

Effect of Shock Wave Therapy Versus Low Level Laser Therapy in Patients with Plantar Fasciitis

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Cite this paper as: Reham Mohamed Lotfy (2024) Effect of Shock Wave Therapy Versus Low Level Laser Therapy in Patients with Plantar Fasciitis. *Frontiers in Health Informatics*, 13(4)461-471

Abstract

Introduction: To compare the efficacy of shock wave therapy versus low level laser therapy in patients with plantar fasciitis.

Methods: Seventy five patients were assigned randomly into three groups. Group A (control group) Patients received conventional physical therapy program in the form of Ice application, deep tissue massage, stretching exercises, joint mobilization, and isometric exercises. This program was administered over twelve sessions three times per week.. Group B (study group): Patients received low level laser therapy in addition to conventional physical therapy program for nine sessions three times per week. Group C (study group): Patients received shock wave therapy in addition to conventional physical therapy program applied for a total of six applications, one each foot. Outcome measures were visual analogue scale, Pressure algometer for Quadratus plantae, active range of motion of plantarflexion and dorsiflexion, stability score between both sides and activity score, Measurements were recorded before and after treatment.

Results: There was no statistically significant difference observed between activity score, pain level, pain pressure threshold, stability score, and active range of motion of plantarflexors and dorsiflexors prior to the study among the three groups. Additionally, post-study analysis revealed no substantial differences in the stability score, active range of motion of plantarflexors, and dorsiflexors among the three groups. However, there was substantial difference post study among the three groups in activity score, pain level, pain pressure threshold for Quadratus plantae.

Conclusions: Both shock wave therapy and low level laser therapy were effective in treating patients with plantar fasciitis.

Key words: Low level laser therapy, Plantar fasciitis, Shock wave therapy

1. Introduction

Plantar fasciitis (PF) is the predominant etiology of persistent heel pain in adults, impacting both physically active young persons and less active elderly individuals (**Neufeld & Cerrato, 2008**). It is caused by a long-term excessive strain on the plantar fascia. The cause of this condition can be attributed to either excessive use, commonly observed in runners and military personnel, or excessive strain, commonly observed in sedentary adults who are obese (with a body mass index greater than 30) and those who spend lengthy periods of time standing (**Abbassian et al., 2012**).

The pain initially manifests as diffuse or migratory, but subsequently concentrates on the medial tuberosity as time passes. Frequently, patients experience pain upon awakening in the morning. This pain diminishes gradually over the course of 30 to 45 minutes (**Kotwalkar et al., 2019**). Research has shown that non-weight-bearing stretching exercises may successfully relieve the severe pain that arises in the morning (**Shinde et al., 2019**).

Low Level Laser Therapy (LLLT) involves the utilization of light to stimulate tissue regeneration, alleviate pain, and reduce inflammation within a biological system (**Huang et al., 2009**).

Shock wave therapy (SWT) has been recommended for the management of various musculoskeletal disorders due to its noninvasive nature and ability to promote bone and tissue regeneration (**Crawford and Thomson, 2003**). It is believed that shock wave therapy stimulates the healing process and provides long-lasting analgesia for orthopaedic diseases. Patients who do not respond to conservative treatment for chronic PF have been advised to undergo this particular treatment (**Buch et al., 2002**).

To our knowledge, few researchers have studied the efficacy of both techniques on ankle joint pain threshold, pain intensity level, active range of motion of ankle joint, foot function ability, and stability between both sides in patients with plantar fasciitis.

2. Methods

2.1. Study Design

The study was designed as a prospective, randomized, controlled trial. It was conducted between May 2023 and October 2023.

2.2. Participants

Seventy five patients their age ranged from 40-60 years of both genders with PF participated in this study that was conducted at private clinic at October 6th city and Ibny Beita medical center-Egyptian Ministry of Health, Giza, Egypt. The inclusion criteria comprised plantar fasciitis for at least 4 weeks, complained from unilateral symptoms and had positive Windlass test and negative Tinel and calcaneus squeeze tests. The age range of the participants was 40 to 60 years, and their BMI varied between 18.5 and 24.9 kg/m². Participants were excluded if they had any prior foot or ankle surgeries, fractures, or traumas. Neuropathic pain due to diabetes mellitus, Peripheral vascular disease, Calcaneal stress fracture or exhibited signs of a foreign body or malignancy of the affected heel, Osteomyelitis of the affected calcaneus, Plantar fascia rupture or surgery history or not longer able to give informed consent to take part in clinical trials.

2.3. Randomization

Every participant was provided with detailed information regarding the nature, aim, and advantages of the study, as well as their entitlement to decline or withdraw at any point. Additionally, they were told about the strict confidentiality of all collected data. The participants were allocated into three equal groups using a computer-based randomization program. There were no participants who withdrew from the trial after the

randomization process. The patients were kept unaware of the group to which they were assigned by an impartial researcher.

2.4. Materials and Procedures

The participants were allocated into 3 groups using a random assignment method. Group A, composed of 25 patients, were given twelve sessions for four weeks (three sessions every week) of traditional physical therapy program consisting of (Instructions, Ice application, deep tissue massage, stretching exercises, joint mobilization, as well as isometric exercises). Group B, composed of 25 patients, received nine sessions for three weeks (three sessions every week) of Low level laser therapy along with traditional physical therapy program. Group C, composed of 25 patients, received six sessions for six weeks (one session every week) of Shock wave therapy in addition to traditional physical therapy program.

2.5. Assessment tools and procedures:

2.5.1. Pressure algometer

Its model is BASELINE, Evaluate pain pressure threshold. Standardized (1.52 cm²) flat circular probe is pushed against subject's skin until pain pressure threshold is reached. It is calibrated in pounds and kilograms. It is done by applying pressure on the skin with a pressure algometer until the patient first experiences pain (Riel et al., 2019).

Its dimensions are as follows 6" x 2" x 4", It was adopted by the researchers that it is valid & reliable method to measure the intensity of pain associated with plantar fasciitis(Plaza- Manzano et al., 2019) .

2.5.2. Visual analog scale (VAS)

VAS is a valid & reliable method for assessing the severity of pain. VAS, which is a 10 cm long horizontal line that is anchored by the phrase "no pain" on one end and "the most severe/unbearable pain you have ever experienced in your lifetime" on the other end, Patients are instructed to indicate the position on the line that most accurately reflects the intensity of their pain. This position is then measured on a 10-centimeter line using a ruler and assigned a numerical score ranging from 0 to 10.

2.5.3. Digital Goniometer device

Studies have shown that digital goniometer as accurate or better than the basic versions The clinical instrument most frequently employed to assess joint ROM is a valid & reliable method for physiotherapists to diagnose the function of the musculoskeletal system in terms of ROM and monitor the effectiveness of an intervention, In addition to displaying data from 0 to 180 degrees on an LCD screen, the device also has the capability to freeze angle measurements for future reference. Arms of the goniometer are marked in inches and centimeters and have a durable powder-coated steel exterior, Assessment was conducted for all patients in every group prior to their involvement in the trial and again following the completion of the treatment to measure ankle dorsiflexion and plantarflexion, Patient was sitting with 90 degree knee flexion, Therapist to stabilise the leg, axis located Lateral calcaneus at bisection of fibula + 5th metatarsal while stationary arm placed parallel to fibula and movement arm placed Parallel with 5th metatarsal.

2.5.4. Foot and ankle ability measure questionnaire (FAAM)

The Arabic version of foot and ankle ability measure questionnaire is a reliable, valid, and feasible instrument, Therefore, it might be considered in the clinical evaluation of Arabic-speaking people with lower leg, foot, and ankle musculoskeletal disorders in Arabic-speaking people (Amir et al., 2021), activity score was evaluated for all patients both before and after treatment. This questionnaire is a self-reported assessment consisting of 29 items that are specific to the foot and ankle region. It includes two subscales: the activities of daily living

subscale (FAAM-A) as well as the sport subscale (FAAM-S). These subscales are scored on a Likert scale that ranges from 4 (indicating no difficulty) to 0 (indicating inability to perform the activity). The FAAM offers an additional response choice, "N/A", for all the listed activities. The scores for each item are computed, and the number of questions completed is multiplied by 4 to determine the maximum achievable score. The maximum achievable score is 84 if all questions are answered. The cumulative score for all elements is subsequently divided by the maximum attainable score and then multiplied by 100%. Greater scores on the questionnaire correspond to an elevated degree of physical functioning.

2.5.5. HUMAC balance system

The current study utilized the Human Assessment Computer (HUMAC) Balance System to evaluate the limits of stability. This system consists of a force plate that is widely accessible. It offers visual feedback and numerical data to both the patient and the tester. The system presents multiple reporting choices containing objective, reliable, valid and relevant data, enabling doctors to gain valuable insights into the patients' development. This data is utilized for both baseline as well as follow-up analysis with eight programs to choose from (Blosch et al., 2019), HUMAC, primarily being part of a video game appliance (Wii Balance Board), is a distinct technology used in assessment and rehabilitation of postural control.

2.6. Treatment tools and procedures

2.6.1. Shock wave therapy

Its model is OCEANUS, OCE-ESWT-002, Shenzhen, China. The device has a voltage of 100-240V, Frequency of 50-60Hz and power consumption 300VA, Shock waves were administered by moving a probe over the heel area to give compressed air pulses in a systematic way for a duration of 5 minutes. One session every week for six weeks, the dosage was set to the five anatomical zones of the foot.

2.6.2. Low level laser therapy

Its model is CHATTANOOGA, NEO MODULE LASER, INTELECT NEO, USA. The device has a power of 100-240VAC and a frequency of 50-60Hz, Five tender points on the plantar fascia were treated with low-level lasers for three sessions over the course of three weeks.

2.6.3. Non- guideline approach

All the patients in the 3 groups were given non-guideline approach consisting of stretching exercises, joint mobilization, ice application, deep tissue massage and isometric exercises, three sessions weekly for four weeks (Group A), three sessions weekly for three weeks (Group B), and one session weekly for six weeks (Group C) as follows:

2.6.4. Stretching exercises

Applied for plantar fascia, Gastrocnemius and soleus muscles. To achieve a stretch along the plantar fascia, the patient will cross the affected leg over the opposite leg and apply pressure to the base of the toes with their fingers. This process will continue until a stretch is felt. plantar fascia stretch 3 repetitions and hold for 30 seconds. Stretching of gastrocnemius-soleus muscle was 3 repetitions and hold for 30 seconds with the knee extended followed by 3 repetitions of 30 seconds stretching with the knee flexed to increase the stretch of the soleus muscle.

The soleus muscle can be stretched by standing with the affected leg positioned behind the opposite leg, with the toes pointing forward. The anterior knee was subsequently flexed, while maintaining the posterior knee in a straight position with the heel on ground. The posterior knee could be flexed to achieve a greater stretch in the soleus muscle.

2.6.5. Deep tissue massage

For one to three minutes per session, deep tissue massage utilized the fingertips as a scraping tool by putting substantial pressure to the plantar fascia with short, slow strokes.

2.6.6. Joint mobilization

While standing at the end of the couch and wrapping the fingertips of both hands around the dorsum of the foot with the thumbs on the plantar aspect, the therapist performed talocrural joint traction. With respect to the joint, it was in resting. Legs were stabilized using the belt.

2.6.7. Ice application

Ice packs were used under the foot with slight pressure for five to ten minutes at the end of each session.

2.6.8. Isometric exercises:

- Isometric exercise for plantar fascia

Patient stood with feet together and a towel folded just in front of his feet, his left foot moved forward with just his toes rested on the towel (keeping the toes in a dorsiflexed position), the heels of both feet raised off the ground slowly so the weight transferred entirely to his left foot by lifting the right foot completely off the ground, the patient hold this position for about 45 seconds, Exercise was repeated up to ten times and then switch to the other foot.

- Quadriceps isometric contraction

Patient's knee was positioned in partial flexion by placing a towel or a foam roller below the knee, patient was asked to straighten his knee and hold the contraction for approximately 45 seconds then relax, exercise was repeated 5 times.

- Isometric hip adduction

The patient was asked to lie flat on his back, therapist placed a ball or a pillow between his knees. Therapist asked him to contract his adductors and squeeze the ball and hold for 45 seconds then relax, exercise was repeated 5 times.

- Isometric hip abduction

The starting position to perform isometric hip abduction was supine lying position with hip and knee slightly flexed with an elastic band placed above the knee to provide resistance of the hip abductor muscles patients were asked to hold for 45 seconds then relax, repeated 5 times.

2.7. Statistical analysis and statistical design

All data were expressed as mean \pm SD. Subject characteristics across the three groups were compared using ANOVA. The normality of the data distribution was checked using the Kolmogorov-Smirnov test. The effects of the assessed variables were compared within and between the groups using MANOVA. Data analysis was carried out using SPSS Inc.'s (Chicago, Illinois, USA) Statistical Package for the Social Sciences, version 20 for Windows. A p-value of 0.05 or below was deemed statistically significant.

3. Results

A total of 75 patients who were randomly assigned to receive the study intervention. regarding group A, 25 patients were given traditional physical therapy program consisting of (Instructions, Ice application, deep tissue massage, stretching exercises, joint mobilization, and isometric exercises) this program was administered over twelve sessions, with each session occurring three times per week. Regarding group B, 25 patients were given

low level laser therapy along with traditional physical therapy program applied for nine sessions three times per week. In group C, 25 patients were given Shock wave therapy along with traditional physical therapy program for a total of six applications, one each foot, weekly. All participants who were randomly assigned to a treatment group successfully completed the trial. There was no substantial difference among three groups regarding the mean values of age, weight, height and BMI ($p > 0.05$) (As presented in **Table 1**).

Table (1) General characteristics of subjects of three groups.

Subject characteristic	Group A	Group B	Group C	f-value	p-value
Age (years)	46.9 ± 6.2	46.6 ± 6.3	46.3 ± 7.6	0.056	0.945
Weight (kg)	67.2 ± 9	67.5 ± 10	68.6 ± 10.4	0.139	0.870
Height (cm)	167.4 ± 9	166.2 ± 8.7	168.7 ± 9.7	0.464	0.631
BMI (kg/m ²)	23.9 ± 1.3	24.3 ± 2	23.9 ± 1.5	0.511	0.602

There were statistically significant effects of the first independent variable (the examined group) on the measured variables ($F=11.88$, $P=0.001$), there were substantial effects of the second independent variable (the measuring periods) on the examined dependent variables ($F=512.3$, $P=0.001$). As well, there was significant interaction ($F=16.79$, $P=0.110$) assessed by 3x 2 mixed MANOVA design statistical analysis (As shown in **Table 2**).

Table (2) Among groups 3 x2 mixed MANOVA design at variable measuring periods and conditions for all dependent variables.

Variation source	F-value	P-value	η^2
Groups	11.88	0.001	0.754
Measuring periods	512.3	0.001	0.993
Interaction	16.79	0.001	0.813

Significant at alpha level <0.05.

Effect on stability

There was no substantial difference regarding the mean values of stability pre-study among the three groups ($p = 0.183$), also there was no substantial difference post study among the three groups ($p = 0.396$).

Effect on plantar and dorsiflexion ROM

There was no substantial difference regarding the mean values of planter and dorsi flexion ROM pre-study among the three groups ($p = 0.319$ and 0.369), as well there was no substantial difference post study among the three groups ($p = 0.057$ and 0.243) respectively. A post hoc test will be conducted to determine the statistical difference among groups in the mean values of planter flexion ROM after the study, there was substantial difference among groups A and B ($P=0.001$) in favor of group B, there was substantial difference among groups A and C ($p=0.001$) in favor of group C, also there was substantial difference among groups B and C ($P=0.001$).

in favor of group C. A post hoc test is conducted to determine the statistical significance of the differences in the mean values of dorsi flexion ROM among the groups after the study, there was no substantial difference among groups A and B ($P=0.098$), while there was substantial difference among groups A and C ($p=0.001$) in favor of group C, also there was substantial difference among groups B and C ($P=0.001$) in favor of group C.

- Effect on activity score

There was no substantial difference in the mean values of activity score pre-study among the three groups ($p = 0.427$), although there were substantial differences among the three groups after the study ($p = 0.027$). A post hoc test was conducted to determine the statistical difference among groups in the mean values of activity score after the study, there was no substantial difference among groups A and B ($P=0.430$), also there was no substantial difference among groups B and C ($p=0.627$), while there was substantial difference among groups A and C ($P=0.023$) in favor of group C.

- Effect on pain

There was no substantial difference in the mean values of pain pre-study among the three groups ($p = 0.125$), Although there were substantial differences among the three groups after the study ($p = 0.001$). Using a post hoc test to determine whether there is a statistically significant difference in the groups' mean pain scores after the study, there was substantial difference among groups A and B ($P=0.006$) in favor of group B, also there was substantial difference among groups A and C ($p=0.001$) in favor of group C, while there was no substantial difference among groups B and C ($P=0.132$).

- Effect on pressure pain threshold of Quadratus muscle

There was no substantial difference in the mean values of PPT of Quadratus pre-study among the three groups ($p = 0.121$), although there was substantial difference post study among the three groups ($p = 0.001$), using a post hoc test to determine whether there is a statistically significant difference in the groups' mean PPT values after the study, there was substantial difference among groups A and B ($P=0.001$) in favor of group B, there was substantial difference among groups A and C ($p=0.001$) in favor of group C, also there was no substantial difference among groups B and C ($P=0.001$) in favor of group C.

4. Discussion

The majority of research examining the efficacy of PF treatments has often been conducted as placebo-controlled trials, with relatively few studies contrasting various treatment modalities (Ulusoy et al., 2017). Although numerous physical therapy techniques are employed in the conservative management of plantar fasciitis, LLLT as well as SWT have gained significant attention in the last few years (M. Roxas 2005). Therefore, in patients with plantar fasciitis, the purpose of this study was to compare the effectiveness of LLLT as well as SWT with regard to ankle joint pain threshold, pain intensity level, active ROM of the ankle joint, foot functional ability, as well as stability between both sides.

To the best of our understanding, this study is the first to directly compare the effectiveness of SWT and LLLT for treating plantar fasciitis. The results of this study demonstrate that both SWT as well as LLLT are effective techniques for managing PF in terms of relieving pain, enhancing foot function, increasing ankle ROM, and improving stability on both sides.

However, SWT proved significantly superior to LLLT therapy in stability score within group.

In a recent study conducted by Ulusoy et al. (2017), the researchers examined the efficacy of three treatment modalities, including therapeutic USG, SWT, as well as LLLT, in patients diagnosed with PF. Pain level, functional level, as well as plantar fascia thickness were assessed using MRI both before and after a one-month

period. A substantial reduction in fascia thickness was observed in all groups. The researchers discovered that both LLLT as well as SWT yielded a similar outcome, and both were more effective than USG in terms of reducing pain along with improving functional outcomes. Their findings are similar to our findings.

Table (3): Comparison between pre- as well as post-study mean values of outcome measures between and within groups

Variables	Group A	Group B	Group C	f-value	P value	η^2
Stability (%)						
Post-study	73.5 ± 15.9	68.3 ± 19.2	67.1 ± 17.6	0.94	0.396	0.025
% of change	31.5%	13.5%	37%			
P-value	0.002*	0.152	0.002*			
(ROM) Dorsi flexion						
Post-study	18.6 ± 1.3	19.1 ± 1.5	19.5 ± 1.2	2.97	0.057	0.076
% of change	8%	19%	20%			
P-value	0.014*	0.001*	0.001*			
(ROM) Planter flexion						
Post-study	38.8 ± 4	39.7 ± 3.6	40.8 ± 4.7	1.44	0.243	0.039
% of change	55%	56%	67%			
P-value	0.001*	0.001*	0.001*			
Activity score (%)						
Post-study	42.3 ± 6.3	44.6 ± 6.3	46.5 ± 2.8	3.78	0.027*	0.095
% of change	46%	53%	63%			
P-value	0.001*	0.001*	0.001*			
Pain (cm)						
Post-study	5 ± 1	4 ± 1.4	3.4 ± 0.9	14	0.001*	0.280
% of change	30.5%	45%	55%			
P-value	0.001*	0.001*	0.001*			
PPT of Quadratus (kg)						
Post-study	2.2 ± 0.4	3.1 ± 0.3	3.9 ± 0.4	150.8	0.001*	0.807
% of change	0%	41%	86%			
P-value	1	0.001*	0.001*			

Between and within group analysis

A 2013 meta-analysis reported that SWT shown efficacy in reducing pain and improving function in tendinopathies, without any observed adverse effects. Nevertheless, there is currently no universally accepted and standardized agreement on the specific procedure for implementing SWT) reduced pain scores and its impact was found to persist for a duration of 12 months in the management of chronic PF. Compared to other methods, SWT is safer as well as more effective for long-term conditions (A. Aqil et al.,2013). Consistent with previous research, we discovered that the treatments were beneficial for the patients in our trial who had existed for at least six months and whose symptoms had not responded to conventional conservative treatments. The impact of SWT and LLLT on pain was assessed in our research using the VAS. We observed a substantial reduction in pain scores among subjects during exercise ($p=0.001$). There was no statistically substantial difference observed among the three groups before the study ($p = 0.125$). However, a statistically substantial difference was observed among the three groups after the study ($p = 0.001$).

Balance, or postural stability, is a complex concept that refers to the body's capacity to prevent falling, move with ease, and respond to disturbances. The term "balance" refers to the capacity to control and restore the position of the body's center of gravity in relation to the base of support (BOS). This ability enables the execution of smooth and coordinated motions in a safe and accurate manner (Patel et al., 2017).

We found no substantial difference in the mean values of stability pre-study among the three groups ($p = 0.183$), also there was no substantial difference post study among the three groups ($p = 0.396$).

The findings of the present investigation contradicted the conclusions of Boonchum et al, who asserted that stretching the Achilles tendon as well as plantar fascia improve the ROM in ankle dorsiflexion (Boonchum et al., 2020). While the current study showed substantial improvement post study only ($p=0.001$) while there was no substantial difference in the mean values of planter and dorsi flexion ROM pre-study among the three groups ($p = 0.319$ and 0.369) respectively, also there was no substantial difference post study among the three groups ($p = 0.057$ and 0.243) respectively.

The study conclusively showed that a thorough comparison was made between shock wave therapy and low level laser therapy for their impacts on ankle joint pain threshold, pain intensity level, active ROM of ankle joint, foot function ability, as well as stability between both sides in patients having plantar fasciitis found substantial differences among groups in pain threshold, pain intensity level and foot function ability but no substantial differences among groups in active ROM of ankle joint as well as stability.

Implications on physiotherapy practice

Shockwave therapy and low level laser therapy are effective in decreasing pain, increasing weight bearing tolerance and improving function in patients suffering from plantar fasciitis faster than conservative physiotherapy treatment alone.

5. Limitations

The results of this study were constrained by its small number of participants. The demographic representation in each group did not necessarily correspond to that of the general population (e.g., sex, age). Additionally, the current patients were not followed up. Therefore, results of this study cannot be generalized to all population, yet it presents a start. To verify and assess our findings, larger and more extensive research is required.

6. Conclusion

Shock wave therapy as well as low level laser therapy are beneficial and effective methods for the treatment of patients with plantar fasciitis with no substantial difference in stability score, range of motion of plantar flexion or dorsi flexion pre and post treatment. There was no substantial difference in the mean values of activity score, pain and pain pressure threshold of Quadratus plantae pre-study among the three groups while there was substantial improvement in mean value of activity score, pain and pain pressure threshold of Quadratus plantae in all groups post study.

Funding: This research did not receive any special recognition from funding organizations, the government, the corporate sector, or the nonprofit sector.

Conflict of interest: The authors declare no conflict of interest.

Acknowledgments

It is with deep gratitude that we acknowledge the many people, particularly the study participants, who helped bring this project to reality.

Disclosure statement

No author has any financial interest or has received any financial benefit from this research.

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