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Original Article

# Pain relief and functional improvement provided by extracorporeal shock wave therapy in plantar fasciitis is better than corticosteroid injection and kinesio taping: A randomized trial

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*ABSTRACT*

**Objectives:** This study aimed to evaluate the results of extracorporeal shock wave therapy (ESWT), corticosteroid injection (CI), and kinesio taping (KT) in terms of pain and function in plantar fasciitis (PF).

**Patients and methods:** In this prospective study, 90 feet of 64 patients (11 males, 53 females; mean age: 38.3±10.4 years; range, 22 to 70 years) who presented with chronic PF between November 2021 and March 2022 were evaluated. The patients were randomized to three groups, with 30 feet in each group: the CI group, the ESWT group, and the KT group. Each group received only the respective treatment modalities assigned to their group. Pain assessment of the patients before the treatment and at six weeks, three months, and six months was evaluated with the Visual Analog Scale (VAS), and their functions were evaluated with the American Orthopedic Foot and Ankle Society (AOFAS) score.

**Results:** There was no statistical difference in the demographic data (age, body mass index, and VAS; all $p>0.05$). At six weeks, VAS was statistically significantly lower in the CI group compared to the other groups ($p<0.001$), but there was no difference in AOFAS between the groups ($p=0.666$). At three months, there was no statistical difference between the groups regarding VAS ($p=0.311$), while the AOFAS was higher in the ESWT group ($p=0.006$). At six months, VAS was lower ($p<0.001$) and AOFAS was higher ($p=0.003$) in the ESWT group.

**Conclusion:** All three commonly used treatment modalities, ESWT, CI, and KT, are effective in reducing pain and increasing function in chronic PF. However, while CIs can be more effective in relieving pain in the early period, the most significant improvement at the end of the sixth month was achieved by ESWT.

***Keywords:*** : Corticosteroid, ESWT, kinesiotaping, plantar fasciitis.

The exact incidence and prevalence of plantar fasciitis (PF) are unknown. However, approximately one million people are estimated to apply to a health institution in a year due to PF.[1] Plantar fasciitis is defined as the degeneration of the plantar fascia after overloading[2] or repetitive microtrauma[3] at its origin in the medial tubercle of the calcaneus. It is characterized by first-step pain in the medial heel, which begins after periods of rest or weightlessness. It is common in people between the ages of 40 to 60, obese individuals, runners, and those with limited foot dorsiflexion. It has also been associated with pes planus, pes cavus, spondyloarthropathies, and a tight Achilles tendon.[4]

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There are multiple options for the treatment of PF, but there is no clear consensus on the best treatment.[5] Symptoms usually resolve spontaneously in the first 12 months after lifestyle modification, rest, nonsteroidal anti-inflammatory drugs (NSAIDs), night splint use, or rehabilitation.[1,6] However, less invasive methods, such as extracorporeal shock wave therapy (ESWT), botulinum toxin A, autologous platelet-rich plasma, dextrose prolotherapy, and corticosteroid injections (CIs), are also used to treat chronic cases.[1,6] Surgical fasciotomy is the last option for patients who do not benefit from these methods.[1] In the treatment of PF, symptoms may take weeks or even months to regress or completely heal.

Corticosteroid injections and ESWT are the most commonly used treatment options in the treatment of PF.[7-9] It is thought that the anti-inflammatory effect of CIs, a minimally invasive method, starts rapidly but loses its effect quickly as well.[10] In addition, complications such as plantar fascia rupture, fat pad atrophy, and osteomyelitis in the calcaneus can be encountered after the injection.[11-14] The mechanical stimulus provided by ESWT stimulates angiogenesis, increases local growth factors, and decreases inflammatory cytokines in the region, in addition to the direct healing stimulation, suppressive effects on nociceptors, and hyperstimulation mechanisms that block the gate control mechanism that have also been described.[14,15] Thus, ESWT, a noninvasive method, provides healing in the damaged tissue and causes fewer complications compared to nonsurgical invasive methods.[10]

Kinesio taping (KT) is a method first designed by Kase et al.[16] in Japan to support muscles and joints without restricting the joint range of motion. It reduces the pressure on the plantar fascia by correcting faulty biomechanics; thus, by creating a lifting effect on the skin, it increases lymphatic drainage and reduces pain.[16-18] It also helps retrain the neuromuscular system, reduce inflammation, improve performance, prevent injury and circulation, and return the body to homeostasis.[16]

Plantar fasciitis is the most common cause of heel pain in outpatient visits.[1] We shared our experience with this condition and the treatment methods commonly used in our clinic, which causes chronic pain and reduces the quality of life. To the best of our knowledge, no study in the English-language literature has explored comparing pain and functional outcomes of these three treatment modalities. In this prospective study, we aimed to compare the pain and functional results of CIs, ESWT, and KT treatment methods during a six-month follow-up and to determine the most effective treatment.

## PATIENTS AND METHODS

Ninety feet of 64 patients (11 males, 53 females; mean age: 38.3±10.4 years; range, 22 to 70 years) who applied to the orthopedics and traumatology outpatient clinic of the Harran University Faculty of Medicine due to PF between November 2021 and March 2022 were evaluated prospectively. The patients were divided into three groups that each included 30 feet: the CI group, the ESWT group, and the KT group. Randomization was achieved by assigning patients admitted to the orthopedics and traumatology outpatient clinic to a treatment group; the first admitted patient was included in the CI group, the second in the ESWT group, and the third in the KT group, which was repeated after three patients. Patients aged between 18 and 70, those previously diagnosed with PF, and patients who did not benefit from conservative treatment for at least six months, did not use anticoagulants, did not have bleeding disorders, and did not have a psychiatric disease were included in the study. Patients who had ESWT or CI treatment previously, were obese, had seronegative spondyloarthropathy, had tarsal tunnel syndrome, had peripheral neuropathy, had a foot-ankle deformity (e.g., pes cavus or pes planus), had a foot or ankle with a mass, had undergone foot or ankle surgery, and had degenerative arthritis around this area were excluded from the study.

Patients' age, sex, height, weight, and body mass index (BMI) were recorded. Patients were clinically evaluated before the treatment and at the six-week, three-month, and six-month follow-up visits. In the clinical evaluation, the American Orthopedic Foot and Ankle Society (AOFAS) score was used for functional assessment, and the Visual Analog Scale (VAS) was used for pain. The AOFAS score was evaluated over a total of 100 points (T-AOFAS): 40 points for pain (P-AOFAS), 50 points for function (F-AOFAS), and 10 points for alignment. The VAS was evaluated between 0 and 10 points, where 0 was no pain, and 10 was severe pain. Direct radiographs were taken to differentiate other foot and ankle pathologies and evaluate the alignment. None of the patients had malalignment.

In the CI group, 40 mg/mL methylprednisolone was applied from the inferomedial side of the heel to the most sensitive area of the medial calcaneus tubercle

of the plantar fascia.[19] The same physician performed two sessions once a week. No complications, such as fat pad necrosis, infection, or rupture, were observed in patients during the postinjection follow-up.

Extracorporeal shock wave therapy was performed by the same physician. The applicator was placed at the point of maximum sensitivity. Two thousand pulses at a frequency of 6 Hz and a pressure of 3 bar were applied to patients with an Auto Wave 695 (Mettler Electronics, Anaheim, CA, USA). Patients underwent two sessions of ESWT per week for two weeks, adding up to four sessions. Local or regional anesthesia was not administered to any patient during ESWT.

Different KT methods have been described for PF; however, the low-dye technique is the most emphasized and frequently applied due to the pathophysiology of PF.[17,20] This study preferred the low-dye KT as the banding method.[17,21] Kinesio taping was done with the Kinesio Tex tape (KinesioTaping, Albuquerque, NM, USA) to the affected extremity once a week for a total of four times by a physical therapy and rehabilitation physician. When utilizing low-dye KT, correction I and mechanical correction techniques were used on the area described by Kase et al.[16] (Figure 1).[17,21] The patient should be in the prone position, the foot and ankle in the neutral position, and the second toe and the cruris in the same line. In the first stage, the first I band starts from the distal fifth metatarsal and lies from the lateral side of the foot to the posterior of the heel. Here, the band is medialized and extended to the first metatarsal. A 50% tension is applied to the middle one-third of the band. In the second stage, four I tapes are placed on the lateral malleolus's lower end without stretching. The I bands were adhered to by applying 50% tension from lateral to medial; each of the four bands adhered to remain halfway through the previous band. Patients were advised to remove the tape in case of any side effects, such as skin irritation and allergic reaction. No side effects were observed in any patient.

**Figure 1.** Kinesiotape application.

Standard gastrocnemius and plantar fascia stretching and strengthening exercises were given to all patients at home during the follow-up. To stretch the plantar fascia, patients were asked to hold their heel with one hand to ensure the stability of the heel and to passively extend their toes with their other hand while sitting. Continuation of movement was requested until the tension of the plantar fascia was felt. To stretch the gastrocnemius, the patient was asked to flex the anterior knee and extend the posterior knee while keeping both heels on the ground. Afterward, they were told to bend forward until they felt a stretch on their posterior leg.[22] Rest was recommended on the first day after the injection. Patients were not given activity limitations, NSAIDs, orthoses, or splints.

### Statistical analysis

The IBM SPSS version 21.0 (IBM Corp., Armonk, NY, USA) was used to construct the databases and perform the statistical analysis. Demographic data were expressed as frequency and percentage (%). All data were evaluated for compliance with normal distribution. Age, BMI, VAS, and AOFAS data were analyzed by normality distribution analysis. The results of these data were given as mean, standard deviation, min, and max. Since the VAS and AOFAS data obtained from the questionnaire studies with BMI did not show normal distribution, they were evaluated with a nonparametric test. Since the age data showed normal distribution, it was evaluated with a parametric test. The Kruskal-Wallis test was used to compare the applied treatment method (CIs, ESWT, and KT) with BMI, VAS, and AOFAS. Analysis of variance was used to compare all three groups with age. In case of significant differences between the groups, the difference originated was determined by the Mann-Whitney U test. In the G-power analysis, the probability of error (significance level) was $\alpha=0.05$, and the impact magnitude was calculated as $1-\beta=0.94$. The Friedman test was used to evaluate the differences between the groups, and the adjusted significance p-value was given. There were no missing data. This

study's statistical significance level was accepted as p<0.05.

## RESULTS

Of the 64 patients included in the study, 26 (22 females, 4 males) had bilateral and 38 (31 females, 7 males) had unilateral PF. In the CI group, 86.36% were female (n=19), and 13.63% were male (n=3); in the ESWT group, 81.81% were female (n=18), and 18.18% were male (n=4); in the KT group, 80% were female (n=16), and 20% were male (n=4). In the CI group (n=22), the mean age was 37.1±9.1 (range, 22 to 52) years. In the ESWT group (n=22), the mean age was 37.3±10.9 (range, 23 to 70) years. In the KT group (n=20), the mean age was 40.4±11.2 (range; 22 to 65) years. There was no statistical difference between the groups in terms of age (p=0.385). The median BMI of all patients was 26.79 (interquartile range [IQR]: 24.22-28.67). The median BMI in the CI group was 27.3 (IQR: 24.21-28.57). In the ESWT group, the median BMI was 27.23 (IQR: 25.47-29.29). In the KT group, the median BMI was 26.14 (IQR: 23.16-28.23). There was no statistically significant difference between the groups in terms BMI (df: 2, p=0.155).

There was no difference in the VAS score between the groups at the baseline evaluation (p>0.338, Table 1). According to the P-AOFAS evaluation, the lowest score was in the CI group; however, the lowest score for the F-AOFAS assessment was in the KT group. The highest AOFAS score was in the ESWT group (Table 1). In bilateral cases, the patient received the same treatment on both feet.

At six weeks, there was a statistically significant difference between the groups regarding VAS and F-AOFAS (p<0.01, Table 1). Visual analog scale scores were statistically significantly lower in the CI group compared to the other two groups (p<0.001). When

**TABLE 1**
Comparative clinical results of the evaluation parameters before and after treatment of groups

| | Total feet (n=90) | CI (n=30) | ESWT (n=30) | KT (n=30) | |
|---|---|---|---|---|---|
| | Median-IQR | Median-IQR | Median-IQR | Median-IQR | *p** |
| Baseline | | | | | |
| VAS | 8-2 | 8-1 | 8-2 | 8-2 | 0.338 |
| P-AOFAS | 0-0 | 0-0 | 0-20 | 0-20 | 0.030 |
| F-AOFAS | 38-8 | 39-2 | 40-13 | 30-13 | <0.001 |
| T-AOFAS | 49-16 | 49-4 | 50-23 | 40-31 | 0.001 |
| 6th week | | | | | |
| VAS | 2-4 | 0-2 | 4-3 | 2.5-1 | <0.001 |
| P-AOFAS | 30-20 | 35-37 | 30-20 | 30-0 | 0.806 |
| F-AOFAS | 43-10 | 43-13 | 50-10 | 42-5 | 0.025 |
| T-AOFAS | 83-28 | 88-23 | 90-23 | 82-5 | 0.666 |
| 3rd month | | | | | |
| VAS | 2-3 | 2-3 | 0-3 | 2-1 | 0.311 |
| P-AOFAS | 30-10 | 30-10 | 40-13 | 30-0 | 0.076 |
| F-AOFAS | 50-7 | 50-7 | 50-6 | 43-8 | 0.005 |
| T-AOFAS | 90-17 | 90-17 | 100-19 | 83-8 | 0.006 |
| 6th month | | | | | |
| VAS | 2-3 | 2-4 | 0-3 | 2-1 | 0.026 |
| P-AOFAS | 30-10 | 30-10 | 40-13 | 30-0 | 0.008 |
| F-AOFAS | 50-8 | 50-7 | 50-6 | 42-10 | 0.004 |
| T-AOFAS | 90-19 | 90-17 | 100-19 | 82-11 | 0.003 |

CI: Corticosteroid injection; ESWT: Extracorporeal shock wave therapy; KT: Kinesio taping; IQR: Interquartile range; VAS: Visual Analog Scale; P-AOFAS: American Orthopaedic Foot and Ankle Society pain score; F-AOFAS: American Orthopaedic Foot and Ankle Society functional score; T-AOFAS: American Orthopaedic Foot and Ankle Society total score; * Kruskal Wallis test. Significance: 6th week VAS: CI-ESWT, KT; KT-ESWT and F-AOFAS: KT-ESWT. 3th month F-AOFAS: KT-ESWT, CI and T-AOFAS: KT-ESWT, CI. 6th month VAS: KT-ESWT and all AOFAS parametries KT-CI, ESWT.

**TABLE 2**
The VAS score before and after treatment in all groups

| | Baseline | | | 6th week | | | 3rd-month | | | 6th-month | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean±SD | Median | Q1-Q3 | Mean±SD | Median | Q1-Q3 | Mean±SD | Median | Q1-Q3 | Mean±SD | Median | Q1-Q3 | *p** |
| Corticosteroid injection | 8.03±0.96 | 8 | 8-9 | 1.17±1.78 | 0 | 0-2 | 2.13±1.8 | 2 | 0-3 | 2.07±2.13 | 2 | 0-4 | <0.001 |
| ESWT | 7.60±1.4 | 8 | 7-9 | 4.10±2.45 | 4 | 2-5.25 | 1.93±2.87 | 0 | 0-3.25 | 1.37±2.22 | 0 | 0-2.5 | <0.001 |
| Kinesio taping | 7.63±1.21 | 8 | 6.75-9 | 2.60±1.47 | 2.5 | 2-3 | 1.93±1.36 | 2 | 1.5-2.25 | 2.27±1.11 | 2 | 2-3 | <0.001 |

VAS: Visual Analog Scale; SD: Standard deviation; Q: Quartile; ESWT: Extracorporeal shock wave therapy; * Friedman test; CI: Baseline-follow ups. ESWT: Baseline-follow ups; 6th week-3rd month, 6th month and KT: Baseline-follow ups.

**TABLE 3**
The P-AOFAS score before and after treatment in all groups

| | Baseline | | | 6th week | | | 3rd-month | | | 6th-month | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean±SD | Median | Q1-Q3 | Mean±SD | Median | Q1-Q3 | Mean±SD | Median | Q1-Q3 | Mean±SD | Median | Q1-Q3 | *p** |
| Corticosteroid injection | 1.33±5.07 | 0 | 0-0 | 25.23±17.57 | 35 | 2.75-40 | 32±6.64 | 30 | 30-40 | 33.67±6.14 | 30 | 30-40 | <0.001 |
| ESWT | 6.67±9.58 | 0 | 0-20 | 27.33±12.01 | 30 | 20-40 | 34.33±8.58 | 40 | 27.5-40 | 34.67±8.60 | 40 | 27.5-40 | <0.001 |
| Kinesio taping | 6±9.33 | 0 | 0-20 | 30.33±5.56 | 30 | 30-30 | 31.33±5.07 | 30 | 30-30 | 30.67±3.65 | 30 | 30-30 | <0.001 |

P-AOFAS: American Orthopaedic Foot and Ankle Society pain score; SD: Standard deviation; Q: Quartile; ESWT: Extracorporeal shock wave therapy; * Friedman test; CI: Baseline-follow ups. ESWT: Baseline-follow ups; 6th week-3rd month, 6th month and KT: Baseline-follow ups.

**TABLE 4**
The F-AOFAS score before and after treatment in all groups

| | Baseline | | | 6th week | | | 3rd-month | | | 6th-month | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean±SD | Median | Q1-Q3 | Mean±SD | Median | Q1-Q3 | Mean±SD | Median | Q1-Q3 | Mean±SD | Median | Q1-Q3 | *p** |
| Corticosteroid injection | 39.03±2.67 | 39 | 38-39.75 | 42.77±8.11 | 43 | 36.75-50 | 47.23±4.05 | 50 | 43-50 | 46.03±6.40 | 50 | 43.25-50 | <0.001 |
| ESWT | 41.6±7.7 | 40 | 37.5-50 | 46.37±5.3 | 50 | 40-50 | 47.03±5.24 | 50 | 43.75-50 | 47.03±5.24 | 50 | 43.75-50 | <0.001 |
| Kinesio taping | 30.4±6.5 | 30 | 24-37 | 41.97±5.47 | 42 | 39.5-44 | 44.23±4.04 | 43 | 42-50 | 43.1±4.88 | 42 | 38.75-48.5 | <0.001 |

F-AOFAS: American Orthopaedic Foot and Ankle Society functional score; SD: Standard deviation; Q: Quartile; ESWT: Extracorporeal shock wave therapy; * Friedman test; CI: Baseline- follow ups. ESWT: Baseline-follow ups; 6th week-3rd month, 6th month and KT: baseline-follow ups.

**TABLE 5**
The T-AOFAS score before and after treatment in all groups

| | Baseline | | | 6th week | | | 3rd-month | | | 6th-month | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean±SD | Median | Q1-Q3 | Mean±SD | Median | Q1-Q3 | Mean±SD | Median | Q1-Q3 | Mean±SD | Median | Q1-Q3 | *p** |
| Corticosteroid injection | 50.37±6.07 | 49 | 48-52 | 79.07±23.66 | 88 | 50-100 | 89.9±9.61 | 90 | 83-100 | 89.37±11.03 | 90 | 82.75-100 | <0.001 |
| ESWT | 58.23±13.39 | 50 | 48-71 | 83.70±16.19 | 90 | 73.75-96.25 | 91.37±13.62 | 100 | 81.25-100 | 91.03±15.21 | 100 | 81.25-100 | <0.001 |
| Kinesio taping | 46.4±14.38 | 40 | 34-64.75 | 82.3±10.28 | 82 | 79.5-84.75 | 85.9±7.3 | 83 | 82-90 | 83.77±7.03 | 82 | 78.75-90 | <0.001 |

T-AOFAS: American Orthopaedic Foot and Ankle Society total score; SD: Standard deviation; Q: Quartile; ESWT: Extracorporeal shock wave therapy; * Friedman test; CI: Baseline- follow ups. ESWT: Baseline-follow ups; 6th week-3rd month, 6th month and KT: baseline-follow ups.

KT and ESWT were compared, it was observed that VAS scores were statistically significantly lower in the KT group (p=0.007). In the KT group, F-AOFAS scores were lower than in the other groups (p=0.025). When KT and ESWT were compared, it was observed that the F-AOFAS score was statistically significantly lower in the KT group (p=0.005).

In the third month, there was a significant difference between F-AOFAS and T-AOFAS scores according to the treatment method (p<0.01, Table 1). The F-AOFAS score was statistically significantly lower in the KT group compared to the ESWT and CI groups (p=0.014 and p=0.002, respectively). In addition, the T-AOFAS value was statistically significantly lower in the KT group compared to the ESWT and CI groups (p=0.005 and p=0.021, respectively).

When treatment methods were compared in the sixth month, all parameters showed a significant difference (p<0.05, Table 1). Visual Analog Scale scores were statistically significantly higher in the KT group compared to the ESWT group (p=0.003). The P-AOFAS score was statistically lower in the KT group compared to the CI and ESWT groups (p=0.017 and p=0.004, respectively). The F-AOFAS score was statistically lower in the KT group compared to the CI and ESWT groups (p=0.014 and p=0.003, respectively). The T-AOFAS score was statistically lower in the KT group compared to the CI and ESWT groups (p=0.013 and p=0.002, respectively).

A statistically significant improvement was observed in VAS and AOFAS scores at six weeks, three months, and six months in all three treatment modalities compared to the preoperative period (p<0.001). There was a statistically significant difference in VAS and AOFAS scores measured over time in all groups (p<0.001, Tables 2-5).

## DISCUSSION

Chronic PF is a common problem among physicians dealing with podiatry, and many methods have been proposed for its treatment. This article is one of the few studies comparing the pain and functional results of ESWT, CIs, and KT, three different treatment modalities commonly used in the treatment of PF.[7-9] In the final results of the study, all three treatment methods had positive effects on recovery; however, ESWT, which is a noninvasive method in the long term, was more significant in terms of improvement in pain and functional scores.

Corticosteroid injections were beneficial in the treatment of chronic PF for less than four weeks; however, conflicting results have been reported for platelet-rich plasma, dextrose prolotherapy, and ESWT.[1] Our study showed that the most significant improvement in VAS scores at week six was in the CI group. Porter and Shadbolt[11] reported that the VAS scores of the CI group were better in the third month than the ESWT group, and there was no difference between the groups at the end of the 12$^{th}$ month. In addition, in the same study, it was underlined that corticosteroid treatment should be preferred primarily because of the higher cost of ESWT. In a study by Erden et al.,[23] in which they compared the VAS scores of CI and ESWT, they showed that pretreatment improvement was increased in both groups in the one-month, three-month, and six-month controls; however, the VAS score was higher in the CI group than in the ESWT group. In our study, the improvement in VAS and AOFAS scores at extended follow-up was more prominent in the ESWT group. In the study by Mishra et al.,[19] which evaluated only the VAS results, there was a significant difference in favour of the CI group in the sixth week. However, they reported a significant increase in patients with severe pain in the CI group compared to the ESWT in the sixth month. In two studies, the CI was more effective in the first three months, but they stated that there was no significant difference compared to ESWT.[24,25] Similarly, in our study, there was no difference between the groups in terms of VAS in the three-month control; however, functional improvement was less in the KT group than in the other groups. Li et al.[26] reported no difference in ESWT and CI VAS scores at 12 months and that the two groups had similar function results in the follow-up period. Similarly, there was no difference in the VAS and AOFAS scores in the CI and ESWT groups at the six-month follow-up in our study. However, VAS scores were significantly higher in the KT group, and the AOFAS score was lower than in the other groups. Similar to our study, in a study evaluating the effectiveness of eight different treatment methods (NSAIDs, CIs, autologous whole blood, platelet-rich plasma, ESWT, ultrasound therapy, botulinum toxin A, and dry needling) in PF with the VAS score, the optimum treatment method was ESWT.[27]

Grady et al.[28] compared the VAS and AOFAS scores in the sixth month between the ESWT and CI groups. According to their study, while there was a significant difference in favour of the ESWT group

in VAS scores at the end of the sixth month, there was no significant difference in AOFAS scores. In our study, while there was an improvement in VAS and AOFAS scores in all groups at the end of the sixth month, the most significant improvement was in ESWT. Xu et al.[10] compared the effect of ESWT and CI and reported that patients had better foot function index scores with ESWT in the third and sixth months, and there was a significant difference between the two groups. In addition, there was a difference in favor of ESWT in pain scores in the early period, contrary to many studies.[29] A total of 51 studies were included in a systematic review, and it was reported that ESWT was the best treatment method for PF in the short, medium, and long term.[30] We found that although CI was more effective in relieving pain in the short term, ESWT was more effective at six months. In addition, AOFAS scores were higher in the short, medium, and long term of ESWT. The fact that it has fewer complications and is more effective in relieving pain in the long term makes ESWT more effective in the treatment of PF.

Corticosteroid injections have been shown to increase the risk of plantar fascia rupture, fat pad atrophy, and osteomyelitis of the calcaneus.[11-14] In our study, there were no complications in any of the patients. However, in the treatment of PF, care should be taken when choosing corticosteroids due to the long-term decrease in the effectiveness of corticosteroids and their complications.

The success of ESWT may vary depending on intensity, pulse cycle, and modalities. However, there is no consensus in the literature on the amount of energy applied and frequency of use in ESWT.[7,26,31] In our clinic, we routinely apply ESWT to patients with Auto Wave 695 at a frequency of 6 Hz and a pressure of 3 bar with 2000 pulses.

We could not find any article reporting the long-term results of KT in the literature. In the study by Ordahan et al.,[32] in which they shared the fifth-week results of ESWT and KT, they could not find any difference between the two groups in VAS and foot and ankle outcome scores. A systematic review reported that KT relieves pain in less than one week.[31] Tezel et al.[33] reported a significant difference in favor of KT in the foot function index scores of the patients six weeks after the treatment; however, there was no statistical difference in VAS and SF-36 (36-Item Short Form Survey) scores. In these studies, KT was reported to be effective, but the follow-up period of the studies was short. In addition, it varies depending on the experience of the physician applying KT and patient compliance. We found that KT improved VAS and functional scores at the end of six months compared to pretreatment, but its effectiveness was less than CI and ESWT. We believe KT, a noninvasive method, can be safely applied in patients unsuitable for ESWT and CI.

Excessive pressure on the plantar fascia and repetitive microtraumas cause PF, a degenerative pathology.[2,3] In conjunction with degeneration, there is a decrease in circulation, an increase in fibroblasts, and a decrease in angiogenesis. In our study, we used CIs, ESWT, and KT to prevent factors that contribute to the development of PF and prevent healing. Corticosteroid injection reduces pain thanks to its anti-inflammatory properties, inhibiting fibroblast proliferation, and protein expression.[22] Extracorporeal shock wave therapy, another frequently used treatment method, induces tissue regeneration and angiogenesis in the plantar fascia.[22] Kinesio taping elevates the skin and subcutaneous tissues, reduces the pressure on the plantar fascia, provides an area for lymphatic drainage and facilitates circulation. Thus, removing the stress on the plantar fascia accelerates healing and reduces pain.[32,33] We believe that CI, ESWT, and KT limit the factors that contribute to the development of PF and impair healing, albeit with different mechanisms. As a result, we observed improvement in pain and functional scores from baseline at six months in all three treatment modalities.

There are several limitations of this study. First, this study included a few patients due to the exclusion and inclusion criteria. Second, we included bilateral cases in the study; therefore, we randomized patients in the study, not their feet. Since we believe that applying different treatments to a patient with bilateral complaints may increase the patient's anxiety and prevent objective evaluation, evaluating other treatments in one person will reduce patient compliance. Third, the success of ESWT may vary depending on intensity, pulse cycle, and modalities,[7] and there may be different results in ESWT applications at different frequencies and intensities. Another limitation is that KT varies depending on the physician's experience and patient compliance. In this study, patient follow-up was six months; longer follow-ups are needed to evaluate treatment efficacy.

In conclusion, if pain and functional limitation continue despite receiving physical therapy in the treatment of chronic PF, three commonly used

treatment methods, ESWT, CIs, and KT, are effective in reducing pain and increasing function. Although CIs appear more effective in relieving pain in the early period, ESWT provides a better improvement in six months.

**Ethics Committee Approval:** The study protocol was approved by the Harran University Clinical Research Ethics Committee (date: 04.10.2021, no: HRU/21.17.30). This study was registered at ClinicalTrials.gov (NCT05647291). The study was conducted in accordance with the principles of the Declaration of Helsinki.

**Patient Consent for Publication:** A written informed consent was obtained from each patient.

**Data Sharing Statement:** The data that support the findings of this study are available from the corresponding author upon reasonable request.

**Author Contributions:** Idea/concept and design: Ö.O, B.S.; data collection and/or processing: Ö.O., H.A., M.A.D.; analysis and/or interpretation: Ö.O.; control/supervision: B.S., M.A.A.; literature review and writing the article: Ö.O., H.A.; critical review: B.S., M.A.A.; references and fundings: Ö.O., H.A.; materials: Ö.O, H.A., M.A.D.

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