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# The use of combined therapy: super inductive stimulation and radial shock wave in the treatment of plantar tendon pain – evaluation of treatment results

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**ABSTRACT**

**Introduction**: The condition commonly referred to as plantar fasciitis is a common musculoskeletal complaint. However, this term is inaccurate, as the dysfunction is not inflammatory in nature; a more appropriate term is "plantar fasciopathy". It affects both athletes and individuals who lead sedentary lifestyles.

**Materials and methods**: The study involved 15 patients with complaints of pain in the plantar tendon area. It was conducted between July and December 2023 at a private physiotherapy office in Kołobrzeg. The study included patients of both sexes, of varying ages and levels of physical activity, all reporting heel pain while walking. The treatment consisted of combination therapy consisting of radial shock wave therapy (RSWT) and super inductive stimulation (SIS).

**Results**: In 11 patients, the pain completely subsided after therapy, and in 4 patients, it was significantly reduced and caused minimal disruption to daily mobility.

**Conclusions**: Combination therapy proved highly effective in treating plantar tendon pain. The presence or absence of gait disturbance or gender did not affect the therapy's effectiveness. When planning treatment, the presence and intensity of pain in the affected area should be considered.

**Keywords**: plantar fasciopathy; heel pain; plantar tendon pain; physiotherapy; radial shock wave therapy; super inductive stimulation; plantar fasciitis; plantar tendonitis.

## INTRODUCTION

The condition known as plantar fasciitis is a common problem experienced by 1 in 10 people during their lifetime. However, this dysfunction should not be referred to as plantar fasciitis. A more accurate term is "plantar fasciopathy", as the condition is not inflammatory in nature [1]. In this publication, both terms – plantar fasciitis and plantar fasciopathy – will be used to describe the condition. The term "plantar fasciitis" will be retained only in the context of its common use to describe the condition.

Plantar fasciitis is the most common cause of heel pain in adults [2], with a higher incidence in women aged 40–60 years [3]. It is associated with various sports, particularly recreational and elite running, where the incidence is reported to be 5–10% [4]. Plantar fasciitis accounts for 20–40% of lower-extremity tendinopathies and affects both athletic and non-athletic populations. Conservative treatment is the first line of therapy for plantar pain [5]. The term "tendinopathy" was introduced in 1998 to describe a clinical syndrome characterized by pain, tendon swelling, and functional impairment. Tendinopathies can arise from traumatic, inflammatory, mechanical (overuse), or iatrogenic origins. Diagnosis of tendinopathies requires precise anatomical knowledge and is based on 3 key signs: pain upon direct palpation of the tendon, pain with passive stretching, and pain during muscle contraction. Calcaneal tendinopathy is the most frequent form [6].

Risk factors for plantar fasciitis include limited ankle dorsiflexion, increased body mass index (BMI), and prolonged standing. Although common in runners, plantar fasciitis can also affect individuals with sedentary lifestyles [1]. Those with excessive pronation (pes planus) or reduced ankle dorsiflexion are also at higher risk for developing the condition [7]. When bilateral, plantar fasciitis is associated with rheumatologic conditions such as rheumatoid arthritis, systemic lupus erythematosus, and gout [5]. Other risk factors include obesity, prolonged standing, flat feet, dysfunction of the soleus-gastrocnemius complex, and ankle instability, all of which place excessive stress on the fascia. Aging reduces the elasticity of the plantar fascia, further contributing to degeneration rather than inflammation, leading to thickening of the fascia [8].

The plantar fascia consists of 3 bands of dense connective tissue that originate from the calcaneus and fan out distally to insert into the base of each proximal phalanx [9]. The medial portion is the most important, as it attaches to the medial tuberosity of the heel bone and supports the longitudinal arch, elongating with increased mechanical load [8]. It functions both as a beam to support the metatarsals during bending forces in gait propulsion and as a truss to absorb forces during the loading phase of gait [10]. Excessive load on the plantar fascia can lead to plantar fasciitis, which, despite its name, is now recognized as a degenerative pathology rather than an inflammatory condition [10, 11].

This tension elevates and reinforces the medial longitudinal arch, allowing the foot to function as a rigid lever for forward propulsion [12]. Plantar fasciitis is considered a biomechanical overuse condition [13], characterized by a chronic degenerative process involving the plantar aponeurosis of the foot, most commonly at its insertion into the medial tubercle of the calcaneus. The process involves repetitive strain that causes microtears, leading to a repair response [14, 15]. Described by Hicks in 1954 as the windlass mechanism, the plantar fascia tenses during the terminal stance to toe-off phases of gait [9, 13, 14]. Histological analysis shows marked thickening and fibrosis of the plantar fascia, with evidence of collagen necrosis, chondroid metaplasia, and calcification [15, 16]. Examination of samples from patients undergoing plantar fascia release surgery reveals myxoid degeneration with fragmentation of the plantar fascia and bone marrow vascular ectasia. These findings support the classification of the condition as degenerative fasciosis rather than fasciitis [16]. Therefore, "plantar fasciopathy" is a more accurate term [1].

Plantar fasciopathy is characterized by intense, sharp pain over the medial plantar heel, particularly with initial steps in the morning or after inactivity, which worsens with prolonged weight-bearing activities [7, 10, 17]. Pain that worsens over time during physical activity suggests a post-traumatic history, microtrauma, or degenerative changes in the affected area (Fig. 1). In contrast, pain from an inflammatory condition would typically subside after some time during movement. Additionally, power Doppler ultrasound can confirm the absence of inflammatory markers in the plantar fascia.

The purpose of this study was to evaluate the effectiveness of combined therapy – super inductive stimulation (SIS) and radial shock wave – in the treatment of plantar tendon pain.

## MATERIALS AND METHODS

The study included 15 patients, 11 women and 4 men (Tab. 1), all of whom presented with complaints of pain in the plantar tendon area. The study was conducted between July and December 2023 at a private physiotherapy clinic in Kołobrzeg. The participants were of varying ages and levels of physical activity, and all reported heel pain while walking. The main criterion for inclusion in the study was the localization of pain at the central point of the heel, specifically at the attachment of the plantar fascia or along its course (Fig. 2). Patients with pain around the Achilles tendon, the periphery or top of the heel bone, or at the attachment of the proximal toe flexor tendon (commonly referred to as the "heel spur") were excluded from the study.

**TABLE 1. Average age of respondents and their percentage in the survey**

| Sex | Average age | Survey percentage |
|---|---|---|
| **Men** | 53 years old | 31.25% |
| **Women** | 58.8 years old | 68.75% |

The same treatment method, namely combination therapy, was applied to all patients. This treatment consisted of a combination of 2 different physiotherapy methods, applied in the correct order and with appropriate parameters.

The methods used to treat plantar fasciitis pain during the combined therapy were:

- radial shock wave therapy (RSWT) – BTL-6000 Topline Power;
- SIS – BTL-6000 Super Inductive System Elite, Focused Field Applicator BTL-299-2.

### Methodology for the procedure

During each treatment, the following sequence was followed: first, the shock wave therapy was applied, followed by the SIS.

#### *Radial shock wave therapy*

The treatment involved 2000 strokes per session at a frequency of 8 Hz, with pressure starting at 2.0 bar in the first session and increasing to 3.0 bar in the final session. The pressure applied in subsequent treatments was adjusted based on the patient's pain tolerance. The treatment began by targeting the area of attachment of the soleus tendon to the heel bone or the point of greatest pain (1000 strokes), followed by moving the applicator along the tendon in the distal direction (1000 strokes) – Figure 3.

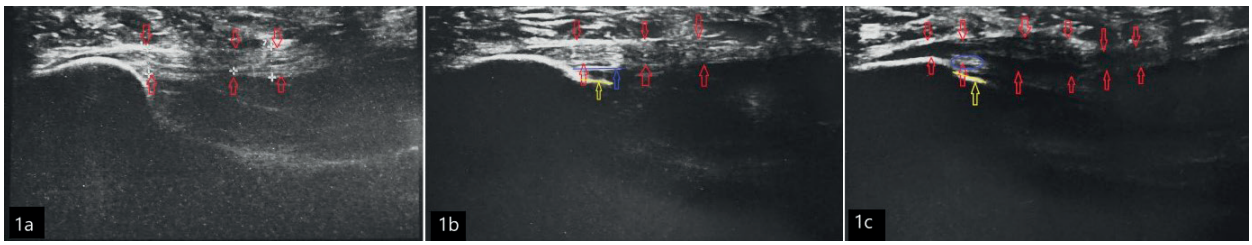


**FIGURE 1.** (a) Uniform thickness of the plantar tendon along its course (red arrows) – a normal image. The full outline of the heel bone shows no visible calcification or enthesopathy; (b) uniform thickness of the plantar tendon along its course (red arrows) – a normal image. Visible enthesopathy of the short toe flexor, known as a heel spur (line and yellow arrow). The hyperechoic outline of part of the plantar tendon near the heel bone may indicate a history of trauma or degenerative changes in the tissue (line and blue arrow); (c) visible changes in the plantar tendon. Thickening along the course of the tendon (red arrows) suggests dysfunction in this region, causing pain. The formation mechanism is likely overload or trauma. Additionally, a trace of previous trauma or degenerative changes is visible (blue oval), along with the heel spur (line and yellow arrow)

**FIGURE 2.** Area of reported pain in plantar fasciopathies

**FIGURE 3.** Direction of radial shock wave therapy execution

### *Super inductive stimulation*

The treatment was administered using a concentrated applicator for 10 min, with 7 sequences. The applicator was positioned over the area affected by the dysfunction, using the contact method (Fig. 4). The recommended intensity was set to the motor threshold, and once the treatment began, the intensity was adjusted according to the patient's motor threshold. This protocol provided analgesic effects based on the activation of the endogenous opioid system and improved tissue trophism through activation of the muscle pump.

The treatment cycle for each patient consisted of 5 separate therapy sessions over a period of 3 weeks. Patients received 2 treatments per week with a minimum interval of 3 days, meaning the first and second weeks had 2 sessions each, and the third week had 1 session.

**FIGURE 4.** Example of applicator placement, most common location of pain occurrence

Before the start of treatment, each patient underwent an examination that included:

- an interview;
- determination of the strength of heel pain during the first morning steps, using the pain numeric rating scale (NRS) scale. The scale ranges 0–10, where 0 represents no pain and 10 represents very severe pain;
- palpation;
- gait analysis, noting whether gait disturbances were present due to severe pain (e.g., limping, offloading the limb) or whether there were no gait disturbances despite the pain;
- determination of the strength of heel pain during both the first morning steps and daytime walking or prolonged standing;
- additional examinations, including ultrasonography, to visualize the problem (not for diagnostic purposes).

After the treatment, each patient underwent an examination that included:

- an interview;
- determination of the strength of heel pain during the first morning steps and during the day or after prolonged standing.

## RESULTS

In 11 patients, the pain completely disappeared after therapy, while in 4 patients, it was significantly reduced and is not very disruptive in terms of daily mobility. It is possible that for these patients, the therapy should be extended with a few more sessions.

Gait disturbances were clearly observed in only 5 patients before the start of therapy, while the remaining patients

experienced no issues other than pain while walking. The only common factor among those with gait disturbances was age. All patients ranged in age 27–90, and gender was irrelevant. Both older and younger patients did not show similar gait disturbances before therapy, despite reporting the same pain intensity on the NRS. Similarly, some patients in the study group had no problems walking despite reporting similar pain levels (Tab. 2). This discrepancy may be related to individual pain tolerance or the presence of other musculoskeletal conditions.

The presence or absence of gait disturbance seems to have little relevance to the effectiveness of treatment. The most important factor for undergoing combination therapy is pain intensity.

## DISCUSSION

The use of combination therapy to reduce plantar tendon pain appears to be more effective than using individual therapies in isolation. Following the principle that all available treatment options should be considered without favoring specific methods, other potential combination therapies and treatment approaches should also be explored. Grieve and Palmer emphasize the importance of patient counseling and education as a foundation, along with general stretching exercises, prefabricated orthotics, massage, myofascial release, specific soft tissue mobilizations, and myofascial trigger point therapy [17]. There is no one-size-fits-all solution for treating pain.

The diagnosis and proper treatment of plantar fasciitis rely on a thorough history and clinical examination. More advanced imaging techniques are reserved for patients with persistent pain or those with uncertain clinical findings. Patients with acute plantar fasciitis tend to have better outcomes compared to those with delayed presentations and chronic pain. Chronic cases of plantar fascial pain often have unpredictable responses to treatment [18].

Clinical practice guidelines recommend a variety of treatment interventions for plantar heel pain, such as corticosteroid injections, exercises, extracorporeal shockwave therapy, or manual therapy. However, the current evidence is inconclusive regarding which treatment is the most effective [5].

Patients with plantar heel pain often exhibit a thickened plantar fascia, abnormal plantar fascia tissue, a thicker loaded plantar heel fat pad, and a plantar calcaneal spur. There is also evidence of hyperemia within the plantar fascia and abnormalities in the calcaneus. While these imaging features may assist in diagnosis, further high-quality studies on these findings would improve their precision and help determine their clinical relevance [19].

Additionally, a positive correlation has been found between plantar fascia thickness and Achilles tendon paratenon thickness, suggesting a potential involvement of the Achilles tendon in plantar fasciopathy pathology [20]. The connection between the plantar fascia and Achilles tendon explains the common focus on relieving tension in the triceps surae during plantar fascia treatment [21].

Besides plantarflexion range of motion (ROM), increased BMI and body mass are also recognized as risk factors for plantar fasciopathy. The risk of developing plantar fasciopathy

**TABLE 2. Summary of patients' pain sensations before and after therapy**

| Patient | Sex | Age | Heel | Painful palpation exam | Gait disturbances before treatment | NRS | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | first steps before treatment | walking or standing before treatment | first steps after treatment | walking or standing after treatment |
| **1** | male | 61 | R | yes | yes | 3 | 3 | 1 | 0 |
| **2** | male | 27 | L | yes | no | 2 | 2 | 0 | 0 |
| **3** | male | 54 | R | yes | yes | 3 | 3 | 1 | 0 |
| **4** | male | 70 | R | yes | no | 3 | 3 | 1 | 1 |
| **5** | female | 53 | L | yes | yes | 3 | 2 | 0 | 0 |
| **6** | female | 90 | L | yes | no | 3 | 3 | 1 | 1 |
| **7** | female | 53 | R | yes | yes | 3 | 2 | 0 | 0 |
| **8** | female | 74 | L | yes | no | 2 | 2 | 1 | 1 |
| **9** | female | 56 | L | yes | yes | 3 | 3 | 1 | 0 |
| **10** | female | 62 | R | yes | no | 3 | 3 | 1 | 0 |
| **11** | female | 42 | L | yes | no | 2 | 2 | 0 | 0 |
| **12** | female | 39 | R | yes | no | 2 | 1 | 0 | 0 |
| **13** | female | 64 | R | yes | no | 3 | 2 | 1 | 0 |
| **14** | female | 70 | L | yes | no | 3 | 2 | 1 | 1 |
| **15** | female | 44 | L | yes | no | 2 | 1 | 0 | 0 |

NRS – numeric rating scale; R – right; L – left

among individuals who train at various levels is frequently discussed among healthcare professionals and active individuals, given its hypothesized role in overuse injury [22]. However, in this study, neither BMI nor physical activity levels were considered when selecting patients for therapy.

It is often speculated that overpronation contributes to plantar fasciopathy, as pronation increases tension on the plantar fascia [23, 24, 25]. Three articles in a meta-analysis used rearfoot motion during running as an indicator of pronation [23, 26, 27]. Pronation is a triplanar movement comprising subtalar eversion, forefoot abduction, and talocrural dorsiflexion [28].

In conclusion, findings from the meta-analysis suggest that the association between increased subtalar or rearfoot eversion and the development of plantar fasciitis as a risk factor remains uncertain.

## CONCLUSIONS

1. Combination therapy, consisting of RSWT and SIS applied in the correct sequence and spaced over a specific timeframe, has been shown to be highly effective in managing plantar tendon pain.
2. The presence or absence of a gait disturbance, as well as gender, do not impact the effectiveness of the therapy.
3. It should be noted that the wide age range of the participants may have influenced the final outcomes of the study.
4. The most important criterion for determining whether a patient should undergo combination therapy is the presence of pain in the affected area.
5. Future studies could be conducted on a larger target group, potentially focusing on specific professional groups or athletes from different sports.

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