

COMPARISON OF THE EFFECTS OF STRETCHING EXERCISES, PROLOTHERAPY, ESWT AND CORTICOSTEROID INJECTION ON VAS SCORES INACTIVE ADULTS WITH CHRONIC PLANTAR FASCIITIS: A RETROSPECTIVE COHORT STUDY

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ABSTRACT

Introduction: Treatment options for plantar fasciitis are numerous, but the effectiveness of these treatment modalities in comparison to each other, and their effects in the short and medium-term are to be investigated.

Method: This study compared the average pain scores (visual analogue scale -VAS) of 182 patients who were treated with either one of exercise therapy, extracorporeal shockwave therapy (ESWT), prolotherapy or corticosteroid injections at baseline, week 3 and month 6, retrospectively.

Results: Each treatment modality improved pain scores significantly, compared to baseline at week 3. In the third week, the lowest VAS scores were observed in patients who received a steroid injection (1.46 ± 0.74). However, at month 6 the lowest VAS scores belonged to the patients who had received ESWT (2.93 ± 0.74). All other treatment groups also had significantly lower VAS scores at month 6 than at baseline.

Conclusion: Exercise therapy, ESWT, prolotherapy and steroid injections are all effective in reducing pain in patients with chronic plantar fasciitis. However, the best outcome was observed with steroid in the short term, and with ESWT in the medium term.

Keywords: ESWT, prolotherapy, steroid injection, exercise therapy.

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Introduction

Chronic plantar fasciitis is a condition found in 15% of all patients who receive medical attention for a foot complaint⁽¹⁾. Although millions of people suffer from the condition each year, it is predominantly seen in young adults and is more common in runners than in the general population⁽²⁾. The diagnosis of plantar fasciitis is made with the help of patient history and physical examination. Pain in the form of stinging, which worsens gradually during the day, is among the complaints frequently expressed by patients. Physical examination reveals tenderness at the fascial insertion point at the anteromedial calcaneus⁽²⁾. Although plantar fasciitis is not a very challenging diagnosis, the same cannot be said for its treatment. Treatment options are vast,

including but not limited to stretching exercises, ice massage, nonsteroidal anti-inflammatory drugs, foot orthoses, extracorporeal shockwave therapy, corticosteroid injections, platelet-rich plasma injections, dextrose prolotherapy, dry needling, botulinum toxin injections, ultrasound, laser therapy, pulsed radiofrequency, taping, strength training, and surgery⁽³⁻⁶⁾. Despite all the various treatment options, there is no widely accepted treatment algorithm for plantar fasciitis⁽⁷⁾. In addition, it is often emphasized in the literature that there is not enough evidence for the effectiveness of many treatment modalities currently used. In this study, it was aimed to investigate how different treatment options (stretching exercises, extracorporeal shock wave therapy, prolotherapy, and steroid injections) affect pain in the short and medium-term in

patients with chronic plantar fasciitis who have not benefited adequately from nonsteroidal anti-inflammatory drug therapy. Our hypothesis is that steroid injections will be most effective in relieving pain in the short term, while in the medium term, all treatment options will provide significant benefit compared to baseline.

Methods

Ethical approval

This retrospective cohort study was approved by the Necmettin Erbakan University Medical Ethics Committee and followed the guidelines of the Declaration of Helsinki. The requirement for informed consent was waived by the Ethics Committee of Necmettin Erbakan because of the retrospective nature of the study.

Patient selection

Patients who presented to our clinics with heel pain between August 2016-December 2021 and were clinically diagnosed with chronic plantar fasciitis were selected retrospectively from their charts.

Subsequently, those who met the following inclusion criteria were selected from among:

- Aged between 25-65, foot and heel pain persistent for at least 6 months;
- A VAS score of at least 5 on the first step in the morning;
- Failed to improve with conservative treatment before (night splint, taping, arc supports, oral anti-inflammatory);
- Exercising regularly for 1 hour 3-4 times a week (jogging, walking, cycling etc.)

The following exclusion criteria were applied:

- History of fracture or trauma in the calcaneal region;
- Presence of diabetes and pregnancy;
- Diagnosis of peripheral neuropathic pain;
- Restless legs syndrome, history of allergy to local anesthetics and steroids, history of local or systemic infection during treatment, to have received steroids or ESWT in the last year.

Procedures

Patients had received either of the four therapy options: stretching exercises (EXE), extracorporeal shock wave therapy (ESWT), dextrose prolotherapy (PRO), or steroid injections (STE).

Stretching exercises

Patients learned the exercises with the help

of a physical therapist. They were also given an illustrated booklet explaining the exercises. The patients were instructed to do the exercises every day for four weeks. Exercises consisted of Achilles and calf stretching exercises, bottle rolling on the soles of the feet, object grasping with the toes, foot extension and rotation, toe elevation and plantar fascia stretching exercises. The patients' compliance with home exercises was not monitored separately.

Extracorporeal shock wave therapy

Patients who received extracorporeal shock wave therapy were treated for 5 sessions, twice a week. ESWT (Vibrolith ortho, Elmed Medical, Ankara-Turkey) was applied with 2000 impulses, 15 Hz, 2,5 bar.

Steroid injections

Steroid injections (1 mL of methylprednisolone acetate 40 mg/mL) were administered to the two most painful and sensitive points in the inferomedial calcaneal region with a 31-Gauge needle.

Dextrose prolotherapy

Following local anesthesia with 2% prilocaine hydrochloride, prolotherapy was applied twice with 3 weeks intervals, and 20% dextrose solution was applied with the peppering technique, starting from the epin calcanei, along the medial plantar fascia.

After steroid injection, prolotherapy and ESWT sessions, individuals were told to avoid moderate and vigorous exercises for 48 hours. After all treatment sessions, ice was applied for 10 minutes.

Main outcome measure

The main outcome measure was visual analogue scale (VAS) score taken at baseline, at week 3 and at month 6.): Patients were asked to rate the intensity of their pain on a 10-cm VAS which was positioned horizontally and read "No Pain" on one end, and "The worst pain" on the other end.

Visual analogue scale is a reliable and valid measure to quantify pain in musculoskeletal conditions^(8,9).

Statistical analysis

The variables were investigated using visual (histograms and probability plots) and analytical methods (Kolmogorov-Smirnov test) to determine normal or nonnormal distributions.

Descriptive analyses are presented using mean \pm standard deviation (SD) for continuous variables and using frequency counts and percentages for

categorical variables. Any significant difference regarding the age, weight, height, body mass index, and symptom duration of participants between groups were examined by a series of analysis of variance tests, and the distribution of sex, presence of a spur and the affected site were examined by a series of chi-square tests. A two-way repeated-measures analysis of variance (ANOVA) was performed to evaluate the effects of group (EXE, ESWT, PRO, STE), time (before, 3 weeks, and 6 months), and time-group interaction on the VAS score.

Later, pairwise comparisons were made using a pairwise t-test with Bonferroni correction when significant effects were observed. All statistical analyses were performed using R Studio, Version 3.6.2. Alpha level was set to 0.05.

Results

Participants

A total of 182 patients were eligible for this study. Patient demographics and their physical characteristics are summarized in Table 1. A series of analysis of variance tests were run to examine the age, weight, height, body mass index, and symptom duration between groups. No statistically significant differences were found ($p=0.973$, $p=0.992$, $p=0.901$, $p=0.848$, and $p=0.57$, respectively).

A series of chi-square tests were run to analyze the distribution of sex, presence of a spur and the affected site. No statistically significant differences were found between groups ($p=0.82$, $p=0.62$, and $p=0.97$, respectively).

VAS scores

Mean VAS scores of all groups at three time points are given in Table 2. Patients' VAS Scores are visualized in Figure 1. The effects of group ($F(3,178)=36.275$, $p<0.001$), time ($F(2,356)=1167.728$, $p<0.001$) and group-time interaction ($F(6,356)=211.537$, $p<0.001$) were significant. When the simple main effect of the group on VAS scores was examined, a statistically significant effect was observed at week 3 and month 6, but not at baseline. (Baseline: $F(3,178)=0.44$, $p=1.00$; Week 3: $F(3,178)=189$, $p<0.001$; Month 6: $F(3,178)=73$, $p<0.001$).

Pairwise comparisons revealed the following results: none of the pairwise comparisons showed significant differences between groups at baseline (all $p>0.05$). All 6 comparisons between 4 groups (EXE vs. ESWT, EXE vs. PRO, EXE vs. STE,

ESWT vs. PRO, ESWT vs. STE, and PRO vs. STE) showed significant differences at third week (all $p<0.001$). VAS scores measured at sixth month were significantly different between pairs of groups ($p<0.001$) except for two (ESWT vs. PRO and EXE vs. STE, both $p>0.05$). Later, the simple main effect of time was examined. Results showed that the effect of time was significant for each treatment group (ESWT: $F(2,123)=197$, $p<0.001$; EXE: $F(2,123)=38.3$, $p<0.001$; PRO: $F(2,123)=117$, $p<0.001$; STE: $F(2,123)=617$, $p<0.001$). Pairwise comparisons among each treatment group between different time-points (Baseline vs. 3 weeks, Baseline vs. 6 months, and 3 weeks vs. 6 months for each group) showed that all comparisons were statistically significant (all $p<0.001$).

| | | EXE n=42 | EST n=42 | PRO n=43 | STE n=55 | p |
|---------------------------|---------|-------------|-------------|-------------|-------------|---|
| Age (years) | | 47.8±10.5 | 48.5±9.0 | 47.9±8.9 | 47.5±9.2 | F (3,178)=0.075, p=0.973 |
| Height (cm) | | 171.0±8.5 | 171.0±7.4 | 171.0±8.5 | 171.0±8.1 | F (3,178)=0.032, p=0.992 |
| Weight (kg) | | 78.8±9.7 | 79.8±9.0 | 79.3±9.6 | 80.1±8.1 | F (3,178)=0.193, p=0.901 |
| BMI (kg/m ²) | | 27.0±2.3 | 27.2±2.6 | 27.2±2.8 | 27.4±2.2 | F (3,178)=0.269, p=0.848 |
| Sex (n, %) | Female | 22 (47.6%) | 21 (50%) | 25 (58.2%) | 27 (49.1%) | X ² (4, N=182)=0.903, p=0.82 |
| | Male | 20 (52.4%) | 21 (50%) | 18 (41.8%) | 28 (50.9%) | |
| Symptom Duration (months) | | 8.4±2.2 | 8.5±2.6 | 8.2±2.0 | 8.0±1.7 | F (3,178)=0.672, p=0.57 |
| Spur (n, %) | Present | 20 (47.6%) | 25 (59.5%) | 20 (46.5%) | 28 (50.9%) | X ² (4, N=182)=1.759, p=0.62 |
| | Absent | 22 (52.4%) | 17 (40.5%) | 23 (53.5%) | 27 (49.1%) | |
| Affected Site (n, %) | Right | 29 (69%) | 29 (69%) | 31 (72.1%) | 40 (72.7%) | X ² (4, N=182)=0.258, p=0.97 |
| | Left | 13 (31%) | 13 (31%) | 12 (27.9%) | 15 (27.3%) | |

Table 1: Patient characteristics.

All continuous data is presented in "mean ± standard deviation". Categorical variables are tested with chi-square test; continuous variables are tested with analysis of variance.

| | EXE n=42 | EST n=42 | PRO n=43 | STE n=55 |
|----------|-------------|-------------|-------------|-------------|
| Baseline | 6.67±1.03 | 6.5±0.94 | 6.65±1.02 | 6.49±0.88 |
| Week 3 | 5.74±1.04 | 3.98±0.84 | 4.74±1.14 | 1.46±0.74 |
| Month 6 | 4.83±0.79 | 2.93±0.74 | 3.35±0.84 | 4.73±0.65 |

Table 2: Mean VAS scores (± standard deviations) of patients.

Discussion

Our study results showed that all four treatment options, namely stretching exercises, ESWT, prolotherapy, and steroid injection, improve the pain score significantly in the first 3 weeks, and 6 months. The greatest reduction in pain score was

observed after steroid injection, in support of our hypothesis. However, the increase of pain score from week 3 to month 6 following steroid injection was also statistically significant. ESWT provided the second greatest reduction in pain in week 3 and best pain scores at month 6. Patients who received ESWT for 5 sessions had significantly less pain than the ones who had a steroid injection at sixth month. Prolotherapy and exercise therapy both resulted in significant pain reduction at both timepoints, prolotherapy being more effective than exercise.

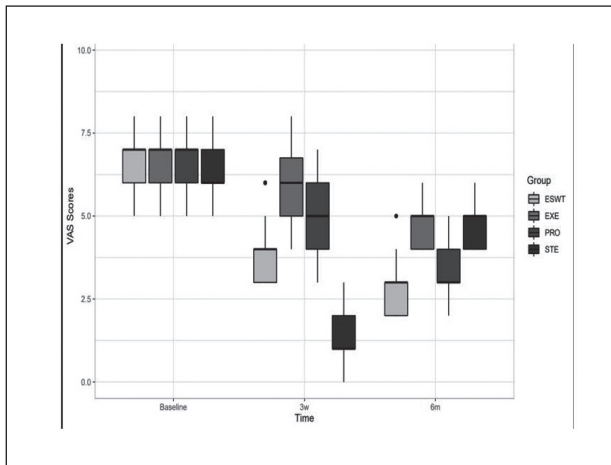


Figure 1: VAS scores of different treatment groups at three time-points.

Minimal important difference (MID), a term suggested by Schunemann and Guyatt describe the minimum change in a variable that can be perceived by the patient⁽¹⁰⁾. In the case of plantar fasciitis and VAS scores, the minimal important difference in average pain, which was the main outcome measure of our study, is 0.8 cm⁽¹¹⁾. All statistically significant differences in mean VAS scores in our study also exceeded the minimal important difference for VAS in plantar fasciitis. However, exercise therapy provided a change of only 0.93 cm in mean VAS score in the first three weeks, which means this difference is barely important for the patients even though there is substantial statistical significance.

Plantar fascia stretching exercises are commonly prescribed by physicians in chronic plantar fasciitis. Indeed, there is enough scientific evidence to support this treatment plan. Both plantar fascia-specific stretching exercise and Achilles tendon stretching exercise effectively improve pain and function at eight weeks and in two years⁽¹²⁾. In a randomized controlled clinical trial, it was shown that stretching exercises are effective at improving pain and function when done daily, and stretching

with strengthening did not result in better outcomes than stretching alone⁽¹³⁾. Although exercise therapy has significant effects on pain, it falls behind when it is compared with other therapy options, such as steroid injections⁽¹⁴⁾, which was also the case in our study results. Prolotherapy, injection of hypertonic dextrose solutions, are used for the treatment of many musculoskeletal conditions, such as tendinopathies, or degenerated or sprained ligaments. In plantar fasciitis, a randomized controlled trial showed that prolotherapy was effective in reducing pain than stretching exercises⁽¹⁵⁾.

A meta-analysis reported that prolotherapy is a safe and effective method of treatment and that its effects were comparable to those of platelet-rich plasma (PRP) injections or ESWT therapy⁽¹⁶⁾. Our study showed that even though prolotherapy significantly improved pain at third week and sixth month, ESWT performed better at both time-points. Locally injected corticosteroids are famous for their short term pain relief effects⁽¹⁷⁾. Although there are concerns on their safety, when precautions such as giving only a limited number of injections, or giving the injections under the guidance of ultrasound make safe use of corticosteroid injections possible⁽¹⁸⁾. Steroid injections are superior to oral non-steroid antiinflammatory drugs, deep friction massage, and dry needling in the short term^(17, 19, 20, 21). In support of the literature, our study findings have demonstrated that patients pain scores were reduced significantly after a single dose of steroid injection. In fact, patients who had the least pain in the third week of their treatment were the ones who had received a steroid injection. However, this effect did not last for 6 months. It is reasonable to combine steroid injections with other treatment modalities which have pain-relieving effects in the long run, such as plantar stretching⁽¹⁷⁾.

There are several limitations to this study. First of all, our outcome measure is limited with average pain score. Pain is the single most debilitating symptom in plantar fasciitis, nevertheless using other measures such as Foot Health Status Questionnaire would have improved this study. Another limitation is that compliance to exercise therapy was not measured. It was shown in previous studies that handing illustrated material significantly improves compliance to exercise therapy and in our study, an illustrated booklet that describes the exercises were given to patients⁽²²⁾. Nonetheless, low compliance may be one of the reasons why the exercise therapy group had higher VAS scores at both time-points

than all other groups.

In conclusion, ESWT, steroid injection, stretching exercises and prolotherapy all effectively reduced pain in our study participants. While choosing a treatment method over the others, features such as the characteristics of the patient and the existing equipment in the institution where the treatment will be performed are also taken into consideration. At this stage, the physician should keep in mind the rapid success of steroid injections in reducing the patient's pain, the gradual pain-relieving effect of ESWT therapy for up to 6 months, that exercise therapy is a safe and effective option, and that prolotherapy is more effective than steroid injection by 6 months.

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Author Contributions:

M.P.Y had the initial idea and drafted the first version. A.E collected all source data, conducted all modelling and statistical analyses. All authors contributed to drafting and interpreting results, and approved the final version of this manuscript. A E is the guarantor of this research. All authors read and approved the final manuscript.

Availability of data and materials:

The data used and analyzed during the current study are available in anonymized form the corresponding author on reasonable request.

Ethics approval and consent to participate:

The requirement for informed consent was waived by the Ethics Committee of Necmettin Erbakan because of the retrospective nature of the study. Data were retrospectively obtained from our clinical database. All data generated or analyzed during this study are included in this published article and its supplementary information files.

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