups had a statistically significant decrease in plantar fascia thickness at 4 and at 8 weeks after treatment compared to baseline (P<0.001) and at 8 weeks compared to at 4 weeks after treatment (P<0.001).

Table (5): Thickness of plantar fascia by ultrasonography (in sagittal plan) in the studied groups along the study period

	Groups		**Test of significance**	**P value**
	Group 1 (Laser therapy) (N=28)	**Group 1 (Ultrasound therapy) (N=28)**		
Baseline	5.77 ± 0.94	5.89 ± 0.86	t= - 0.603	0.549
At 4 weeks after treatment	4.36 ± 0.71	4.60 ± 0.73	t = -1.264	0.212
At 8 weeks after treatment	3.02 ± 0.65	3.61 ± 0.71	t = -3.275	0.002*
Interclass significance	p1 < 0.001* p2 < 0.001* p3 < 0.001*	p1 < 0.001* p2 < 0.001* p3 < 0.001*		

P1: Significance between level at baseline and at 4 weeks after treatment P2: Significance between level at baseline and at 8 weeks after treatment P3: Significance between level at 4 weeks after treatment and at 8 weeks after treatment

As shown in table (6), there were no staistisctcally significant differences between both groups as regards presence of calcaneal spur at baslaine and after treatment (p=0.554 for each).

Table (6): Calcaneal spur in the studied groups at baseline and after treatment

	Groups				**Test of significance**	**P value**
	Group 1 (Laser therapy) (N=28)		**Group 1 (Ultrasound therapy) (N=28)**			
Baseline						
Calcaneal spur	7	25 %	9	32.1 %	$\chi 2$= 0.350	0.554
No Calcaneal spur	21	75 %	19	67.9 %		
After treatment						
Calcaneal spur	7	25 %	9	32.1 %	$\chi 2$= 0.350	0.554
No Calcaneal spur	21	75 %	19	67.9 %		

P: probability Categorical data expressed as Number (%) $\chi 2$= Chi-square test

Table (7) showed the degree of satisfaction in both groups. There was a high statistically significant increase in satisfaction in lasar group in comparison with ultrasound therapy ($p < 0.001$).

Table (7): Comparison of the degree of satisfaction in the studied groups

	Groups				**Test of significance**	**P value**
	Group 1 (Laser therapy) (N=28)		**Group 1 (Ultrasound therapy) (N=28)**			
Degree of satisfaction						
Not satisfied	1	3.6 %	6	21.4 %	MC = 17.857	< 0.001*
Satisfied	9	32.1 %	19	67.9 %		
Highly satisfied	18	64.3%	3	10.7 %		

DISCUSSION

In this study, there was no statistically significant difference between the two study groups regarding age, sex, BMI, clinical presentation and the disease duration indicating the process of efficient randomization to avoid the selection bias. In the current study, the ratio of female subjects who belonged to group 1 was 64.3%, while the ratio of female subjects who belonged to group 2 was 53.6%.

An earlier Egyptian study that was carried out to assess the efficncny of US in the detection of PF in comparison with the findings of magnetic resonance imaging (MRI) in individuals with inferior heel pain found that sonography was more accurate than MRI. According to the findings, this pathology was also more prevalent in females, who accounted for 85.71% of the cases included that were diagnosed with PF [(12)].

The current study revealed that the mean BMI was 28.74 ± 3.20 kg/m^2 and 29.38 ± 2.35 kg/m^2 in the cases of group 1 and group 2 respectively. This comes in agreemnt with the outcomes of **Sabir *et al.*** [(12)] who found a statistically significant increase in the BMI of people with PF in compsriosn with those in the control group (p 0.05). The cases had mean values of 34.2 kg/m^2 for BMI, while the controls had mean values of 25.2 kg/m^2.

The current study displayed that the laser group had a mayo score that was statistically significantly greater than the control group (p=0.002). When compared to the value at the beginning of the study, the Mayo score had significantly improved in both groups four and eight weeks after treatment had been completed. This improvement was statistically significant. Additionally, there was a statistically significant increase in the mayo score in both groups eight weeks after treatment in comparison with four weeks after treatment. This is supported by a study that was conducted on laser therapy (scanning method) of plantar fasciitis by **Macias *et al.*** [(13)] who showed that laser therapy (scanning method) of plantar fasciitis can activate the process of healing and decrease pain by enhancing the speed, quality, and strength of tissue repair and by reducing the inflammatory processes.

In the current study, the FFI-P in both groups experienced a decrease that was statistically significant at both 4 weeks and at 8 weeks after treatment in comparison with the value that was obtained before treatment. The mean FFI-P at 8 weeks in laser group FFI-P was significantly lower. This also agreed with **Malik *et al.*** [(7)] who showed that the mean value of pain intensity on functional foot index (FFI) in group B (ultrasound therapy) pre-treatment was 73.35 ± 1.17 decreased to 58.27 ± 1.61 following treatment I (at the end of 5th session) decreased to 35.88 ± 1.17 following treatment II (at the end of 10th session). This was in accordance with the outcomes of **Khatri *et al.*** [(14)] who conducted their study on a total of 52 patients diagnosed with plantar fasciitis and randomly assigned them to either group A or group B. In group A, participants received therapeutic traditional ultrasound in addition to stretching exercises, whereas in group B, participants received laser therapy (using the scanning method) in addition to stretching exercises. Their findings indicated that the mean FFI after treatment was 112.55 ± 36.01 in the ultrasound group and 65.95 ± 38.44 in the laser group, respectively with a high significant difference between both groups ($P<0.001$).

In this study, the FAAM was demonstarted to be statistically significantly higher in group that had been treated with lasers (p 0.001). When compared to the value at the beginning of the study, the FAAM levels were significantly higher at both 4 weeks and 8 weeks after treatment in both groups. This increase was statistically significant. In addition, there was a statistically significant rise in the FAAM in both groups eight weeks after treatment, when compared to four weeks after treatment. This rise occurred eight weeks after treatment. This is in accordance with the findings of **Koteeswaran *et al.*** [(2)] who examined thirty cases diagnosed with plantar fasciitis. These cases were haphazardly divided into two groups using a lot system. Both of group A and group B underwent plantar fascia stretching, as well as laser therapy (scanning method). In the case of group A and ultrasound therapy in the case of group B respectively. They came to the conclusion that laser therapy with PF stretching is of grear efficincy compared to US therapy with PF stretching in terms of improving the subjects' quality of life (QoL) when they had PF.

Also, based on all the tested parameters, it would be not surprising to find higher patients' satisfaction in the laser-treated group. In the laser group, there was 9 cases (32.1%) satisfied and 18 cases (64.3%) highly

satisfied while in the ultrasound group, there was 19 cases (67.9%) satisfied and 3 cases (10.7%) highly satisfied. The satisfaction degree was statistically significaly higher in the laser group ($p < 0.001$).

The condition known as calcaneal spur, which impacts a large number of people of varying ages, has been linked to plantar heel pain. It is an outgrowth of the heel bone that is made of bone. Because of its location within the PF origin, the spur tip site causes constant traction on the PF, which in turn causes inflammation of the PF. It is possible for a calcaneal spur to cause symptoms, particularly in older patients, obese patients, female patients, and patients with previous diagnosis of osteoarthritis [(15)].

This study showed that calcaneal spur before treatment was detected by ultrasonography in 7 cases (25%) in the laser group and in 9 cases (32.1%) in the ultrasound group, with no statistically significant difference between the studied groups ($p=0.554$). After treatment, there was no change in the presence of the calcaneal spur in both groups, indicating no affection by either the laser or the ultrasound treatment.

No preceding researches have reported the effects of either technique in the complete disappearance of calcaneal spur in cases with plantar ascites and it should be considered for subsequent studies. Overall, in assessing the data from the present study, it was observed a general positive response to the PF stretch. In addition, on the contrary to therapeutic conventional US, the laser therapy (scanning method) beam did not attenuate owing to change of medium and this might be additional reason for better results than conventional ultrasound. Hence, laser therapy (scanning method) in conjunction with stretching exercises proved to be more efficint comapered to traditional US in the context of PF management.

CONCLUSION

On the basis of the findings of our investigation, we included that PF is a frequent state associated with impairment of functions and quality of life among the included cases. The patients who suffered from plantar fasciitis showed signs of improvement after receiving either ultrasound or laser therapy (using the scanning method). When it comes to the treatment of PF, it has been demonstrated that laser therapy, specially the scanning method, when combined with stretching exercises, was more effective than traditional ultrasound.

RECOMMENDATIONS

Further studies should be performed including larger number of patients from more than one center with a longer duration of follow up for assessment of the efficacy of treatment modalities

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