

CLINICAL SCIENCE

COMPARISON OF RADIAL SHOCKWAVES AND CONVENTIONAL PHYSIOTHERAPY FOR TREATING PLANTAR FASCIITIS

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OBJECTIVE: To compare radial shockwave treatment and conventional physiotherapy for plantar fasciitis.

MATERIALS AND METHODS: Thirty-two patients with plantar fasciitis were included in this study. They were randomly divided into two groups. Group 1 was composed of 16 patients who underwent 10 physiotherapy sessions each, consisting of ultrasound, kinesiotherapy and instruction for stretching exercises at home. Group 2 was composed of 16 patients who underwent three applications of radial shockwaves (once a week) and received instruction for stretching exercises at home. Pain and ability to function were evaluated before treatment, immediately afterwards, and three months later. The mean age of the patients was 47.3 ± 10.3 years (range 25-68); 81% were female, 87% were overweight, 56% had bilateral impairment, and 75% used analgesics regularly.

RESULTS: Both treatments were effective for pain reduction and for improving the functional abilities of patients with plantar fasciitis. The effect of the shockwaves was apparent sooner than physiotherapy after the onset of treatment.

CONCLUSION: Shockwave treatment was no more effective than conventional physiotherapy treatment when evaluated three months after the end of treatment.

KEYWORDS: Plantar fasciitis; Shockwave therapy; Physiotherapy.

INTRODUCTION

Shockwaves have been used for 15 years as an alternative treatment for musculoskeletal disorders.^{1,2} The treatment consists of mechanical acoustic waves that are transmitted through liquid and gaseous media.¹⁻³ Their biological effect comes from the mechanical action of (mechanical) ultrasonic vibrations on tissues.²⁻⁴

Shockwaves can be focal or radial. Focal shockwaves have high tissue penetration power (10 cm) and impact force (0.08–0.28 mj/mm²). They produce mechanical and biological effects of greater intensity, including destruction

of fibrosis and stimulation of neovascularization in treated tissues.¹⁻³ Radial shockwaves are pneumatic waves that are generated by air compressors. They transmit radially, with lower penetration (3 cm), less impact (0.02-0.06 mj/mm²) and limited biological effect.⁵ They have been shown to be effective for treating musculoskeletal disorders that are more superficial, with clinical results that are similar to those of focal shockwaves.^{2,6,7} The effect of radial shockwaves is less intense, but they have been shown to cause disintegration of fibroses and calcifications and increase blood circulation at the treated location.⁵⁻⁹

Plantar fasciitis is a degenerative abnormality of the plantar fascia that affects up to 10% of the general population.^{10,11} Shortening caused by changes in the collagen matrix of the plantar fascia is the pathophysiological basis of this disease, which evolves to include pain and functional changes of gait.^{1,3,12-14} Shortening of the plantar fascia leads to chronic bone traction in the heel and formation of heel spurs. The preferred treatment is physiotherapy, with

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the aim of suppressing pain and restoring the mechanical function of the plantar fascia for gait improvement. The use of ultrasound to promote analgesia associated with stretching of the plantar fascia and the posterior leg muscles is one of the most commonly indicated therapeutic alternatives.^{10,11,14,15} Treatment of plantar fasciitis using focal and radial shockwaves has shown good results with regard to pain reduction and improved function using only a small number of applications (three to six).^{1,3,5-7,14}

The aim of the present study was to compare the results of two conservative plantar fasciitis treatments:

- Treatment 1 – application of ultrasound and kinesiotherapy: stretching of the posterior muscle chain of the legs (ischiotibial and sural triceps) and strengthening of the tibialis anterior performed by a physiotherapist, together with instruction for active stretching of the gastrocnemius and plantar fascia to be performed at home.
- Treatment 2 – application of radial shockwaves, together with instruction for active stretching of the gastrocnemius and plantar fascia to be performed at home.

METHOD

This was a randomized, prospective and comparative clinical study.

Sample

Thirty-two patients with plantar fasciitis that was diagnosed by anamnesis, physical examination and ultrasonography were treated. All patients agreed to participate in the study and signed a free and informed consent statement. The inclusion criteria were:

- diagnosis of plantar fasciitis, with plantar fascia of more than 4 mm thickness as evaluated by ultrasonography;
- age between 20 and 68 years;
- literate;
- painful symptoms lasting three months or more;
- absence of heart pacemaker use;
- absence of anticoagulant use and absence of coagulation disease;
- absence of other musculoskeletal disorders of any etiology with clinical manifestations in the lower limbs or vertebral column;
- absence of central or peripheral neuropathy of any etiology;
- absence of systemic inflammatory disease;
- absence of associated metabolic and endocrine diseases;
- absence of psychiatric disorders;
- ability to visit the hospital for treatment and evaluations.

The mean age of the patients was 47.3 ± 10.3 years (range 25-68 years). Twenty-six patients (81%) were female and six (19%) were male. Eighteen patients (56%) were affected bilaterally, 24 (75%) were using analgesics and 23 (72%) had not undergone any previous treatment. Twenty-eight patients (87%) were considered to be overweight and only 11 (34%) performed any regular physical activity.

Treatment

After the patients had been selected, they were divided into two groups of 16 participants each in accordance with randomly drawn numbers:

- *Group 1 – Conventional physiotherapy*: These patients were treated with ultrasound at a frequency of 1.0 Hz and intensity of 1.2 watts/cm². Ten sessions were undertaken at a frequency of two sessions per week. All patients performed exercises after ultrasound application to stretch all posterior leg muscles and strengthen the tibialis anterior. All patients were followed up and guided by the same physiotherapist in all sessions. All patients were advised to perform active stretching of the gastrocnemius and plantar fascia at home.
- *Group 2 – Radial shockwave therapy*: These patients were treated with applications of radial shockwaves, which were always administered by the same physician. Swiss Dolor Clast equipment was used with a low-intensity applicator. Two thousand beats were applied at a frequency of 6 Hz and a pressure of 3 MPa. The patients were positioned in ventral decubitus, with the dorsum of the foot supported on the edge of the bed. The applicator was placed perpendicular to the insertion of the plantar fascia into the calcaneus, and a gel was used to maintain contact with the skin. The sessions were performed once per week for a total of three sessions. All patients were advised to perform active stretching of the gastrocnemius and plantar fascia at home.

Evaluation

Evaluations were made before the treatment, immediately afterwards, and three months after treatment. These evaluations were always performed by the same examiner. The evaluations consisted of:

- Pain assessment
- Periodicity of pain, i.e. the number of times per week that patients experienced pain
- Duration of pain, i.e. the number of hours per day with pain
- Visual analog scale (VAS) assessment of morning pain, gait pain and orthostatic pain

- Use of Fischer's algometer to quantify painful pressure on the insertion of the plantar fascia into the calcaneus and on the middle third of the medial gastrocnemius
- Use of analgesics during treatment.

RESULTS

There were no differences between groups 1 and 2 with regard to gender, age, physical activity, ethnicity, side affected or body mass index (BMI). Both groups showed improvement of pain symptoms including reduced number of episodes of pain per week (Table 1) and hours of pain per day (Table 2). There were decreases in the intensity of morning pain (Table 3), general pain (Table 4) and pain in the orthostatic position (Table 5), as evaluated using the VAS. There was a decrease in the intensity of pain in the calcaneus (Table 6) and calf (Table 6) when measured using Fischer's algometer. Most patients had decreased their intake of analgesics by the final evaluation at three months after treatment (Table 7). There was no statistically significant difference between the groups in any of the parameters used for evaluation.

DISCUSSION

The plantar fascia is one of the most important static structures that support the medial longitudinal arch. Plantar fasciitis occurs as a result of repetitive microtrauma at the origin of the medial tuberosity of the calcaneus; traction forces during support lead to an inflammatory process that results in fibrosis and degeneration.¹¹ Heel spurs and nerve trapping (medial calcaneal, lateral plantar or fifth-finger abductor) can be associated with the inflammatory process.¹⁰ Women are affected more often than men. Plantar fasciitis is associated with obesity and the climacterium.¹⁴ In the present study, patients were more frequently female (81%), mostly overweight (87%), and their mean age was 47.3 ± 10.3 years.

The occurrence of plantar fasciitis is related to professional and leisure activities that require support of body weight and is not related to loss of strength, muscle trophism or joint range of motion (ROM).¹⁶ Most patients in the present study (63%) performed their work while standing (nurses, cleaners and security guards), thus indicating the importance of mechanical factors in the etiopathogenesis of this disease. None of the patients in this study presented loss of strength or decreased ROM. On the other hand, morning pain was reported by 85% of the patients, gait pain by 72% and orthostatic pain by 78%; these findings are similar to those in other reports. Morning pain is an important evaluation criterion. In the present study, all patients

quantified their morning pain as greater than or equal to five on the VAS before treatment.^{6,7,17} After treatment, 14 of the 16 patients in each group had VAS scores of less than five, thus suggesting that both treatments were effective for pain reduction.

Plantar fasciitis leads to lateral body weight support on the foot or forefoot (supported on the toes) during gait because of pain in the medial region of the calcaneus or at the proximal insertion of the plantar fascia; this leads to chronic shortening of the Achilles tendon and pain in the medial portion of the gastrocnemius.^{11,14,15} Fischer's algometer permits simple and reproducible quantification of pain in the medial tuberosity of the calcaneus and the medial portion of the gastrocnemius. In total, 22% of the patients reported intense pain in the calcaneus (up to 4 kg on Fischer's algometer), while 45% of the patients did not report any significant pain in the gastrocnemius at the first evaluation. This latter finding is in contrast to previous reports that pain was present in the calcaneus and gastrocnemius of most patients. The combination of fasciitis with overweight may enhance the effects of the latter in altering postural balance.¹⁸

In many cases, plantar fasciitis is bilateral.¹² In the present sample, 56% of cases were bilateral. Chronic plantar fasciitis (symptoms lasting for more than three months) responds better to shockwave treatment than does the acute form (less than three months of symptoms).^{8,9} The present sample population only included chronic cases of plantar fasciitis.

Thickening of the plantar fascia to more than 4 mm has been correlated with greater intensity of pain and functional limitation,¹⁹⁻²¹ but this relationship was not observed in the present study. The thickness of the plantar fascia in the present study ranged from 4 mm to 9 mm, but without any correlation with the intensity of the pain. Furthermore, no decrease in the ROM of the first metatarsal-phalangeal joint was observed, in contrast to the findings reported in the literature.^{16,22} Furthermore, there were no observed decreases in ankle- flexion or extension.

Surgical treatment of plantar fasciitis is rare. It does not always produce good results and recurrence occurs in 30% of cases.²³⁻²⁶ The first-choice treatment is conservative non-surgical treatment.^{27,28} Application of therapeutic ultrasound accompanied by stretching exercises is one of the most indicated physiotherapeutic treatments for plantar fasciitis.^{10,15} In the present study, the continuous form was used with constant wave intensity. The applied doses ranged from 1.2 to 3.0 W/cm².¹⁰ Radial shockwave therapy has shown good results without side effects, but it is a relatively new technology with high cost and needs to be comparatively evaluated with other types of conservative treatment.⁵⁻⁷ In the

Table 1 – Weekly periodicity of pain symptoms in group 1 (conventional physiotherapy) and group 2 (shockwave physiotherapy) before treatment, immediately afterwards, and three months later

Weekly frequency of pain	Group 1 (n = 16)			Group 2 (n = 16)		
	Evaluation 1	Evaluation 2	Evaluation 3	Evaluation 1	Evaluation 2	Evaluation 3
Without pain	0 (0%)	5 (31%)	7 (44%)	0 (0%)	6 (37%)	6 (37%)
Pain once a week	0 (0%)	2 (13%)	3 (19%)	0 (0%)	0 (0%)	1 (6%)
Pain twice or more per week	16 (100%)	9 (56%)	6 (37%)	16 (100%)	10 (63%)	9 (56%)
p*	0.001			0.008		

* Friedman test – intragroup evaluation. ANOVA – intergroup evaluation – $p > 0.05$ (N.S.). Group 1 = ten physiotherapy sessions (ultrasound and kinesiotherapy); Group 2 = three sessions of shockwave therapy. Evaluation 1 – before treatment; Evaluation 2 = immediately after treatment; Evaluation 3 = three months after treatment

Table 2 – Number of hours of pain per day in Groups 1 and 2 before and after treatment

Number of hours of pain per day	Group 1 (n = 16)			Group 2 (n = 16)		
	Evaluation 1	Evaluation 2	Evaluation 3	Evaluation 1	Evaluation 2	Evaluation 3
0 hours	0 (0%)	6 (37%)	8 (50%)	0 (0%)	6 (37%)	7 (44%)
Less than 4 hours	7 (44%)	8 (50%)	7 (44%)	8 (50%)	9 (56%)	8 (50%)
At least four hours	9 (56%)	2 (13%)	1 (6%)	8 (50%)	1 (6%)	1 (6%)
p*	0.000			0.001		

* Friedman test – intragroup evaluation. ANOVA – intergroup evaluation – $p > 0.05$ (N.S.). Group 1 = ten physiotherapy sessions (ultrasound and kinesiotherapy); Group 2 = three sessions of shockwave therapy. Evaluation 1 – before treatment; Evaluation 2 = immediately after treatment; Evaluation 3 = three months after treatment

Table 3 – Patient distribution according to intensity of morning pain on visual analog scale (VAS) in Groups 1 and 2 before and after treatment

VAS	Group 1 (n = 16)			Group 2 (n = 16)		
	Evaluation 1	Evaluation 2	Evaluation 3	Evaluation 1	Evaluation 2	Evaluation 3
Good (0-1)	0 (0%)	7 (44%)	9 (56%)	1 (6%)	7 (44%)	10 (62%)
Regular (2-5)	1 (6%)	5 (31%)	5 (31%)	3 (19%)	4 (25%)	4 (25%)
Poor (6-10)	15 (94%)	4 (25%)	2 (13%)	12 (75%)	5 (31%)	2 (13%)
p*	0.000			0.000		

* Friedman test – intragroup evaluation. ANOVA – intergroup evaluation – $p > 0.05$ (N.S.). Group 1 = ten physiotherapy sessions (ultrasound and kinesiotherapy); Group 2 = three sessions of shockwave therapy. Evaluation 1 – before treatment; Evaluation 2 = immediately after treatment; Evaluation 3 = three months after treatment

Table 4 – Patient distribution according to intensity of gait pain on visual analog scale (VAS) in Groups 1 and 2 before and after treatment

VAS	Group 1 (n = 16)			Group 2 (n = 16)		
	Evaluation 1	Evaluation 2	Evaluation 3	Evaluation 1	Evaluation 2	Evaluation 3
Good (0-1)	2 (13%)	10 (62%)	11 (69%)	2 (13%)	8 (50%)	10 (62%)
Regular (2-5)	3 (19%)	3 (19%)	3 (19%)	2 (13%)	3 (19%)	3 (19%)
Poor (6-10)	11 (69%)	3 (19%)	2 (13%)	12 (75%)	5 (31%)	3 (19%)
p*	0.002			0.001		

* Friedman test – intragroup evaluation. ANOVA – intergroup evaluation – $p > 0.05$ (N.S.). Group 1 = ten physiotherapy sessions (ultrasound and kinesiotherapy); Group 2 = three sessions of shockwave therapy. Evaluation 1 – before treatment; Evaluation 2 = immediately after treatment; Evaluation 3 = three months after treatment

Table 5 – Patient distribution according to intensity of orthostatic pain on visual analog scale (VAS) in Groups 1 and 2 before and after treatment

VAS	Group 1 (n = 16)			Group 2 (n = 16)		
	Evaluation 1	Evaluation 2	Evaluation 3	Evaluation 1	Evaluation 2	Evaluation 3
Good (0-1)	2 (13%)	6 (37%)	8 (50%)	1 (6%)	7 (44%)	8 (50%)
Regular (2-5)	2 (13%)	6 (37%)	5 (31%)	2 (13%)	3 (19%)	5 (31%)
Poor (6-10)	12 (75%)	4 (25%)	3 (19%)	13 (81%)	6 (37%)	3 (19%)
p*	0.003			0.000		

* Friedman test – intragroup evaluation. ANOVA – intergroup evaluation – $p > 0.05$ (N.S.). Group 1 = ten physiotherapy sessions (ultrasound and kinesiotherapy); Group 2 = three sessions of shockwave therapy. Evaluation 1 – before treatment; Evaluation 2 = immediately after treatment; Evaluation 3 = three months after treatment

Table 6 – Patient distribution according to intensity of pain in calcaneus obtained by Fischer's algometer in Group 1 (conventional physiotherapy) and Group 2 (shockwave physiotherapy) before the treatment, immediately afterwards, and three months later

Fischer's algometer (calcaneus)	Group 1 (24 feet treated)			Group 2 (26 feet treated)		
	Evaluation 1	Evaluation 2	Evaluation 3	Evaluation 1	Evaluation 2	Evaluation 3
Up to 4 kg (very poor)	5 (21%)	0 (0%)	0 (0%)	6 (23%)	1 (4%)	0 (0%)
> 4-6 kg (poor)	8 (33%)	1 (4%)	0 (0%)	11 (42%)	0 (0%)	0 (0%)
> 6-8 kg (regular)	9 (38%)	5 (21%)	2 (8%)	6 (23%)	4 (15%)	0 (0%)
> 8-10 kg (good)	2 (8%)	8 (33%)	1 (4%)	3 (12%)	6 (23%)	5 (19%)
Without pain	0 (0%)	10 (42%)	21 (88%)	0 (0%)	15 (58%)	21(81%)
p*	0.000			0.000		

* Friedman test – intragroup evaluation. ANOVA – intergroup evaluation – $p > 0.05$ (N.S.). Group 1 = ten physiotherapy sessions (ultrasound and kinesiotherapy); Group 2 = three sessions of shockwave therapy. Evaluation 1 – before treatment; Evaluation 2 = immediately after treatment; Evaluation 3 = three months after treatment

Table 7 – Patient distribution according to intensity of pain in gastrocnemius obtained by Fischer's algometer in Groups 1 and 2 before and after treatment

Fischer's algometer (gastrocnemius)	Group 1 (24 feet treated)			Group 2 (26 feet treated)		
	Evaluation 1	Evaluation 2	Evaluation 3	Evaluation 1	Evaluation 2	Evaluation 3
Up to 4 kg (very poor)	9 (38%)	2 (8%)	2 (8%)	13 (50%)	4 (15%)	4 (15%)
> 4-6 kg (poor)	2 (8%)	4 (17%)	3 (13%)	4 (15%)	3 (12%)	6 (23%)
> 6-8 kg (regular)	0 (0%)	1 (4%)	2 (8%)	0 (0%)	1 (4%)	3 (12%)
> 8-10 kg (good)	0 (0%)	2 (8%)	2 (8%)	0 (0%)	1 (4%)	0 (0%)
Without pain	13 (54%)	15 (63%)	15 (63%)	9 (35%)	17 (65%)	13 (50%)
p*	0.000			0.000		

* Friedman test – intragroup evaluation. ANOVA – intergroup evaluation – $p > 0.05$ (N.S.). Group 1 = ten physiotherapy sessions (ultrasound and kinesiotherapy); Group 2 = three sessions of shockwave therapy. Evaluation 1 – before treatment; Evaluation 2 = immediately after treatment; Evaluation 3 = three months after treatment

Table 8 – Frequency and percentage of patients who had stopped using analgesics three months after treatment

	Stopped using analgesics three months after treatment		Total number who used analgesics before treatment	p
	Yes	No		
Group 1	10 (76.9%)	3 (23.1%)	13 (100%)	0.411
Group 2	7 (53.8%)	6 (46.2%)	13 (100%)	

Fisher's exact test - $p > 0.5$ (N.S.)

present study, there were no complications from the use of radial shockwaves.

The aim of the present study was to comparatively evaluate shockwaves with conventional physiotherapeutic treatment for plantar fasciitis. All patients were advised to perform active stretching of the gastrocnemius twice per day to improve ankle flexibility, but only group 1 (conventional physiotherapy) underwent a kinesiotherapy regimen under guidance from a physiotherapist at all treatment sessions. Reinforcement of instructions by a physiotherapist at the ten treatment sessions might have influenced the good results observed for this group. More specifically, the constancy of such guidance might have greatly contributed to adherence to the exercise program and to the change of habits. Although the quality of this treatment depends on the physiotherapist, it gives good results when applied carefully and judiciously. In group 2 (shockwave therapy), the patients were individually advised to perform active stretching of the gastrocnemius, but they did not receive any specific kinesiotherapy regimen during the treatment sessions and did not have any subsequent follow-up. All guidance was given during the three treatment sessions and at the assessments. Shockwave therapy might be more efficient for treatment of plantar fasciitis pain than conventional physiotherapy, but comprehensive rehabilitation programs that are implemented carefully and with good guidance increase patient adherence and promote both pain reduction and functional improvement.

Three months after treatment, the patients in both groups presented reduced morning pain, gait pain and orthostatic pain; decreased duration (hours/day) and periodicity (number of crises per week) of pain; and diminished use of analgesics.

There was no difference in the efficacy of the two treatments, but the more immediate effect of shockwave therapy provided faster relief from pain and incapacitation. For shockwave treatment to be effective and long-lasting, it must be complemented with the use of insoles for impact absorption, as well as changes in footwear, weight loss, restrictions on running or walking long distances and stretching of the gastrocnemius and plantar fascia.^{20,28} Active stretching of the gastrocnemius muscle and the plantar fascia may improve painful symptoms in cases of plantar fasciitis.^{10,15,20,27,28} In the present study, all treated patients were advised to perform such stretching. Better functioning of the foot and ankle, particularly with regard to gait, is of prime importance for maintaining the improvements gained by therapy.

Correct clinical and functional diagnosis of plantar fasciitis together with a simple but well implemented rehabilitation program is a good approach to treating this disorder. It is therefore not always necessary to utilize sophisticated resources or technology to achieve optimal results.^{10,15,27} The results of the present study show that a comprehensive rehabilitation program might be effective for treating plantar fasciitis, despite its simplicity. These results are not in agreement^{4,20,29} with the findings of Ogden,³⁰⁻³² who reported that shockwaves were greatly superior for treating plantar fasciitis as compared to other treatments, and that symptoms disappeared in 90% of the cases treated.

CONCLUSION

The two evaluated treatments were effective for reducing pain and incapacitation among patients with plantar fasciitis for at least three months after treatment.

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