

# Radial Extra Corporeal Shockwave Therapy Versus Ultrasound Therapy in the Treatment of Plantar Fasciitis

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## ABSTRACT

**Introduction:** Patients with plantar fasciitis usually suffer from reduced mobility due to the pain caused by the movement of the tendons involved. **Aim:** This study was aimed to compare both shockwave and ultrasound therapies in patients with plantar fasciitis by assessing the pain intensity, and both the functionality of the lower limbs and the quality of life impairments. **Methods:** Total amount of 88 patients with plantar fasciitis constituted the shockwave group, 56 the ultrasound group and 15 the control group. The self-administered questionnaire "University of Peloponnese Pain, Functionality and Quality of Life Questionnaire" was used. The intensity of pain, functionality impairment and quality of life impairment were evaluated on a five-point Likert scale, before treatment, immediately after and at 4-week follow-up. **Results:** The pain reduction and the improvement of functionality and quality of life after shockwave treatment and ultrasound treatment significantly increased both post-treatment ( $p < 0,001$ ) and at the 4-week follow-up ( $p < 0,001$ ) compared to post-treatment. However, the improvements in the ultrasound group were not as pronounced as in shockwave group ( $p < 0,001$ ).

**Conclusions:** Although both radial shockwave and ultrasound therapies were found to be effective in patients with plantar fasciitis, the statistical analysis showed that radial shockwave is significantly more effective than ultrasound therapy.

**Keywords:** shockwave therapy, ultrasound therapy, rehabilitation, musculoskeletal injuries, plantar fasciitis.

## 1. INTRODUCTION

Plantar fasciitis is a foot disorder that is defined as an irritation or partial rupture of plantar fascia due to repetitive overload. Histopathological findings show that plantar fasciitis is a degenerative disease without inflammation, and therefore should be appropriately classified as a fasciosis or fasciopathy (1, 2). Patients usually report a gradual onset of pain on the plantar side of the heel, on the medial side of the curve. Pain appearance may also be sudden in individuals who have performed a jump and their feet have not properly landed on the ground. The disorder can last over a long time so that it makes every day activities difficult to perform (3).

Treatment modalities for plantar fasciitis can be either conservative or surgical. Conservative treatments include night splints, orthotic devices,

cast immobilization for 4 to 6 weeks, oral non-steroid anti-inflammatory drugs (NSAIDs), corticosteroid injections, stretching exercises, or the use of physical therapy methods. Physical therapy modalities most commonly used for plantar fasciitis are laser therapy, ultrasound therapy, iontophoresis and extracorporeal shock wave therapy. Finally, surgery is recommended as a last resort after at least 12 months from the onset of the disease and when other conservative methods of treatment have failed (3-6).

Therapeutic ultrasound is a commonly used physiotherapeutic method for treating plantar fasciitis. It uses mechanical waves and its effect on tissues depends on the frequency, intensity, duration of action and the method of application used. Extracorporeal shockwave therapy (ESWT) has been widely used as an

alternative method for the treatment of plantar fasciitis because it is noninvasive, its recovery time is fast and it is convenient for daily life of patients.

**2. AIM**

The aim of the present research was to compare two therapeutic modalities, radial shockwave and ultrasound, in individuals suffering from plantar fasciitis by comparing the pain, the functionality and the quality of life before the treatment, immediately after the treatment and the 4-week follow-up. Additionally, comparisons were also made between the two intervention groups and the control group.

**3. METHODS**

**Research Population:** The sample consisted of 159 individuals suffering from plantar fasciitis who attended an orthopaedic clinic between February 2015 and August 2017. From the sample, 88 individuals received radial shockwaves and constituted the shockwave group (Group I), 56 individuals constituted the ultrasound group (Group II) and 15 individuals made up the control group (Group III). Individuals under the age of 18 were excluded from the study.

**Research Tools:** For the purposes of this study, the self-administered questionnaire ‘University of Peloponnese Pain, Functionality and Quality of life Questionnaire’ was used on a 5-point Likert scale for the lower limbs, as described by Dedes et al (7).

Patients of group I received radial shockwaves by using a STORZ MEDICAL Masterpulse MP200 device and using the following parameters: For the first session a high frequency of 21 Hz, a pressure of 1.6 bar and 1500 shocks were used to achieve analgesia, whereas for the second and third sessions, a frequency of 15 Hz, a pressure of 1.8 bar and 2500 shocks were applied for therapy.

Patients of group II received ultrasound waves by using a Gymna Pulson 200 device at a 3 MHz frequency and a 2 W/cm<sup>2</sup> intensity.

Individuals in the control group (group III) were treated with conservative therapy, which included local application of NSAIDs, the use of splints, an exercise program, modification of activity levels, friction massage, and using hot or cold packs on the injured part of the body.

**Ethical considerations:** The present research met all the ethical

principles that govern the conduct of research such as full confidentiality of the participants, safety of the material and anonymity of the participants. Finally, the study protocol was in compliance with Helsinki Declaration and was approved by the University’s Ethical Committee.

**4. RESULTS**

Plantar fasciitis was diagnosed in 159 individuals (72 males and 87 females). From these, 88 individuals (36 males and 52 females) constituted group I, 56 patients (29 males and 27 females) constituted group II, and 15

PLANTAR FASCIITIS	Shockwave Group (n = 88)	Control Group (n=15)	Independent t-test Differences	P-value*
<b>Pain</b>				
Pre-Treatment Mean ± SD	2.52 ± 0,42	2.52 ± 0.19	-0.003	0.978
Post-Treatment Mean ± SD	0.06 ± 0.1	2.29 ± 0.2	-2.23	<0.001
P-value**	<0.001	<0.001		
4-Week Follow-up Mean ± SD	0.00 ± 0.00	2.27 ± 0.19	-2.27	<0.001
P-value***	<0.001	0.165		
<b>Functional Impairment</b>				
Pre-Treatment Mean ± SD	2.46 ± 0.4	2.40 ± 0.25	0.06	0.431
Post-Treatment Mean ± SD	0.15 ± 0.21	2.27 ± 0.2	-2.11	<0.001
P-value**	<0.001	<0.001		
4-Week Follow-up Mean ± SD	0.01 ± 0.04	2.23 ± 0.17	-2.23	<0.001
P-value***	<0.001	0.082		
<b>Quality of life Impairment</b>				
Pre-Treatment Mean ± SD	2.23 ± 0.38	2.40 ± 0.15	-0.17	0.900
Post-Treatment Mean ± SD	0.14 ± 0.18	2.27 ± 0.16	-2.13	<0.001
P-value**	<0.001	<0.001		
4-Week Follow-up Mean ± SD	0.00 ± 0.02	2.24 ± 0.14	-2.24	<0.001
P-value***	<0.001	0.334		

**Table 1: Plantar fasciitis results in pain, functional impairment and quality of life impairment of both shockwave and control groups pre-treatment, post-treatment and at the 4-week follow-up. \*Comparison between shockwave and control groups pre-treatment, post-treatment and at the 4-week follow-up. \*\*Comparison between pre-treatment and post-treatment within each group. \*\*\*Comparison between post-treatment and 4-week follow-up within each group.**

PLANTAR FASCIITIS	Ultrasound Group (n = 56)	Control Group (n=15)	Independent t-test Differences	P-value*
<b>Pain</b>				
Pre-Treatment Mean ± SD	2.69 ± 0,32	2.52 ± 0,19	0.17	0.064
Post-Treatment Mean ± SD	0.89 ± 0.23	2.29 ± 0.20	-1.40	<0.001
P-value**	<0.001	<0.001		
4-Week Follow-up Mean ± SD	1.01 ± 0.25	2.27 ± 0.19	-1.26	<0.001
P-value***	<0.001	0.165		
<b>Functional Impairment</b>				
Pre-Treatment Mean ± SD	2.69 ± 0,33	2.40 ± 0,25	0.29	0.002
Post-Treatment Mean ± SD	0.90 ± 0.23	2.27 ± 0.20	-1.37	<0.001
P-value**	<0.001	<0.001		
4-Week Follow-up Mean ± SD	1.02 ± 0.24	2.23 ± 0.17	-1.21	<0.001
P-value***	<0.001	0.082		
<b>Quality of life Impairment</b>				
Pre-Treatment Mean ± SD	2.64 ± 0,34	2.40 ± 0,15	0.24	0.010
Post-Treatment Mean ± SD	0.85 ± 0.25	2.27 ± 0.16	-1.41	<0.001
P-value**	<0.001	<0.001		
4-Week Follow-up Mean ± SD	0.94 ± 0.24	2.24 ± 0.14	-1.31	<0.001
P-value***	<0.001	0.334		

**Table 2: Plantar fasciitis results in pain, functional impairment and quality of life impairment of both ultrasound and control groups pre-treatment, post-treatment and at the 4-week follow-up. \*Comparison between ultrasound and control groups pre-treatment, post-treatment and at the 4-week follow-up. \*\*Comparison between pre-treatment and post-treatment within each group. \*\*\*Comparison between post-treatment and 4-week follow-up within each group.**

patients (7 males and 8 females) constituted group III. 70 individuals of group I were submitted to 3 treatments, 15 to 4 treatments and 3 to 5 shockwave treatments, while all 56 individuals of group II were submitted to 10 treatments. The frequency of the shockwave treatments was once a week for 75 individuals, one every 10 days for 8 individuals and one every 15 days for 5 individuals, while the frequency of the ultrasound treatments was three times a week. 84 individuals of group I and 13 of group II did not take any medication whereas all individuals of group III used local application of NSAIDs and 4 individuals of group I and 42 of group II used NSAIDs orally.

**a) Comparison of group I versus group III:** (Table 1)

In group I, the mean of reported pain, functional impairment and quality of life impairment were significantly decreased ( $p < 0.001$ ) and thus improvements in all three parameters were observed immediately after the treatment.

These reductions were even more pronounced in all parameters after the 4-week follow-up compared to immediately after the treatment values ( $p < 0.001$ ). In group III, only minor reductions and thus improvements were seen in all parameters recorded both immediately after the treatment and the 4-week follow-up. Thus, the results in group I were significantly better compared to group III, both immediately after the treatment ( $p < 0.001$ ) and in the 4-week follow-up ( $p < 0.001$ ).

**b) Comparison of group II versus group III:** (Table 2)

In group II, the mean in pain intensity, functional impairment and quality of life impairment were significant diminished immediately after the treatment ( $p < 0.001$ ) and therefore significant improvements in all three parameters were obtained. However, the reductions obtained in the 4-week follow-up were slightly inverted towards those in the pre-treatment state. Therefore, the results obtained in group II were significantly better compared to group III both immediately after the treatment ( $p < 0.001$ ) and the 4-week follow-up ( $p < 0.001$ ).

**c) Comparison of group I versus group II:** (Table 3)

The results obtained in group I by assessing the pain intensity, functionality impairment and quality of life impairment were significantly better compared to group II both immediately after the treatment ( $p < 0.001$ ) and the 4-week follow-up ( $p < 0.001$ ).

**5. DISCUSSION**

Plantar fasciitis, a degenerative syndrome of the plantar fascia, is a repetitive strain injury of the medial arch and heel that is usually caused by compressive forces making the longitudinal arch of the foot flat. The most important clinical aspect of the disease is localized pain during the first few steps in the morning or after

PLANTAR FASCIITIS	Shockwave Group (n = 88)	Ultrasound Group (n=56)	Independent t-test Differences	P-value*
<b>Pain</b>				
Pre-Treatment Mean ± SD	2.52 ± 0.42	2.69 ± 0.32	-0.17	0.011
Post-Treatment Mean ± SD	0.06 ± 0.10	0.89 ± 0.23		
P-value**	< 0.001	< 0.001	-0.83	< 0.001
4-Week Follow-up Mean ± SD	0.00 ± 0.00	1.01 ± 0.25		
P-value***	< 0.001	< 0.001	-1.01	< 0.001
<b>Functional Impairment</b>				
Pre-Treatment Mean ± SD	2.46 ± 0.40	2.69 ± 0.33	-0.23	< 0.001
Post-Treatment Mean ± SD	0.15 ± 0.21	0.90 ± 0.23		
P-value**	< 0.001	< 0.001	-0.75	< 0.001
4-Week Follow-up Mean ± SD	0.01 ± 0.04	1.02 ± 0.24		
P-value***	< 0.001	< 0.001	-1.01	< 0.001
<b>Quality of life Impairment</b>				
Pre-Treatment Mean ± SD	2.23 ± 0.38	2.64 ± 0.34	-0.41	< 0.001
Post-Treatment Mean ± SD	0.14 ± 0.18	0.85 ± 0.25		
P-value**	< 0.001	< 0.001	-0.71	< 0.001
4-Week Follow-up Mean ± SD	0.00 ± 0.02	0.93 ± 0.24		
P-value***	< 0.001	< 0.001	-0.93	< 0.001

**Table 3: Plantar fasciitis results in pain, functional impairment and quality of life impairment of both shockwave and ultrasound groups pre-treatment, post-treatment and at the 4-week follow-up. \*Comparison between shockwave and ultrasound groups pre-treatment, post-treatment and at the 4-week follow-up. \*\*Comparison between pre-treatment and post-treatment within each group. \*\*\*Comparison between post-treatment and 4-week follow-up within each group.**

periods of inactivity. The discomfort is usually improved with further ambulation but at the end of the day it becomes unbearable making everyday activities and functioning difficult and sometimes impossible to perform.

Therapeutic ultrasound has been extensively used to treat a vast diversity of disorders, including plantar fasciitis, and its therapeutic effects are usually attributed to both its thermal and non-thermal effects in tissues. The thermal effects occur when the generated sound waves pass through the skin and cause a vibration of the injured tissues resulting in a temperature increase of the local tissues. If the temperature is raised to about 40-45°C for at least 5 min, then an increase in blood flow locally will occur which aids to reduce local swelling and initiate the resolution of chronic inflammatory state. It has also been shown to reduce muscle spasm and increase extensibility of collagen fibers. The non-thermal effects are cavitation and acoustic micro streaming. Cavitation refers to the formation, oscillation and collapse as a micro-explosion of gas-filled bubbles in the interstitial tissue fluids on the injured area where ultrasound is applied. This cavitation process is crucial in enhancing the acoustic micro streaming events. Micro streaming alters the structure, function and permeability of cell membranes by increasing the activity levels within the cell and thus stimulates the tissue repair. Although ultrasound energy acts as a triggering factor for this process, it is the increased cellular activity that is responsible for the therapeutic effects of the modality (8, 9).

ESWT can induce neovascularisation at the junction of the tendon-bone, it stimulates collagen synthesis and release of growth factors such as VEGF (vascular endothelial growth factor), PCNA (proliferating cell nuclear antigen) and eNOS (endothelial nitric oxide synthase). Subsequently, these factors lead to the improvement of

the blood supply and to an increase in cell proliferation and ultimately to the tissue regeneration of tendons and bones for tissue repair (10, 11).

The findings of the present study show that radial shockwaves achieved statistically significant improvements in pain intensity, functionality and quality of life in patients with plantar fasciitis both immediately after the completion of the therapy and the 4-week follow-up. Accordingly, statistically significant improvements in pain, functionality and quality of life were noticed in patients treated with therapeutic ultrasound, but the findings were less pronounced compared to shockwaves. Thus, the present study clearly demonstrated that radial ESWT is more effective than ultrasound therapy in reducing pain and improving functionality and quality of life for plantar fasciitis.

Ulusoy et al (12) in a randomized controlled trial investigated the clinical outcomes of laser therapy (5 sessions a week for 3 weeks, 830 nm with 50 mW, total dose 8 J/cm<sup>2</sup> for 200 sec), ultrasound therapy (5 sessions a week for 3 weeks, 1 MHz frequency, 2 W/cm<sup>2</sup> power for 5 min on continuous mode) and extracorporeal shockwave therapy (1 session a week for 3 weeks, 2000 shockwaves, 2.5 bar pressure, 10 Hz frequency) for the treatment of plantar fasciitis. Each of the three modalities improved the pain VAS scores, heel sensitivity as assessed by heel tenderness index, Roles-Maudsley score that assesses activity limitations, and ankle-hind-foot scale of AOFAS scale scores after the treatment compared to before treatment. However, ESWT and laser therapy proved significantly superior in providing pain improvement and functional outcomes compared with ultrasound therapy at 1 month after treatment, but no significant difference was observed between laser therapy and ESWT.

Konjen et al (13), in a randomized control trial, compared the effectiveness of radial ESWT and ultrasound therapy in the treatment of chronic fasciitis. The radial ESWT group was treated once a week for 6 weeks at 2000 impulses with 10 Hz frequency and 2 bar pressure, whereas the ultrasound group was treated 3 times a week for 6 weeks at 3 Mz frequency and 0.5-1 watt/cm<sup>2</sup> on continuous mode. Pain was assessed by VAS scores before treatment and at 1, 3, 6, 12 and 24 weeks after treatment, while foot mobility function was evaluated by the mobility subscale of the plantar fasciitis pain and disability scale before and after treatment. Their findings showed that both radial ESWT and ultrasound are effective in reducing pain and increasing mobility, but radial ESWT was significantly more effective than ultrasound.

In another study, Cheing et al (14) compared the effectiveness of ESWT and ultrasound therapy for managing heel pain. ESWT was performed once a week, whereas ultrasound therapy was performed 3 times a week over a 3-week period and the treatment effect was evaluated post-treatment and 3 weeks after the completion of the therapy. Both treatment groups reduced the intensity of heel pain on palpation as assessed by VAS score and this reduction was maintained at the 3-week follow-up.

However, ESWT was shown to be more effective in reducing heel pain than ultrasound therapy. Similarly, the randomized control study by Kaewpinthong et al (15) showed that ESWT decreased pain significantly and these reductions were higher than ultrasound therapy at 3, 6, and 12 weeks after the treatment.

Greve et al (16) compared ultrasound and r-ESWT treatments in plantar fasciitis, but the ultrasound group included kinesitherapy. Thus, the first group received ultrasound at 1.0 Hz frequency and 1.2 W/cm<sup>2</sup> intensity along with kinesitherapy and home exercises for a total 10 sessions administered twice a week. The second group received radial ESWT once a week for 3 weeks with 2000 impulses at 6 Hz frequency and 3 Mpa pressure, and home exercises. The findings revealed that both treatments were effective for pain reduction and for improving the functional ability among patients but radial ESWT showed its pain reducing effect faster, but there was no difference between the groups three months later. In 2013, the same research group extended their study to a 12-month follow-up (17) where they found that both treatments were effective for improving pain and functional ability, but the improvement with shockwaves was faster.

## 6. CONCLUSION

From the results of the present study, it is evident that radial extracorporeal shockwave therapy and ultrasound therapy are both effective in relieving pain and improving the functionality and quality of life in plantar fasciitis. However, extracorporeal shockwave therapy displayed relative superiority in comparison with the ultrasound therapy intervention. The present study had several limitations with first most important being the short follow-up period. Second, a placebo group could not be included because of ethical concerns since the patients had been experiencing pain for about 6 months and the first-line treatment had failed. Further research may be necessary to elucidate the ideal parameters of shockwave therapy, comparing different treatment combinations in the medium to long term duration.

- **Author's contribution:** GIP, VD and AM gave substantial contribution to the conception and design of the work. VD, KT, MP and AM gave substantial contribution to acquisition of data. GIP, VD, KT, MP, AMD and CN gave substantial contribution to analysis and interpretation of data. GIP and VD had a role in drafting the article. KT, MP, AMD, CN and AM had a role in revising the article critically for important intellectual content. Each author gave final approval of the version to be published and agreed to be accountable for all aspects of the work ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.
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- **Declaration of patient consent:** The authors certify that they have obtained all appropriate patient consent forms
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