© Wydawnictwo UR 2016
ISSN 2450-6761
doi: 10.15584/medrev.2016.4.9

http://www.pmurz.rzeszow.pl/
Medical Review 2016; 14 (4): 465–472

REVIEW PAPER / PRACA POGLĄDOWA

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Extracorporeal shock wave therapy in the treatment of plantar fasciitis

Pozaustrojowa terapia falą uderzeniową w leczeniu zapalenia powięzi podeszwy

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ABSTRACT

Plantar fasciitis is reported as the most common cause of chronic plantar heel pain. An extra-corporeal shock waves have been used in the treatment of plantar fasciitis with promising results.

The purpose of this paper was to present results from randomized controlled trials to estimate of the effectiveness of ESWT in the treatment of plantar fasciitis.

Method: MEDLINE, EBCO, PubMed, ScienceDirect and SpringerLink databases were searched, using the keywords: ESWT, plantar fasciitis, shock wave, randomized clinical trials.

Results: Ten randomized clinical trials was critically appraised. Eight studies report significant decreases in pain symptoms and better function scores associated with an extra-corporeal shock wave therapy. However two studies show no meaningful improvement of clinical outcome in patients treated with extracorporeal shock wave therapy for

STRESZCZENIE

Zapalenie powięzi podeszwy jest najczęstszą przyczyną przewlekłego bólu podeszwowej strony pięty. Wyniki terapii zapalenia powięzi podeszwy zewnętrzną falą uderzeniową są obiecujące.

Celem pracy jest przedstawienie wyników randomizowanych badań klinicznych mających na celu ocenę skuteczności fali uderzeniowej w terapii zapalenia powięzi podeszwy.

Metody: Analizą objęto doniesienia opublikowane w bazach: MEDLINE, EBCO, PubMed, ScienceDirect oraz SpringerLink. Użyte słowa kluczowe: terapia zewnętrzną falą uderzeniową, zapalenie powięzi podeszwy, randomizowane badania kliniczne.

Wyniki: Wyniki dziesięciu randomizowanych badań klinicznych zostały objęte analizą. Analiza wyników ośmiu z nich wskazuje na istotne zmniejszenie dolegliwości bólowych oraz polepszenie funkcji u pacjentów leczonych przy uży-

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Participation of co-authors / Udział współautorów: A – Author of the concept and objectives of paper / autor koncepcji i założeń pracy; B – collection of data / zbieranie materiału; C – implementation of research / realizacja badań; D – elaborate, analysis and interpretation of data / opracowanie, analiza i interpretacja wyników; E – statistical analysis / analiza statystyczna danych; F – preparation of a manuscript / przygotowanie manuskryptu; G – working out the literature / opracowanie piśmiennictwa; H – obtaining funds / pozyskanie funduszy

Received / Artykuł otrzymano: 1.06.2016 | Accepted / Zaakceptowano do publikacji: 5.12.2016
Publication date / Data publikacji: december / grudzień 2016

Wyszyńska J, Podgórska-Bednarz J, Świtała A, Skrzypiec J. *Extracorporeal shock wave therapy in the treatment of plantar fasciitis*. Medical Review 2016; 14 (4): 465–472. doi: 10.15584/medrev.2016.4.9

chronic plantar fasciitis compared with placebo.

Summary: In most cases shockwaves therapy was a safe and effective method for treatment of chronic plantar fasciitis and helped the patient to avoid surgery for recalcitrant heel pain but warrants further larger studies.

Keywords: extracorporeal shock wave, therapy, plantar fasciitis

ciu fali uderzeniowej. Natomiast wyniki pozostałych dwóch badań nie wskazują na znaczącą poprawę stanu pacjentów leczonych falą uderzeniową w porównaniu z grupą kontrolną pacjentów nieotrzymującą leczenia.

Podsumowanie: W większości przypadków terapia zewnętrzną falą uderzeniową jest efektywną metodą leczenia zapalenia powięzi podeszwy, pomaga pacjentom uniknąć leczenia operacyjnego, jednakże celowe byłoby przeprowadzanie badań klinicznych obejmujących liczną grupę pacjentów.

Słowa kluczowe: zewnątrzustrojowa fala uderzeniowa, terapia, zapalenie powięzi podeszwy

Introduction

Chronic plantar heel pain is a generalized term used to describe a range of undifferentiated conditions affecting the plantar heel [1]. Plantar fascia is the principle static and dynamic stabilizer of the longitudinal arches of the foot. It also acts as a shock absorber and helps to protect the underlying soft tissues. Degenerative changes can cause acute or chronic inflammation and may also cause calcification at the origin of the plantar fascia and bony traction spur formation [2].

Plantar fasciitis (PF) (also referred to as plantar heel pain syndrome, heel spur syndrome or painful heel syndrome) is reported as the most common cause of chronic plantar heel pain, is an inflammation of the plantar fascia [3, 4]. The term PF has been used for years, likely in an attempt to identify the actual symptoms occurring along the plantar fascia with or without presence of a spur. More recently, the term plantar fasciosis has been advocated to de-emphasize the presumed inflammatory component and reiterate the degenerative nature of histologic observations at the calcaneal enthesis [5]. It presents as pain on the underside of the heel. Patients often describe a sharp pain, generally worse after rest, especially on waking, worsening with the first steps, but lessening with progressive exercise [6].

The epidemiology of chronic plantar heel pain in the general population is currently undetermined. It is estimated that 7–15 % of older adults report tenderness beneath the heel, and that approximately one million medical consultations per year are for the diagnosis and treatment of PF. PF also account for approximately 8% of all running-related injuries [7].

The etiology is multifactorial; mechanical overload is generally believed to be fundamental to the development of the condition. Obesity not only increases the risk of PF, but also increases the level of disability, which is proportional to the body mass index. Work related weight bearing and biomechanical abnormalities in the foot such as tight Achilles tendon, and/or foot types, improper footwear, and reduced ankle dorsiflexion are common predisposing factors [8]. PF is usually seen as an overuse injury in athletes, runners in particular but is also seen in the general population [9, 10]. It is estimated that one in ten people will develop PF during their lifetime [11].

Treatment for PF can be divided into numerous categories as listed below: (1) Conservative care (patient education, soft tissue therapy/massage, acupuncture, taping, night splints, stretching, ice, heat, orthotics, laser, ultrasound, electric modalities, diathermy, transcutaneous electrical nerve stimulation – TENS, extra-corporeal shock wave therapy, nutritional considerations: vitamin C, zinc, glucosamine, brninelain, fish oil, manual therapy: joint mobilization and manipulation) [12–18]; (2) Injections and medication (local anaesthetics, steroids, Botulinum toxin A and/or saline) [4,19]; (3) Surgical intervention [20].

Traditionally the first line of treatment of PF has been rest, analgesics, night splints and orthoses. Patients not responding to this treatment are usually advised infiltration with corticosteroids (such as triamcinolone, betamethasone or iontophoresis with dexamethasone). Surgery (fascioctomy, neurolysis of the nerve to abductor digiti minimi and excision of the heel spur) has been successfully used in resistant cases [3, 2]. Surgery is recommended as a last resort and usually only after failure of at least six months of conservative therapy [4, 21]. However, there are potential complications inherent with any open procedure, such as infection, nerve injury, medial arch flattening, lateral column pain, and thrombosis. Patient and physician dissatisfaction has led to a search for an alternative to the open procedure [22].

Recently, an alternative modality called extracorporeal shock wave therapy (ESWT) has evolved as a safe treatment option for resistant PF [22, 23]. A shock wave is defined as an acoustic wave at the front of which pressure rises from the ambient value to its maximum within a few nanoseconds [24]. Shockwaves can be focal or radial. Focal shockwaves have high tissue penetration power (10cm) and impact force (0,08–0,28 mJ/mm^2). They produce mechanical and biological effects of greater (than radial shockwaves) intensity, including destruction of fibrosis, stimulation of neovascularization in treated tissues, direct suppressive effects on nociceptors and an hyperstimulation mechanism, that would block the gate-control mechanism. Radial shockwaves are pneumatic waves that

are generated by air compressors, which are transmitted radially with lower penetration (3cm), less impact (0.02-0.0628 mJ/mm^2) and limited biological effect. In contrast to focused shock wave therapies, the radial technique is used to treat the painful region rather than a painful point [25, 26]. Three different types of machines can produce shock waves based on electrohydraulic, electromagnetic, or piezo-electric principles [27]. It is non-invasive method, has a relatively short recovery time and claims a success rate comparable to surgery [3,28]. There is unknown the precise mechanism of action of extracorporeal shock waves. However it has been thought that faster soft tissue healing, reduced calcification, increased blood circulation, inhibition of pain receptors and denervation are responsible for the clinical effects [2]. Several musculoskeletal entities which can be treated by ESWT include: calcific tendinitis of the shoulder, lateral/medial epicondylitis, painful tendinosis, delayed union and nonunion of fractures, Achilles and patellar tendinopathies, as well as osteonecrosis of the femoral head [29, 30]. This form of therapy has been recommended for the last 10 years as an alternative therapy for patients with chronic PF who have failed to respond to multiple conservative pharmacologic and therapeutic interventions [29].

Despite numerous publications, the application of ESWT in PF, associated or not with heel spur, is still controversial and the results in some studies are positive and in others not.

The purpose of this review was to conduct an evaluation of evidence from randomized controlled trials to estimate of the effectiveness of ESWT. The aim was to determine if ESWT is effective in the treatment for patients with plantar heel pain compared with a control group.

Methods

Randomized controlled trials (RTCs) were identified by searching the following data sources: MEDLINE, EBSCO, PubMed, ScienceDirect, SpringerLink (from 2002 to 2016). Keywords used in the search included: randomized controlled trials, shock wave therapy or SWT, combined with plantar fasciitis. Articles found in the search were then screened to ensure that participants in the studies had a clinical diagnosis of plantar fasciitis.

Results

Ten RCTs that evaluated ESWT for plantar fasciitis had satisfactory study design and methodologies and were, therefore, accepted for inclusion in this review. The trials evaluated different doses of ESWT against either a placebo dose or a control dose so low as to be considered therapeutically ineffective. Adult participants with a clinically confirmed diagnosis of plantar heel pain were included (the duration of pain was greater than 6 months).

Of the 10 RTCs that met inclusion criteria, eight were placebo controlled trials [26, 31-37]: patients in placebo groups were treated with low, therapeutically ineffective dose or were treated similarly to treatment groups except that a sound-reflecting pad or foam membrane were placed between their foot in to ensure that no shock waves were transmitted through the skin. In two trials [25,38] patients from control groups received traditional treatment.

The first study was conducted by Rompe and colleagues. The treatment group (I) consisted of 50 subjects (21 women, 29 men) with a mean age of 44 years and pain duration of 8 months. The placebo group (II) consisted of 50 participants (20 women, 30 men) with mean age of 49 years and pain duration of 10 months. Group I received a total of 3000 impulses of an energy flux density of 0.08 mJ/mm^2 applied on heel spur. The group II received a relatively small dose of ESWT - 30 impulses of an energy flux density of 0.08 mJ/mm^2. This procedure was completed once a week for three consecutive weeks. The three main outcome measures used were a 100-point visual analogue scale (VAS) for resting, night and pressure pain, a 5-point walking ability scale (as per the previous study), as well as a modified version of the Roles and Maudsley score - an objective, 4-point scale (excellent, good, acceptable and poor) describing overall symptom relief, patient satisfaction, and walking ability. Patients were also surveyed on any additional treatments they were using for their symptoms and were followed up at 6 months. At six months, the rate of good and excellent outcomes according to the four-step score was significantly (47%) better ($p < 0.0001$) in group I than in group II. Analyzing the results on a VAS in group I the score for pain caused by manual pressure at six months had decreased to 19 points from 77 points before treatment. In group II the ratings before treatment and at six months were 79 and 77 points respectively ($p < 0.0001$ for the difference between groups). In group I, twenty-five individuals were able to walk completely without pain at six months compared with zero of fifty patients in group II ($p < 0.0001$). A series of three treatments with 1000 impulses of low-energy shock waves appear to be an effective therapy for PF. In contrast, three applications of 10 impulses did not improve symptoms substantially [31].

The promising result from the earlier studies by Rompe and colleagues led them to conduct a study examining the effect of low-energy ESWT on PF symptoms specifically suffered by long-distance runners. Forty-five running athletes (23 females, 22 males, mean age of 40 years) with intractable plantar heel pain for more than 12 months were included. Twenty-two were assigned to a treatment group and received three applications of 2100 impulses of low-energy shock waves. The placebo group (n = 23) were treated similarly except that a sound-reflecting pad was placed between their foot and the shock wave head of the

ESWT machine, to ensure that no shock waves were transmitted through the skin. Follow-up examinations were performed at 6 months and at 1 year by a blinded observer. In this study were used: 10-point VAS to assess pain on first walking in the morning and the American Orthopedic Foot and Ankle Society's Ankle-Hindfoot Scale. After 6 months, self-assessment of pain on first walking in the morning was significantly reduced from an average of 6.9 to 2.1 points on a VAS in the treatment group and from an average of 7.0 to 4.7 points in the placebo group. The mean difference between groups was 2.5 points. While both groups scored higher on the Ankle-Hindfoot Scale, treatment group scores were significantly higher than the placebo group ($p = 0.0025$). Similar results were found at 12-month follow-up where the treatment group fared significantly better on both the VAS and Ankle-Hindfoot Scale ($p < 0.0001$ and $p = 0.0211$, respectively). The results of these studies indicated that low-energy shock waves were safe and effective method for treatment of chronic PF in long-distance runners [32].

The aim of the third study was to evaluate the use of ESWT in the treatment of PF. All patients (n = 23) with PF with a mean duration of symptoms of 11 months were randomly divided into treatment group (13 patients) and into placebo group (10 patients). All patients had failed one or more method of treatment - conservative, topical non-steriodal anti-inflammatory drugs, steroid injection and/or surgery. The placebo group received treatment with a claps on the heel, they were not aware of the fact that they were not receiving treatment as the shock waves were intercepted by the claps. The treatment group received 2000 shock waves at 2.5 bars of air pressure with a frequency of 8-10 Hz. A total of three treatments were given at an interval of two weeks. The patients were reviewed at three and six months after the final treatment. A baseline pain score was obtained using the VAS (0-10). In the treatment group, the mean pain score of the 13 patients reduced from 5.9 to 1.9 at six months follow-up. Twelve patients (93%) showed significant improvement and one patient remained unchanged. No significant benefit was reported in the 10 patients in the placebo group. The mean pain score in this group dropped from 7.0 to 6.6. The difference between treatment and placebo group was statistically significant. The conclusion was that ESWT is an effective form of treatment for PF [33].

Kudo et al. used in study a large sample of 114 participants to determine whether ESWT can safely and effectively relieve the pain associated with chronic PF, as demonstrated by pain with walking in the morning. The patients with PF recalcitrant to conservative therapies for at least 6 months, were randomized to two groups. There were no significant differences between groups. Treatment group (n = 58) in a single session received 3,800 total shock waves - approximated total energy delivery of 1,300 mJ/mm^2. The placebo group (n = 56) received the identical treatment procedure but shock waves were prevented from entering the patients' foot by a thin foam cushion placed on the therapy head with an application of ultrasound gel. The results of the study indicate a statistically significant difference between groups in the primary outcome measure of change from baseline to 3 months after treatment in VAS pain scores in the first few minutes of walking. In the treatment group, the mean pain score reduced from 7.5 to 3.9 at three months follow-up months (a mean percentage improvement: 49.1%). In the placebo group, the mean pain score decreased from 7.9 to 5.3 at 3 months, a mean percentage improvement: 33.3% (49.1% vs. 33.3%; $p = 0.0124$). There was a statistically significant difference between treatments in the number of participants whose changes in VAS scores met the study definition of success at 3 months post treatment and between treatment groups in the change from baseline to 3 months post treatment in the Roles and Maudsley Score ($p = 0.0027$). The results of this study confirmed that ESWT is a safe and effective treatment for patients who have failed previous conservative nonsurgical treatments for chronic PF [34].

A randomized controlled clinical trial conducted by Wang et al. evaluated long-term results of shock wave therapy on 149 subjects with an established diagnosis of PF. Patients were randomized into 2 groups: shockwave group (n = 79 patients, 85 heels) and control group (n = 70 patients, 83 heels). There were no differences between the groups in the scores for pain and function. Patients in the shockwave group received 1500 impulses of an energy flux density of 0.32 mJ/mm^2 to the affected heel in a single session. In the control group, patients received conservative treatment consisting of: nonsteroidal anti-inflammatory drugs, orthotics, program of exercise, physiotherapy and/or a local cortisone injection. The shockwave group was evaluated at 5 to 6 years, the conservative treatment group was evaluated at 34 to 64 months. Both groups were evaluated with a 100-point scoring system including 70 points for pain and 30 points for function. The clinical outcomes were assessed as excellent, good, fair, or poor. Findings indicated that the shockwave group showed significantly better pain and function scores as compared with the control group after treatment. The overall results for the shockwave group and placebo group were respectively: excellent 69.1% vs. 0%; good 13.6% vs. 55%; fair 6.2% vs. 36%; poor 11,1% vs. 9% ($p < 0.001$). For the shockwave group the recurrence rate was 11% (9/81 heels) versus 55% (43/78 heels) for the control group ($p < 0.001$). There were no systemic or local complications. This is the next study that demonstrates that ESWT is more effective and has a lower recurrence rate than conservative treatment for patients with PF [38].

Malay et al. conducted a randomized, controlled, double-blinded, multicenter comparison of ESWT vs. placebo for PF. A total of 172 participants (mean age

of 51 years, main duration of foot pain was 30 months) were randomized into two groups: treatment or placebo, in ratio of 2:1. Patients in the treatment group (n = 115) were treated by ESWT at energy levels (0.22 mJ/mm^2 to 0.32 mJ/mm^2). The intervention session lasted 25 minutes, during which 3800 shockwaves were administered. For participants in the placebo group (n = 57) a foam-insulated membrane was used to absorb the shockwaves and inhibit transmission of most of the energy. The VAS was used to measure results at three months follow-up. The objective of blind assessor's was to assess the primary outcomes during the first 3 months of follow-up. Participants were also followed up to 1 year to identify any adverse outcomes that may have been related to the shockwave treatment. According to the blinded assessor (on the VAS), heel pain decreased by an average of 2.51 in the ESWT group and 1.57 in the placebo group (p = 0.045). According to the patients' self-assessment (on the VAS) heel pain displayed a mean reduction of 3.39 and 1.78 in the ESWT and placebo group respectively (p = 0.001). No serious adverse events were observed at any time. The results of this clinical investigation demonstrate the safety and efficacy of the ESWT device for treatment of proximal PF had been unresponsive to exhaustive conservative treatment [35].

A double-blind, randomized, placebo-controlled trial with parallel group design was conducted by Gollwitzer et al. Assess the efficacy and safety of extracorporeal shockwave therapy compared with placebo in the treatment of chronic painful heel syndrome were conducted among 40 participants. All of the participants were required to have a baseline pain level designated as ≥5, as measured on a 0 to 10 VAS and they had to display significant, functional limitations as determined by a Roles and Maudsley Score of 3 (fair) or 4 (poor). Patients were randomly assigned: 20 to the ESWT group (0.25 mJ/mm^2) and 20 to the placebo group (an air-chambered polyethylene foil was located between the coupling head and the participant, which absorbed all the acoustic energy). Participants had history of at least 6 month of chronic plantar heel pain that proved resistant to conservative treatments. Two-thousand shockwaves were applied at each ESWT session. A total of 3 shockwave interventions were performed within weekly intervals. Follow-up evaluations were performed at 6 weeks and 12 weeks after the last intervention session, and outcome measures were determined by measuring heel pain on a 10-cm VAS and by physical examination. The primary outcome was the change in composite heel pain (morning pain, pain with activities of daily living and pain upon application of pressure with a focal force meter "F-meter") as quantified using a VAS at 6 weeks after completion of the interventions compared with baseline measurement. Secondary outcome measures included: changes in morning pain, pain with activities of daily living and pain upon focal pressure application with the F-meter, as measured on a visual analog pain scale, as well as the change in the Roles and Maudsley score at 12 weeks after the baseline measurement. The final percent change from baseline in the heel pain VAS was reduced by 73.2% in the ESWT group, and this was 32.7% greater than the reduction observed in the placebo group. The difference was not statistically significant (p = 0.0302), but reached clinical relevance (Mann-Whitney effect size = 0.6737). In regard to the secondary outcomes, active extracorporeal shockwave therapy displayed relative superiority in comparison with the sham intervention. The results of the present study support the use of electromagnetically generated ESWT for the treatment of chronic, painful plantar heel syndrome [36].

Gerdesmeyer et al. conducted a multi-center, randomized controlled trial of 251 patients comparing radial extracorporeal shock wave therapy and placebo in the treatment of chronic PF. Radial ESWT or identical placebo were administered in 3 sessions, each 2 weeks (± 4 days) apart. In the treatment group (n = 129), 2000 impulses of radial shock waves with an energy flux density of 0.16 mJ/mm^2 and a rate of 8 impulses per second were applied at each treatment session. Patients in the control group (n = 122) received identical placebo intervention with a placebo hand-piece that prevented transmission of shock waves. The primary outcome measure was overall heel pain reduction measured by the percentage change of the VAS composite score 12 weeks after treatment compared with baseline. Secondary outcome measures were changes in visual analog scale scores, success rates, Roles and Maudsley score, SF-36, and patients' and investigators' global judgment of effectiveness 12 weeks and 12 months after extracorporeal shock wave therapy. Radial ESWT proved significantly superior to placebo with a reduction of the visual analog scale composite score of 72.1% compared with 44.7% (p = 0.0220) and an overall success rate of 61.0% compared with 42.2% in the placebo group (p = 0.0020) at 12 weeks. Superiority was even more pronounced at 12 months and all secondary outcome measures supported radial ESWT to be significantly superior to placebo (p < 0.025). Compared with focused shock wave applicators, radial ESWT devices address larger treatment areas, thus providing potential advantages in superficial applications like tendinopathies and skin conditions. The authors concluded that radial ESWT significantly reduces pain (based on VAS and self-report), improves function and quality of life in patients with recalcitrant PF. Radial ESWT can be strongly recommended for patients with therapy-resistant plantar painful heel syndrome. Especially in the cases of failed nonsurgical treatment, radial ESWT represents an excellent alternative to surgery because anesthesia is not required and long recovery times are avoided [26].

The clinical significance of the treatment effects of ESWT were also questioned in some reviews. There are

also reports that provide limited evidence for the effectiveness of extracorporeal shock wave in the treatment of chronic PF.

Haake at al. aimed to determine effectiveness of ESWT in chronic PF. Patients were randomized to receive ESWT (135 patients) or placebo (137 patients). ESWT comprised 4000 impulses of a positive energy flux density (0.08 mJ/mm^2) under local anaesthesia with 2 ml mepi-vacaine 1%. Therapy was applied every two weeks (± 2 days) (3 × 4000 impulses). In the placebo group a polyethylene foil filled with air was fixed with ultrasound gel in front of the coupling cushion to reflect the shock waves. The primary end point was the success rate after 12 weeks, success was defined by a Roles and Maudsley score of 1 or 2 and if the patient received no additional treatment. Secondary end points encompassed the Roles and Maudsley score and pain intensities (pain at rest, pain at night, pain at pressure, morning pain) on visual numeric rating scales (0 for no pain to 10 for unbearable pain), walking ability and the need for additional treatments for one year after the last intervention. The primary end point could be assessed in 94% (n = 256) of patients. The difference in success rates was 3.6% (8.0% to 15.1%, p = 0.5927) and the odds ratio was 1.18 (0.675 to 2.07). Despite two centres recruiting only nine and seven patients, none of the observed differences reached the minimal clinically relevant difference of 20%. The success rate of treatment for chronic PF 12 weeks after intervention was 34% (n = 43) in the extracorporeal shock wave therapy group and 30% (n = 39) in the placebo group (95% confidence interval 8.0% to 15.1%). No difference was found in the secondary end points. Few side effects occurred during and after the treatment. Majority of them were reported by the therapy group than by the placebo group [24 (18%) *v* 12 (9%)]. Side effects were skin reddening (16 (12%) in therapy group; 5 (4%) in placebo group), pain (7 (5%) in therapy group; 2 (2%) in placebo group), and local swelling (3 (2%) in therapy group; 0 (0%) in placebo group). Authors expected a higher risk for side effects in the therapy group than in the placebo group (odds ratio 2.26, 1.02 to 5.18). From analysis of above research results followed that conventional therapy can be as effective as ESWT. This study concluded that ESWT wasn't more efficient method than conventional therapy. Nevertheless, there were a number of differences in this study. First, in the study were used very high dose: 4000 impulses in one session. This is considerably higher than in other studies. Energy flux density is the main variable responsible for the biological effects induced by ESWT. This is the first study that used such a high number of impulses; therefore, it is possible that this dose had a negative effect for this condition. In addition, the common practice is to provide ESWT once a week for PF, but the authors used atypical approach of bi-weekly treatment [37].

Another study confirming the comparable effects of PF treatment of shock wave and conventional physiotherapy is Greve's research. Researchers compared the results of two conservative PF treatments. Thirty-two patients with PF enrolled in this study. The mean age of the patients was 47.3 ± 10.3 years (from 25 to 68 years of age). 81% of patients were female, 87% of patients were overweight, 56% had bilateral impairment and 75% used analgesics regularly. Patients were randomly assigned into two groups. Patients from group I (n = 16) underwent 10 physiotherapy session each, consisting of ultrasound at a frequency of 1.0 Hz and intensity of 1.2 W/cm^2. All patients performed exercises after ultrasound application to stretch all posterior leg muscles and strengthen the tibialis anterior. Group II (n = 16) was treated with applications of radial shockwaves. Two thousand impulses were applied at a frequency of 6 Hz and a pressure of 3 MPa. 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. Pain and ability to function were evaluated before treatment, immediately afterwards, and three months later. Both groups showed improvement of pain symptoms including reduced number of episodes of pain per week and hours of pain per day. There were observed decreases in the intensity of morning pain, general pain and pain in the orthostatic position as evaluated using the VAS. Researchers also observed the decrease in the intensity of pain in the calcaneus and calf when measured using Fischer's algometer. Most patients had decreased their intake of analgesics by the final evaluation at three months after treatment. There was no statistically significant difference between the groups in any of the parameters used for evaluation. Both treatments were effective for pain reduction and for improving the functional abilities of patients with PF but the effect of the shockwaves was apparent sooner than physiotherapy after the onset of treatment. Shockwave treatment was no more effective than conventional physiotherapy treatment when evaluated three months after the end of treatment. The results of the present study show that a comprehensive rehabilitation program might be effective for treating PF, despite its simplicity [25].

Summary

Extracorporeal shock wave therapy has been proposed as a therapy for PF, after conservative treatment has failed and before surgical management is indicated. The purpose of this review was to analyze the literature critically, assessing the effectiveness of ESWT for reduction pain associated with PF. Ten randomized clinical trials were critically appraised. Eight studies report significant decreases in pain symptoms and better function scores associated with ESWT however, two studies show no meaningful improvement of clinical outcome in patients treated with extracorporeal shock wave therapy for chronic PF compared with placebo or conventional physiotherapy. The

differences in shock-wave energy to the target tissue relate specifically to the method of generation of the shock wave, the size and volume of the ellipsoid, and the depth of energy penetration. These factors may result in significant differences in the potential clinical efficacy.

Many people with PF (90%) will get symptom relief from conservative methods of treatment. That's why ESWT is not considered a suitable therapy for the first-line management of heel pain by the majority of the investigators. This may be because of limited access to this relatively new and expensive equipment or, more likely, because of the favourable natural history of this condition. In chronic cases, refractory to conservative methods, more invasive treatment may be warranted. Surgical management is more cost-efficient than ESWT; it can have significant side effects such as plantar fascia rupture or stress fracture. In addition surgical release of the plantar fascia requires patients to be hospitalized and immobilized for long periods of time. In contrast, ESWT can be done on an out-patient basis with no patient restrictions and has no significant side effects [29, 39-41]. In conclusion, ESWT is a reasonable treatment alternative for PF that is not responsive to conservative treatment.

Bibliography / Bibliografia

1. Lareau CR, Sawyer GA, Wang JH, DiGiovanni CW. Plantar and medial heel pain: diagnosis and management. J Am Acad Orthop Surg 2014;22(6):372-380.
2. Puttaswamaiah R, Chandran P. Degenerative plantar fasciitis: A review of current concepts. The Foot 2007;17:3–9.
3. Roxas M. Plantar Fasciitis: Diagnosis and Therapeutic Considerations. Altern Med Rev 2005;10(2):83-93.
4. Cotchett MP, Landorf KB, Munteanu SE. Effectiveness of dry needling and injections of myofascial trigger points associated with plantar heel pain: a systematic review. J Foot Ankle Res 2010;3:18.
5. Thomas JL, Christensen JC, Kravitz SR et. al. The diagnosis and treatment of heel pain: a clinical practice guideline-revision 2010. J Foot Ankle Surg 2010;49(3 Suppl):S1-19.
6. Jeswani T, Morles J, McNally E. Getting to the heel of the problem: plantar fascia lesions. Clin Radiol 2009;64(9):931-939.
7. Riddle DL, Schappert SM. Volume of ambulatory care visits and patterns of care for patients diagnosed with plantar fasciitis: a national study of medical doctors. Foot Ankle Int 2004;25(5):303–310.
8. Wearing S, Smeathers J, Urry S, Hennig E, Hills A. The Pathomechanics of Plantar Fasciitis. Sports Med 2006;36(7):585-611.
9. Folman Y, Bartal G, Breitgand A, Shabat S, Ron N. Treatment of recalcitrant plantar fasciitis by sonographically-guided needle fasciotomy. Foot Ankle Surg 2005;11:211–214.
10. Abdel-Wahab N, Fathi S, Al-Emadi S, Mahdi S. High-resolution ultrasonographic diagnosis of plantar fasciitis: a correlation of ultrasound and magnetic resonance imaging. Int J Rheum Dis 2008;11:279–286.
11. Crawford F, Atkins D, Edwards J. Interventions for treating plantar heel pain. Cochrane Database Syst Rev 2000;(3):CD000416.
12. Costa I, Dyson A. The integration of acetic acid iontophoresis, orthotic therapy and physical rehabilitation for chronic plantar fasciitis: a case study. J Can Chiropr Assoc 2007;51(3): 166–174.
13. Stuber K, Kristmanson K. Conservative therapy for plantar fasciitis: a narrative review of randomized controlled trials. J Can Chiropr Assoc 2006;50(2):118-133.
14. Digiovanni B, Nowaczenski D, Malay D et. al. Plantar Fascia-Specific Stretching Exercise Improves Outcomes in Patients with Chronic Plantar Fasciitis. J Bone Joint Surg Am 2006;88(8):1775-1781.
15. Grieve R, Palmer S. Physiotherapy for plantar fasciitis: a UK-wide survey of current practice. Physiotherapy 2016, doi: 10.1016/j.physio.2016.02.002.
16. Huffer D, Hing W, Newton R, Clair M. Strength training for plantar fasciitis and the intrinsic foot musculature: A systematic review. Phys Ther Sport 2016, doi: 10.1016/j.ptsp.2016.08.008.
17. Scheuer R, Friedrich M, Hahne J, Holzapfel J, Machacek P, Ogon M, Pallamar M. Approaches to optimize focused extracorporeal shockwave therapy (ESWT) based on an observational study of 363 feet with recalcitrant plantar fasciitis. Int J Surg 2016;27:1-7.
18. Mardani-Kivi M, Karimi Mobarakeh M, Hassanzadeh Z et. al. Treatment Outcomes of Corticosteroid Injection and Extracorporeal Shock Wave Therapy as Two Primary Therapeutic Methods for Acute Plantar Fasciitis: A Prospective Randomized Clinical Trial. J Foot Ankle Surg 2015;54(6):1047-1052.
19. Genc H, Saracoglu M, Nacir B, Erdem H, Kacar M. Long-term ultrasonographic follow-up of plantar fasciitis patients treated with steroid injection. Joint Bone Spine 2005;72:61–65.
20. Cottom JM, Maker JM, Richardson P, Baker JS. Endoscopic Debridement for Treatment of Chronic Plantar Fasciitis: An Innovative Technique and Prospective Study of 46 Consecutive Patients. J Foot Ankle Surg 2016;55(4):748-752.
21. El Shazly O, El Beltagy A. Endoscopic plantar fascia release, calcaneal drilling and calcaneal spur removal for management of painful heel syndrome. Foot (Edinb) 2010;20(4):121-125.
22. Hyer Ch, VanCourt R, Block A. Evaluation of Ultrasound-Guided Extracorporeal Shock Wave Therapy (ESWT) in the Treatment of Chronic Plantar Fasciitis. J Foot Ankle Surg 2005;44(2):137-143.
23. Chuckpaiwong B, Berkson E, Theodore G. Extracorporeal Shock Wave for Chronic Proximal Plantar Fasciitis: 225 Patients with Results and Outcome Predictors. J Foot Ankle Surg 2009;48(2):148–155.

24. Rompe J, Meurer A, Nafe B, Hofmann A, Gerdesmeyer L. Repetitive low-energy shock wave application without local anesthesia is more efficient than repetitive low-energy shock wave application with local anesthesia in the treatment of chronic plantar fasciitis. J Orthop Res 2005;23(4):931-941.
25. Greve J, Grecco M, Santos-Silva P. Comparisonof radial shockwaves and conventional physiotherapy for treating plantar fasciitis. Clinics 2009;64(2):97-103.
26. Gerdesmeyer L, Frey C, Vester J et. al. Radial Extracorporeal Shock Wave Therapy Is Safe and Effective in the Treatment of Chronic Recalcitrant Plantar Fasciitis. Am J Sports Med 2008;35(11):2100-2109.
27. Ogden JA, Toth-Kischkat A, Schultheiss R. Principles of shock wave therapy. Clin Orthop 2001;387:8–17.
28. Weil L, Roukis T, Weil L, Borrelli A. Extracorporeal Shock Wave Therapy for the Treatment of Chronic Plantar Fasciitis: Indications, Protocol, Intermediate Results, and a Comparison of Results to Fasciotomy. J Foot Ankle Surg 2002;41(3):166-172.
29. Ogden J, Alvarez R, Levitt R, Johnson J, Marlow M. Electrohydraulic High-Energy Shock-Wave Treatment for Chronic Plantar Fasciitis. J *Bone Joint Surg Am 2004;*86:2216-2228.
30. Lohrer H, Nauck T, Dorn-Lange N, Schöll J, Vester J. Comparison of radial versus focused extracorporeal shock waves in plantar fasciitis using functional measures. Foot Ankle Int 2010;31(1):1-9.
31. Rompe J, Schoellner C, Nafe B. Evaluation of Low-Energy Extracorporeal Shock-Wave Application for Treatment of Chronic Plantar Fasciitis. *J Bone Joint Surg 2002*;84:335-341.
32. Rompe J, Decking J, Schoellner C, Nafe B. Shock Wave Application for Chronic Plantar Fasciitis in Running Athletes A Prospective, Randomized, Placebo-Controlled Trial. Am J Sports Med 2003;31(2):268-275.
33. Mehra A, Zaman R, Jekin A. The use of a mobile lithotripter in the treatment of tennis elbow and plantar fasciitis. Surg J R Coli Surg 2003;5:290-292.
34. Kudo, Dainty K, Clarfield M, Coughlin L, lavoie P, Lebrun C. Randomized, Placebo-Controlled, Double-Blind Clinical Trial Evaluating the Treatment of Plantar Fasciitis with an Extracorporeal Shockwave Therapy (ESWT) Device: A North American Confirmatory Study. J Orthop Res 2006;24(2):115-123.
35. Malay S, Pressman M, Assili A et.al. Extracorporeal Shockwave Therapy Versus Placebo for the Treatment of Chronic Proximal Plantar Fasciitis: Results of a Randomized, Placebo-Controlled, Double- Blinded, Multicenter Intervention Trial. J Foot Ankle Surg 2006;45(4):196–210.
36. Gollwitzer H, Diehl P, Korff A, Rahlfs V, Gerdesmeyer L. Extracorporeal Shock Wave Therapy for Chronic Painful Heel Syndrome: A Prospective, Double Blind, Randomized Trial Assessing the Efficacy of a New Electromagnetic Shock Wave Device. J Foot Ankle Surg 2007;46(5):348–357.
37. Haake M, Buch M, Schoellner C et.al. Extracorporeal shock wave therapy for plantar fasciitis: randomised controlled multicentre trial. BMJ 2003;327:75.
38. Wang CJ, Wang FS, Yang KD, Weng LH, Ko JY. Long-term results of extracorporeal shockwave treatment for plantar fasciitis. Am J Sports Med 2006;34(4):592-596.
39. Dogramaci Y, Kalaci A, Emir A, Yanat A, Gokce A. Intracorporeal pneumatic shock application for the treatment of chronic plantar fasciitis: a randomized, double blind prospective clinical trial. Arch Orthop Trauma Surg 2010;130:541-546.
40. Burton A, Overend T. Low-energy extracorporeal shock wave therapy: a critical analysis of the evidence for effectiveness in the treatment of plantar fasciitis. Phys Ther Rev 2005;10:152–162.
41. Thomson C, Crawford F, Murray G. The effectiveness of extra corporeal shock wave therapy for plantar heel pain: a systematic review and meta-analysis. BMC Musculoskelet Disor 2005;6:19.