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ORIGINAL PAPER

SHORT-TERM COMPARISON OF THE EFFECTIVENESS OF EXTRACORPOREAL SHOCKWAVE THERAPY AND ULTRASOUND THERAPY IN THE TREATMENT OF PAINFUL HEEL SPURS: A PRELIMINARY STUDY

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Summary

Background. A heel spur is a disease associated with the formation of a bone growth near the heel bone, causing severe pain and inflammation of the plantar fasciitis.

Material and methods. The study included 39 patients diagnosed with painful heel spurs who were randomly assigned to two research groups. The first group (18 patients) underwent a series of ultrasound therapy (UT), and the second group (21 patients) was treated with extracorporeal shockwave therapy (ESWT). The therapeutic effects were assessed with the use of a survey including basic demographic data, Visual Analogue Scale (VAS) scale, Laitinen scale, and a SF-36 questionnaire.

Results. The ESWT caused a statistically significantly greater reduction in pain compared to the patients group treated with the UT as assessed in the VAS scale (67.23% vs. 27.34%; $p<0.001$) and the Laitinen scale (60.65% vs. 30.77%; $p<0.001$). The results of the SF-36 questionnaire improved significantly in both groups (13.71% vs. 9.01% for the physical dimension and 16.33 vs. 9.68 for the mental dimension) with no statistical significance between two examined groups ($p>0.05$).

Conclusions. The ESWT has shown higher therapeutic effectiveness in the treatment of heel spurs compared to the UT regarding a reduction in the intensity of pain. Quality of life improved in both groups, although there was no significant difference in the therapeutic effectiveness of both assessed physical procedures.

Keywords: heel spurs, extracorporeal shockwave therapy, ultrasound therapy, quality of life, pain

Introduction

A heel (calcaneal) spur, which takes the form of a beaked bone growth, is an overload and degenerative change occurring in the heel bone, which causes severe stabbing pain in the heel and the plantar part of the foot, especially felt when moving and putting load on the foot. Heel spurs may occur unilaterally (70-80% of cases) or bilaterally (approx. 30% of cases) [1]. There are two different forms of heel spurs – upper heel spurs located on the upper surface of the heel bone (heading towards the Achilles tendon) and lower heel spurs located on the plantar side of the heel near the medial tubercle [1,2].

The main cause of heel spur formation is usually chronic, excessive load on the heel bone and adjacent tissues, which may be the result of prolonged standing, walking, or running, especially on hard surfaces. A factor contributing to the development of spurs may also be inappropriate footwear that does not provide adequate support for the arch of the foot, wearing high-heeled shoes, or choosing footwear incorrectly. Other causes include degenerative changes, being overweight, and systemic and metabolic diseases (e.g. gout), which may negatively affect the joints and tendons in the foot. The development of heel spurs may also occur as a result of congenital defects or foot injuries that affect the biomechanics of gait. Additional risk factors include being between 40 and 60 years of age and genetic factors [1,3].

Diagnosis of heel spurs involves anamnesis, conducting a physical examination, and performing imaging examinations such as: X-ray, ultrasound, or magnetic resonance imaging (MRI) of the foot. These help to determine the condition of the plantar fasciitis, whether it is thickened or damaged and whether there is a bony growth [1,4].

In the initial period, heel spurs are treated conservatively. Therapy includes compresses and cold compresses, as well as pharmacological agents: painkillers and anti-

inflammatory drugs. Moreover, physical treatments such as ultrasound, iontophoresis, phonophoresis, shock wave therapy, laser therapy, and pulsed magnetic field) can be utilized. Shoe inserts or heel counters are also used to help distribute the pressure on the foot and reduce the load on the plantar fascia. Other treatment methods include Kinesiology Taping, elements of manual therapy with an individually selected set of exercises, and, especially, joint mobilization and manipulation, which help increase the mobility of the foot joints and reduce the tension on the plantar fascia. In the treatment of heel spurs, massage is also used to loosen the plantar fascia and tense muscles of the calf and foot, which can provide pain relief, help break down adhesions, and improve tissue elasticity. In addition, botulinum toxin injections can be used in particularly painful areas. If conservative treatment does not bring about the expected results within 6 months, surgical treatment should be recommended. Surgical techniques used to treat heel spurs include percutaneous or open arthroscopic methods, which allow for partial plantar fascia resection, nerve decompression, and removal of the heel spurs [2,5,6].

The physical treatments most frequently used to treat heel spurs include ultrasound therapy (UT) and extracorporeal shockwave therapy (ESWT). Ultrasounds use a mechanical ultrasonic wave with a frequency of 1 or 3 MHz which locally overheats tissues and improves metabolic and regenerative processes in tissues and cells, increasing the degree of permeability of cell membranes and, above all, causing an analgesic effect. The ESWT utilizes high-energy sound waves, generating a sharp increase in pressure in a very short time, which promotes therapeutic effects such as dissolving calcium deposits, improving tissue vascularization, and reducing muscle tension. A special advantage of the ESWT is the rapidly appearing analgesic effect, which can occur after just a few treatments and lasts for a longer period of time [7,8].

Physiotherapy has changed significantly over the last few years, and it offers variety of

innovative methods to treat pain and promote healing. Among the various treatment options available today, the ESWT and UT are gaining significant attention for their effectiveness in the treatment of musculoskeletal diseases. However, choosing the appropriate treatment can often be a difficult task [9].

Aim of the study

The aim of this study was to compare the therapeutic effectiveness of the ESWT and UT in the treatment of heel spurs.

Material and methods

This prospective clinical study involved 39 patients, 24 women (61.5%) and 15 men (38.5%), 55.9±14.3 years of age, with diagnosed painful heel spurs located on the right or left lower limb. The duration of symptoms in the respondents was on average 2 years. The study was conducted at the MEDIHAD Specialist Physicians and Rehabilitation Clinic in Wieluń (Poland) between January and June 2024.

Inclusion criteria for the study were: patients of both genders, between 18 and 60 years of age, unilateral heel spurs diagnosed by an orthopedist and confirmed by physical examination and X-ray, presence of heel pain for at least 8 weeks, no contraindications to the UT and ESWT, no other treatments performed during examination, as well as informed and voluntary consent to participate in the study.

Exclusion criteria from the study: <18 and >60 years of age, pregnancy, thrombophlebitis, atherosclerosis, renal failure, local infection of the lower limb, neoplastic disease, history of Achilles tendon surgery, ankle instability, anticoagulant therapy,

physiotherapy within 6 weeks preceding the study, rheumatoid arthritis, bilateral Achilles tendon tendinopathy, pathological skin conditions, coagulation disorders, atherosclerosis and thrombophlebitis, contraindications to the ESWT and UT, use of other pharmacological treatments, lack of voluntary and informed consent to participate in the study.

The patients were randomly assigned to two research groups (Figure 1). In the first group (18 patients), a series of 10 ultrasound procedures were performed every day using the Solatronic SLE device (EIE, Otwock, Poland) with a 5 cm^2 head that emitted ultrasound at a frequency of 1 MHz at an intensity of 0.8 W/cm^2. The pulse frequency was 100 Hz, and the duty cycle was 25-75%. The procedures were performed with the use of a dynamic technique, and the time of each procedure was 8 minutes. Ultrasonic gel was used as a coupling substance. During the procedure, patients took a prone position with a roller placed under their lower legs. The working head (probe) was moved in circular manner on the lateral, medial, and plantar sides of the heel, along with the plantar aponeurosis.

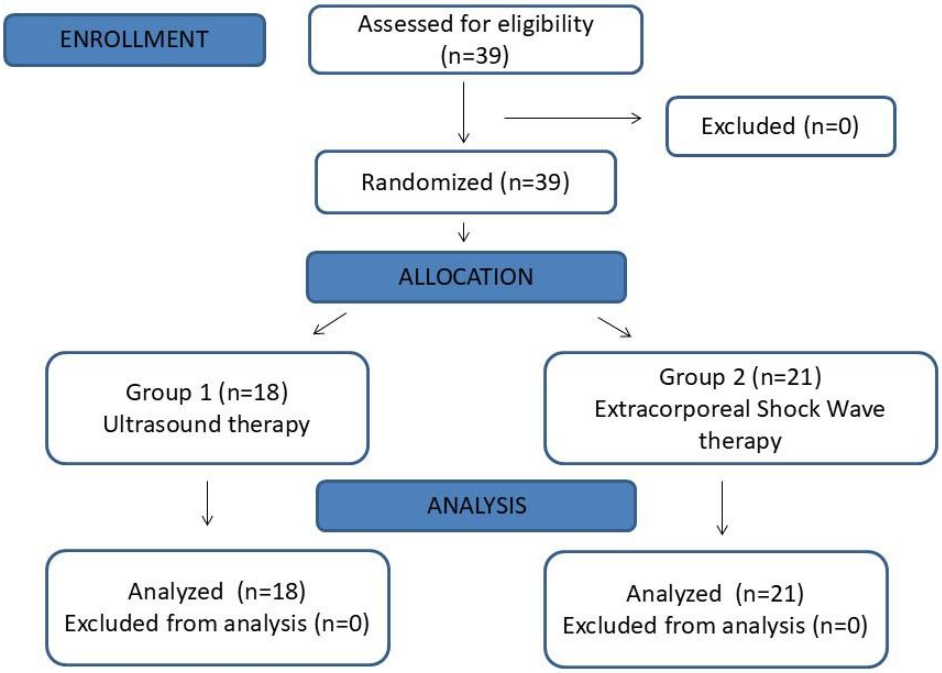

Figure 1. Study design

The second group (21 patients) underwent a series of 5 focused ESWT procedures using the Impactis M+ device (Astar, Bielsko-Biała, Poland), performed every 3 days. The following physical parameters were used: pressure 3.5 bar, pulse frequency 10 Hz, number of generated pulses: 3,000. Treatments were performed every 3 days (5 treatments in the entire series). During the procedure, patients assumed a prone position with a roller placed under their lower legs. The therapist found the most sensitive area on the foot by palpation. Procedures were performed by the same physiotherapist under a constant room temperature of 24°C.

The research tool was a self-developed questionnaire containing basic demographic data of the examined patients (gender, age, education, place of residence, marital status, and the nature of work performed). To assess the pain intensity, the Visual Analogue Scale (VAS) and Laitinen scale were used. The VAS scale evaluates patients' pain perception on a scale of 10 vertical or horizontal lines, from 0 (no pain) to 10 points (the most severe pain). The Laitinen scale evaluates 4 areas, each assessed on a scale from 0 to 4. The intensity of pain, frequency of pain, frequency of taking painkillers, and limitation of motor activity were rated. The maximum number of points is 16, which means that the patient experiences the maximum degree of problems in all assessed areas [10]. The Polish shortened version of the SF-36 questionnaire was used to assess quality of life [11]. The questionnaire consists of 36 questions that cover 8 main areas of health: physical functioning, physical health limitations, pain perception, general sense of health, vitality, social functioning, emotional functioning, and mental health. The results for individual areas were presented on scales from 0 to 100 points, with higher values indicating a worse quality of life or worse health condition. All the patients were assessed before and after the end of the treatment series.

Statistical analysis of the collected data was performed with the use of Statistica 13.3 (Statsoft, Kraków, Poland). The distribution of data was analyzed by means of the Shapiro-

Wilk test. The Student's t-test was used to compare two unmatched groups of parametric data. The level of statistical significance was set at $p<0.05$.

To assess the effectiveness of individual methods (UT and ESWT) in the treatment of heel spurs, a standardized effectiveness index was used. For this purpose, the effectiveness index was calculated according to a self-developed formula for the VAS scale, Laitinen scale, and index assessed using the SF-36 questionnaire:

Efficacy [%] = value before a series of treatments: value after a series of treatments × 100%

The effectiveness index calculated in this way made it possible to determine by what percentage the intensity of pain felt was reduced (assessed on the VAS and Laitinen scale) and by what percentage the patients' quality of life improved, assessed with the SF-36 questionnaire, compared to the baseline values before and after the end of physical treatment procedures.

Results

The study included 24 women (61.5%) and 15 men (38.5%), and the gender distribution in individual groups was similar. The majority of the examined patients were 55 to 60 years of age (33.3% in each group), followed by 45-54 years of age (38.1% in the ESWT group and 27.8% in the UT group). Details are presented in Table 1.

Table 1. Demographic data of patients in both study groups

Variable	Category	Total		Treatment methods			
				ESWT (n=21; 53.8%)		UT (n=18; 46.2%)	
		n	%	n	%	n	%
Gender	Women	24	61.5	13	61.9	11	61.1
	Men	15	38.5	8	38.1	7	38.9
Age (years)	18-24	2	5.1	1	4.8	1	5.6
	25-34	2	5.1	1	4.8	1	5.6
	35-44	9	23.1	4	19.0	5	27.8
	45-54	13	33.3	8	38.1	5	27.8
	55-60	13	33.3	7	33.3	6	33.3
Education	Basic	1	2.6	0	0.0	1	5.6
	Medium	3	7.7	2	9.5	1	5.6
	Vocational	21	53.8	12	57.1	9	50.0
	Higher	14	35.9	7	33.3	7	38.9
Domicile	City	19	48.7	12	57.1	7	38.9
	Rural	20	51.3	9	42.9	11	61.1
Marital status	Single	6	15.4	4	19.0	2	11.1
	Married	24	61.5	12	57.1	12	66.7
	Widow/Widower	9	23.1	5	23.8	4	22.2
Nature of work	Physical	19	48.7	11	52.4	8	44.4
	Intellectual	13	33.3	6	28.6	7	38.9
	Professionally inactive	7	17.9	4	19.0	3	16.7

The majority of respondents (53.8%) had vocational education (57.1% in the ESWT group and 50.0% in the UT group), followed by higher education (35.9%) (33.3% in the ESWT group and 38.9% in the UT group). More than half of the examined patients (51.3%) lived in the countryside, with urban residents predominant in the group treated with the ESWT (57.1%), and rural residents in the group treated with the UT (61.1%). The majority of examined patients (61.5%) were married (57.1% in the ESWT group and 66.7% in the UT group). The majority of patients (48.7%) performed manual labor (52.4% in the ESWT group and 44.4% in the UT group).

The ESWT had statistically significantly (p<0.05) higher therapeutic effectiveness in reducing the intensity of pain compared to the UT – reducing the intensity of pain by an

average of 68.23±21.68% vs. 27.34±25.85%, respectively (Table 2).

Table 2. Comparison of the therapeutic efficacy [%] of the ESWT and UT in the treatment of heel spurs in terms of the intensity of pain using the VAS scale

Methods	Mean	SD	*p*
ESWT	67.23	21.68	<0.001
UT	27.34	25.85	

Notes: *p* – Student's t-test.

The ESWT was statistically significantly more effective in reducing the intensity of heel spur pain assessed on the Laitinen scale than the UT ($p<0.05$) – reducing pain on average by 60.65±26.09% vs. 30.77±26.62% (Table 3).

Table 3. Comparison of the therapeutic efficacy [%] of the ESWT and UT in the treatment of heel spurs in terms of the intensity of pain using the Laitinen scale

Methods	Mean	SD	*p*
ESWT	60.65	26.09	0.001
UT	30.77	26.62	

Notes: *p* – Student's t-test.

After the treatment in both groups of patients, there was a reduction in the values of indicators both in the physical and mental dimensions of the SF-36 questionnaire, which confirmed an improvement in patients treated with both methods compared to only physical methods, with no statistically significant differences between two groups of patients ($p>0.05$) (Table 4).

Table 4. Comparison of the therapeutic efficacy [%] of ESWT and UT in the treatment of heel spurs in terms of quality-of-life assessment using the SF-36 questionnaire in both groups of patients

Methods	Physical dimension		Mental dimension		*p*
	Mean	SD	Mean	SD	
ESWT	13.71	3.67	16.33	4.62	0.166
UT	9.01	6.17	9.68	7.16	

Notes: *p* – Student's t-test.

Discussion

Physical treatments used in medicine have many advantages that can contribute to improving the health of patients. These include: anti-inflammatory, anti-swelling, and analgesic effects, stimulating and accelerating regenerative processes, and reducing decreased or increased muscle tension. The above-mentioned therapeutic effects are also reflected in the treatment of plantar fasciitis accompanying heel spurs [6,12,13].

The aim of this paper was to compare the ESWT and UT in the treatment of painful heel spurs. The research results showed a higher therapeutic effectiveness the ESWT compared to the UT in terms of pain as assessed using the VAS and Laitinen scale. The Laitinen scale recorded not only a decrease in the intensity of the pain but also a decrease in the frequency, a decrease in the frequency of taking analgesics, and an improvement in the function of the treated limb.

The ESWT has both mechanical and cellular effects. Although the biological mechanisms of ESWT-related analgesia are still controversial, it has been suggested that the beneficial effects may be related to accelerated micro-destruction and neovascularization.

Transient damage or increased permeability of neuronal cell membranes is the most important effect, and these mechanisms may explain the analgesic results of the ESWT. The biological properties of the ESWT also include its effects on specific growth factors. Neovascularization and cellular regeneration are also accelerated in tissues, which promotes healing processes [9]. On the other hand, the UT uses a high-frequency sound wave to generate gentle heat in body tissue. This therapeutic heat increases blood flow and can help speed healing, relieve pain, reduce inflammation, and increase tissue elasticity [8,9].

Results similar to ours were presented by Mańko et al. [8] in a study in which 40 patients with heel spur were assigned to two research groups treated with the ESWT and UT. The results of that study also showed the higher analgesic effectiveness of the ESWT compared to the UT, assessed using the VAS and Laitinen scale [8].

In another study, Krukowska et al. [14] analyzed the comparative effectiveness of the analgesic ESWT and UT therapy in the treatment of patients with plantar fasciitis occurring in 47 patients with heel spurs. Pain intensity was assessed three times (before the procedure, after the first week of therapy and after the second week of therapy) using the VAS and the Laitinen scale. In both groups, a reduction of pain intensity was observed, especially in the first week of the treatment, but in the case of the ESWT, fewer treatments were needed to achieve comparable improvement [14].

The study by Koch et al. [15] included 30 patients with pain in the heel area and difficulties in moving due to severe heel pain. The patients underwent five ESWT sessions. After completing the therapy, as in our case, a statistically significant reduction in the level of pain assessed using the VAS and Laitinen scales was achieved, and the effects were subjectively felt after just five ESWT sessions [15].

Nazim et al. [16] analyzed the PubMed and Embase databases for clinical studies on the use of the ESWT in various foot and ankle disorders. 24 clinical trials were identified, and

an analysis of the clinical evidence showed that the ESWT could provide symptomatic benefits in the treatment of plantar fasciitis with minimal and unnoticeable side effects. The meta-analysis also showed significantly greater pain relief assessed on the VAS scale compared to placebo or conservative treatment [16].

Şah et al. [17] compared the effects of the radial and focused ESWT on plantar calcaneal spurs. In this study, 99 patients with plantar heel spurs were randomly assigned to three treatment groups according to the types of ESWT: radial, focused, and sham. Foot Function Index (FFI) scores were used as a measure of treatment effect compared to the baseline values (week 0). At the end of the first week of treatment and in the fifth and thirteenth week of long-term follow-up, the FFI values in the radial and focused ESWT treatment groups were statistically significantly better compared to the group in which sham therapy was used [17].

Badil Güloğlu et al. [18] compared the effectiveness of the low-level laser therapy (LLLT) and ESWT in the treatment of heel spurs. 62 patients participated in the study. In both groups, a total of 15 exercise sessions and LLLT and ESWT treatments were performed, respectively. The study results confirmed that both physical methods improved the effectiveness of treatment, with greater improvement in pain relief assessed by FFI being achieved using the ESWT [18].

A heel spur is a disease associated with inflammation of the plantar fasciitis and often the formation of a bony exostosis, causing pain and discomfort in the heel area, negatively affecting daily activities and quality of life [1,2]. The statistical analysis performed on the results of the SF-36 questionnaire confirmed that both methods had a comparable impact on improving the quality of life of the studied patients but did not show any statistical differences between the two groups of patients.

A study by Zare Bidoki et al. [19] compared the effectiveness of high-intensity laser

therapy (HILT) with the ESWT in patients with plantar fasciitis. The study involved 38 patients who were assigned into two study groups depending on the treatment method used using online randomization. The VAS, Heel Tenderness Index, and SF-36 questionnaire were used to assess the therapeutic effects. The groups were compared at the start and 9 months after the end of therapy. Patients treated with the ESWT achieved statistically significantly greater improvement assessed using the VAS (p=0.03) and SF-36 (p=0.002) compared to patients treated with HILT [19].

The ESWT is one of the most modern physical therapeutic methods, the use of which is attracting increased interest from both therapists and patients who want to effectively and quickly get rid of the pain and discomfort associated with heel spurs. Although the favorable therapeutic results of this method have been shown in many studies, including those presented in this article, questions remain regarding the long-term effectiveness of this method and its possible side effects.

Limitations of the study

A limitation of our study is that our study population contained a small number of patients. Larger patient groups should be studied to generalize the results. The sample size was not calculated, as well as there was a lack of long-term follow-up and absence of a control group. Nonetheless, we believe that these drawbacks do not outweigh the contributory value of this study.

Conclusions

The ESWT has shown higher therapeutic effectiveness than the UT in the treatment of

heel spurs regarding a reduction in the intensity of pain; however, additional evidence is needed due to the various limitations of the study. Both methods improved the quality of life of treated patients, but neither of them showed higher effectiveness in this respect.

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The research was approved by the Local Ethics Committee at the Jan Długosz University in Częstochowa (No. KE-O/12/2024).

Artificial intelligence (AI) was not used in the creation of the manuscript.

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