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Original Article

Comparison of the effectiveness of peloid therapy and kinesiotaping in patients with unilateral plantar fasciitis: A prospective, randomized controlled study

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ABSTRACT

Objectives: This study aimed to compare the efficacy of peloid therapy and kinesiotaping for unilateral plantar fasciitis (PF).

Patients and methods: In the randomized controlled study, a total of 114 patients (89 females, 25 males; mean age: 45.1±8.3 years; range, 27 to 65 years) diagnosed with unilateral PF between January 2021 and March 2023 were randomly divided into three equal groups: the peloid group (peloid therapy and home-based exercise + heel pad), the kinesiotaping group (kinesiotaping and home-based exercise + heel pad), and the control group (home-based exercise + heel pad). Peloid therapy was performed over two weeks for a total of 10 sessions. Kinesiotaping was applied four times over two weeks. Plantar fascia, calf, and Achilles stretching exercises and foot strengthening exercises were performed, and prefabricated silicone heel insoles were used daily for six weeks. Patients were evaluated three times with clinical assessment scales for pain, the Heel Tenderness Index, and the Foot and Ankle Outcome Score before treatment, at the end of treatment, and in the first month after treatment.

Results: Statistically significant improvements were observed for all parameters at the end of treatment and in the first month after treatment compared to the baseline in every group ($p<0.001$). No superiority was found between the groups.

Conclusion: Peloid therapy or kinesiotaping, given as adjuncts to home-based exercise therapy and shoe insoles in patients with unilateral PF, did not result in additional benefits.

Keywords: Exercise therapy, foot orthoses, kinesio tape, mud therapy, peloid therapy, plantar fasciitis

The plantar fascia is a connective tissue band that connects the heel (calcaneus) to the base of the toes, supports the foot arch, and acts as a shock absorber in the foot biomechanics. Plantar fasciitis (PF) is an inflammatory and degenerative foot condition. It is the most common cause of adult-acquired inferior calcaneal heel pain, often induced by micro-tears and chronic periostitis of the medial calcaneal tubercle due to repetitive microtrauma.[1] Its etiology is multifactorial, and the cause remains unclear in many cases. Some predisposing factors are obesity, aging, pes planovalgus, excessive pronation, pes cavus, heel pad atrophy, a tight Achilles tendon, prolonged standing, long-distance running, ballet dancing, and seronegative spondyloarthropathies.[2,3] Plantar fasciitis is prevalent among individuals aged 40 to 60, and it is more common in females. It affects approximately 10% of the overall population and is associated with limitations in daily activities and decreased quality of life.[4,5]

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The first-line treatment for PF is conservative management. Surgery is the last and very rare option and may include open or endoscopic fasciotomy in patients resistant to conservative approaches. Conservative therapy includes rest, modification of daily life activities, local cold application, foot orthoses (arch supports, heel pads, and night splints), gastrocnemius and plantar fascia stretching exercises, medication (topical or oral nonsteroidal anti-inflammatory drugs, and paracetamol), specific manual techniques (deep friction massage and myofascial release), kinesiotaping (KT), physical therapy modalities (therapeutic ultrasound, extracorporeal shock-wave therapy, paraffin, laser therapy, and peloid therapy), and local injections (dry needling, steroids, platelet-rich plasma, dextrose prolotherapy, and botulinum toxin A).[6-8] The vast majority of patients with PF need to consult a physician, and about 90% of them achieve symptomatic cures within three to 12 months with these treatments.[3,6,7] Despite high-quality and extensive research, the superiority of conservative therapy options over each other continues to be discussed, and there remains no universally acknowledged standard treatment protocol.

Peloids are compounds formed over numerous years through biological, climatological, and geological processes and consist of inorganic and organic substances that can be used as semicolloid medical mud in a lot of medical fields. Recent randomized controlled trials (RCTs) showed the effectiveness of peloids in degenerative foot diseases (hallux rigidus and PF).[9,10] Kinesiotaping has been increasingly used for various musculoskeletal diseases, including PF. The application of KT involves various techniques, such as muscle inhibition and facilitation, mechanical correction, lymphatic correction, functional correction, and tendon techniques. It supports natural healing by expanding the subcutaneous space, reducing tissue inflammation and swelling, supporting lymphatic circulation, causing slight stretching of the underlying tissues, and reducing muscle tension without restricting joint movement or reducing proprioception.[11] Kinesiotaping reduces pain in PF by reducing subtalar pronation, supporting the arches of the foot, and decreasing tension in the plantar fascia.[12] The short-term beneficial effects of KT in the treatment of PF were demonstrated in some studies.[13-15] However, there is insufficient evidence to show the efficacy of KT and peloid therapy for the treatment of PF.[16] Additionally, there is no study in the literature comparing the efficacy of peloid therapy and KT, which are two safe and preferable treatment options, used as the first line in the management of symptomatic PF. Hence, this study aimed to compare the efficacy of peloid therapy and KT in terms of pain reduction, functional improvement, and quality of life for the conservative treatment of unilateral PF.

PATIENTS AND METHODS

This randomized controlled tertiary hospital-based study was conducted with 114 patients (89 females, 25 males; mean age: 45.1±8.3 years; range, 27 to 65 years) who applied to the Konya Beyhekim Training and Research Hospital, Physical Medicine and Rehabilitation Clinic, diagnosed with unilateral PF between January 2021 and March 2023. The diagnosis of PF was based on clinical guidelines associated with the International Classification of Function, Disability, and Health of the Orthopedic Section of the American Physiotherapy Association.[17] The inclusion criteria were patients ≥18 years old with a pain severity >3 according to the Visual Analog Scale (VAS) and previous heel pain lasting at least three months. Exclusion criteria were previous trauma or injuries, previous foot surgery, lumbar radiculopathy, rheumatic diseases, other causes of heel pain including foot fractures, instability, foot deformities (excluding mild asymptomatic hallux valgus), tarsal tunnel syndrome, a history of local steroid or PRP injections, current PF treatment (other physical therapy applications or medications), pregnancy, major psychiatric disorders, malignancy, and bilateral heel/foot pain. Patients were randomized into three equal groups (n=38 in each group) using the envelope method by an assistant unaware of the research: the peloid group (peloid therapy and home-based exercise + heel pad), the kinesiotaping group (kinesiotaping and home-based exercise + heel pad), and the control group (home-based exercise + heel pad). The sociodemographic characteristics (age, sex, body mass index, education level, marital status, and employment status) and clinical aspects (medical history, duration of complaints, and painful side) were recorded.

The peloid therapy group received a total of 10 sessions of peloid/mud therapy at 45°C for 30 min, five days a week for two weeks. Peloid therapy encompassed approximately 90% of the foot and ankle and was applied about 2 cm thickness on

the heel (Figure 1). After administration of peloid therapy, the foot was wrapped in stretch film and a thick cover to preserve heat. Following the end of the therapy, the peloid layer was removed and was not reused. The clay-like mud used for peloid therapy in this study is originally from Eskişehir, Türkiye. The peloid was blended with sodium chloride water at a spa facility in the Tuzla region of Istanbul and transformed into applicable mud packs. The mud is gray in color and odorless, the pH value is 8.47, and the total mineralization is 3,406.758 mg/L. Detailed chemical analysis of the peloid used in the present study is the same as peloid used in the study by Kasapoğlu et al.[18] for the treatment of hand osteoarthritis. In addition to peloid therapy, these patients were given a home exercise program and a prefabricated silicone heel pad, as in the control group.

Kinesio tape was applied to the second group by the same physiatrist a total of four times in two weeks (15 to 16 days), with tape left on for three days and removed one day before the next application. Standard 5-cm lengths of various colors of BB Kinesiology Tape (WETAPE Inc., Pyeongtaek, Korea) were used. Before the application, one strip was prepared in the form of a rake with a length of about 30 to 35 cm, cut longitudinally into four slices, and the other strip was prepared as an I tape with a length of about 15 to 20 cm. The ankle was in a neutral position of 90° during application. Calcaneal taping and mechanical correction techniques were applied (Figure 1).[15,19] In this application, the tape was applied from the insertion point to the origin point with submaximal (75%) tension while maintaining the taped joint in its functional position. The mechanical correction was applied from the posterior transverse arch to the levels of the lateral and medial malleolus, typically utilizing an I-shaped tape with moderate (50%) tension applied to the central portion of the band.[19] In accordance with the general principle, they were adhered to both the proximal and distal ends of each tape without applying tension.

A home-based exercise program and a prefabricated silicone heel pad were given to the control group. As exercises, plantar fascia stretching, Achilles tendon stretching, and calf stretching (two times per day, five repetitions for 30 sec each time), and plantar flexor and intrinsic muscle strengthening (double heel raise and towel curl exercises, two times per day, 10 repetitions each time) were given every day for six weeks. These same exercises were demonstrated practically by a physician, and a printed document describing the exercises visually was given to all patients. Participants with a compliance rate of less than 75% to the home-based exercise program and insole use were excluded from the study.

Figure 1. Peloid therapy and kinesiotaping applications.

Evaluation parameters

Participants in the study were evaluated three times with clinical assessment scales: before treatment, at the end of treatment (two weeks), and in the first month after treatment (six weeks). All participants were given brief information about the disease, and it was emphasized that they could continue with their usual activities of daily living. Until the study was completed, patients were firmly told not to take any medication or other treatment and only to take paracetamol 500 mg tablets every 6 to 12 h if needed. They were asked not to take any analgesics for a minimum of 24 h prior to all assessments, including the baseline assessment.

The VAS was employed to measure pain severity in the heel, with patients assessing their pain level using a 10-cm scale during weight-bearing activities. The VAS was chosen because it is an easily applicable and universally accepted global scale that can adequately reflect pain in PF and is used as the primary outcome of many trials on this subject.[20]

The sensitivity of the attachment site of the plantar fascia to the inferior calcaneus was evaluated by the researcher with the Heel Tenderness Index (HTI). The point of greatest sensitivity by pressing was noted: 0=no pain, 1=painful, 2=painful with a tendency to pull back, and 3=painful with the foot fully pulled back.[9]

The Foot and Ankle Outcome Score (FAOS) is a 42-item questionnaire that was developed to assess the patient's opinion about a variety of foot-related disorders, including PF.[21] The test consists of five subscales: pain, symptoms, function in daily living, function in sports and recreational activities, and quality of life. Each question has a Likert-type score ranging from 0 to 4. Scores range from 0 to 100 for each subscale. Higher scores indicate fewer complaints (100 indicating no symptoms, and 0 indicating

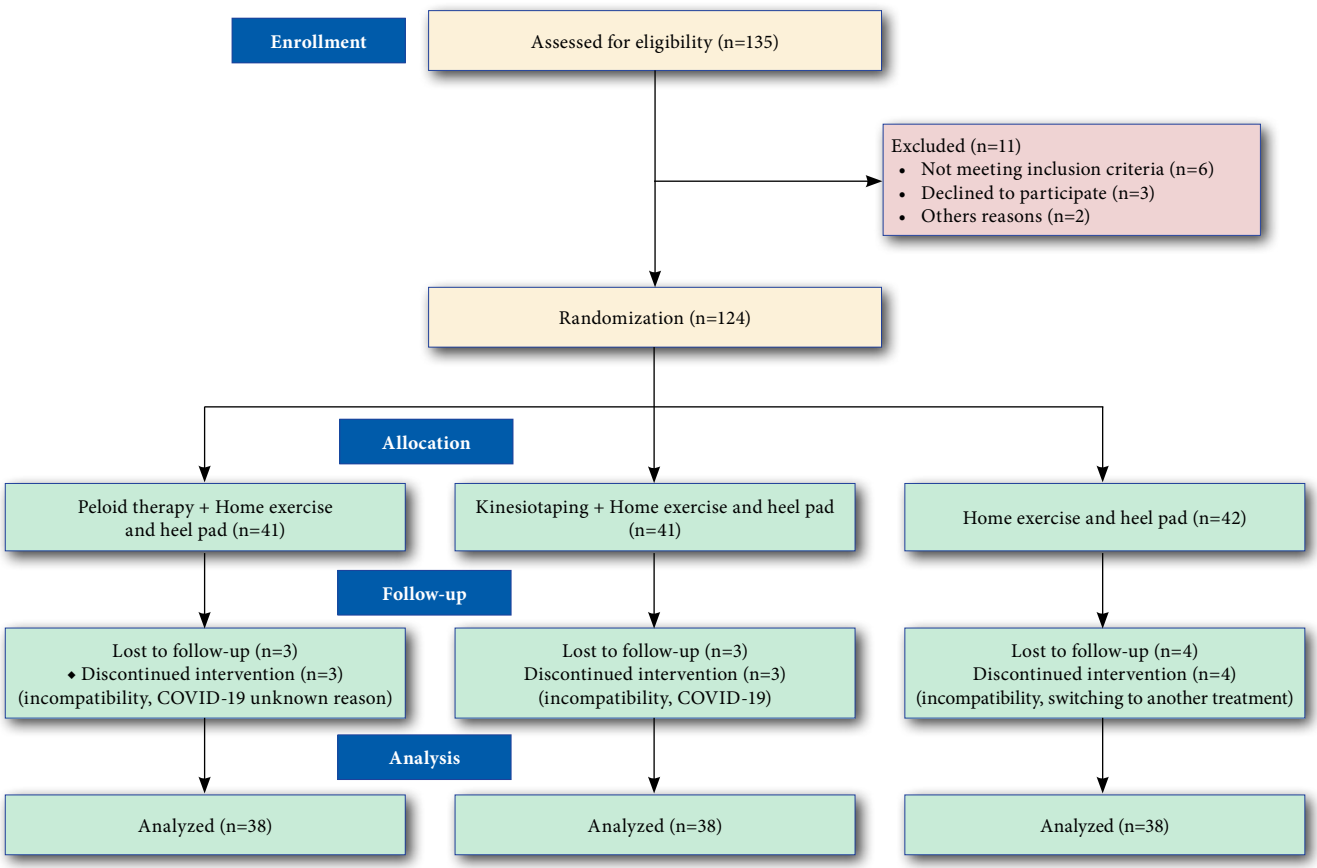

Figure 2. CONSORT flow diagram of the study.
COVID-19: Coronavirus disease 2019.

extreme symptoms). A validity and reliability study of the Turkish version of this questionnaire was conducted.[22]

Statistical analysis

Statistical analysis was performed using IBM SPSS version 22.0 software (IBM Corp., Armonk, NY, USA). The chi-square and Fisher exact tests were used to evaluate nonparametric categorical data. The Shapiro-Wilk test was used to determine whether the variables had normal distribution. The Kruskal-Wallis test or the one-way ANOVA (analysis of variance) was used to compare variables between three independent groups. Friedman test or repeated measures ANOVA with post hoc Bonferroni correction was used for repeated measurements at different times for intragroup comparisons. For intragroup measurements of two nonparametric dependent variables, the Wilcoxon signed-rank test was employed. The statistical significance level was set at $p<0.05$.

The G*Power version 3.1.9.4 (Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany) was used for power analysis in the study. Based on the literature review, considering the primary outcome of VAS pain value in this study, it was determined that a minimum of 33 patients per group should be included with an effect size of 0.3, an alpha of 0.05, and a power of 0.90.[9,10,12]

RESULTS

A total of 124 patients were randomized at baseline, and 114 patients completed the study. The study was completed with 38 patients in each group. No treatment-related side effects (discomfort, allergies, and wound development) were reported by the participants or observed during medical follow-up, and no patient discontinued the study for this reason. Figure 2 shows the flowchart for the study.

The mean symptom duration of the participants was 11.0±7.2 months (median: 9 months). There was no statistically significant difference between the groups regarding age, sex, body mass index, educational status, marital status, employment status, receiving analgesic/anti-inflammatory treatment before

TABLE 1
Baseline sociodemographic and clinical characteristics of the patients

	Group 1 (n=38) (Peloid therapy + exercise + heel pad)			Group 2 (n=38) (Kinesiotaping + exercise + heel pad)			Group 3 (n=38) (Exercise + heel pad)			
	n	%	Mean±SD	n	%	Mean±SD	n	%	Mean±SD	*p*
Age (year)			47.7±7.5			44.3±8.2			43.1±8.6	0.510[a]
Sex										0.514[b]
Female	32			29			28			
Male	6			9			10			
Body mass index (kg/m^2)			29.9±3.4			30.2±3.9			30.1±2.9	0.921[a]
Educational status										0.708[b]
Illiterate	1	2.6		3	7.9		4	10.4		
Primary school	20	52.6		18	47.4		16	42.2		
Junior high school	2	5.3		6	15.7		3	7.9		
High school	6	15.7		4	10.5		10	26.3		
University	9	23.7		7	18.5		5	13.2		
Marital status										0.367[c]
Married	35	92		38	100		36	95		
Single	3	8		-	-		2	5		
Employment										0.273[c]
Housewife	23	60.5		27	71		21	55.3		
Worker	15	39.5		10	26.3		17	44.7		
Retired	-	-		1	2.6		-	-		
Painful side										0.511[b]
Right	23	61		21	55		18	47		
Left	15	39		17	45		20	53		
Disease duration (months)			11.6±10.03			11.29±6.13			10.08±4.34	0.371[d]

SD: Standard deviation; a One-way ANOVA test; b Person's chi-square test; c Fisher exact test; d Kruskal Wallis test.

TABLE 2
Evaluation of patients' VAS-pain scores and HTI

Variables	Group 1 (Peloid therapy) Mean±SD	Median	Group 2 (Kinesiotaping) Mean±SD	Median	Group 3 (Control) Mean±SD	Median	Between-group analysis p^*
VAS-pain							
W0	7.79±1.19		7.61±1.13		7.11±1.11		0.058
W2	4.79±1.9		4.47±1.69		4.68±1.56		0.529
W6	4.42±2.09		3.97±1.52		4.24±1.24		0.510
P^a	<0.001		<0.001		<0.001		
p^b (w0-w2)	<0.001		<0.001		<0.001		
p^b (w0-w6)	<0.001		<0.001		<0.001		
p^b (w2-w6)	0.366		0.184		0.100		
W0-W2	−3.0±2.13		−3.13±1.91		−2.42±1.8		0.229
W0-W6	−3.37±2.03		−3.63±1.68		−2.87±1.6		0.165
W2-W6	−0.7±2.22		−0.5±1.9		−0.45±1.55		0.977
Heel Tenderness Index							
W0	1.95±0.46	2	1.79±0.66	2	1.87±0.41	2	0.352
W2	0.66±0.71	1	0.76±0.64	1	1.13±0.74	1	0.012
W6	0.63±0.67	1	0.71±0.57	1	0.92±0.67	1	0.131
P^a	<0.001		<0.001		<0.001		
p^b (w0-w2)	<0.001		<0.001		<0.001		
p^b (w0-w6)	<0.001		<0.001		<0.001		
p^b (w2-w6)	0.564		0.816		0.33		
W0-W2	−1.03±0.88		1.29±0.8		−0.74±0.79		0.11
W0-W6	−1.08±0.88		−1.32±0.87		0.94±0.77		0.97
W2-W6	−0.5±0.57		−0.27±0.79		−0.1+±0.58		0.31

VAS: Visual Analog Scale; HTI: Heel Tenderness Index; SD: Standard deviation; W0: Baseline; W2: At the end of treatment; W6: One month after treatment; W0-W2, W0-W6, W2-W6: Pre- and post treatment differences; * Kruskal Wallis test; a Friedman test; b Wilcoxon signed rank test; For the Heel Tenderness Index.

inclusion in the study, and duration of symptoms (Table 1).

There was a significant decrease in VAS-pain score and HTI in all three groups compared to pretreatment, at the end of treatment ($p<0.001$ for all), and at the six-week follow-up ($p<0.001$ for all, Table 2). To determine which of the treatment methods was more effective, the difference scores for all three groups were calculated and compared. There was no statistically significant difference in VAS-pain and HTI parameters in the second and sixth weeks (Table 2). Patients in the three groups had significant improvements for all subgroup scores on FAOS at the end of treatment ($p<0.001$ for all) and at the six-week follow-up ($p<0.001$ for all, Table 3). When the difference scores for the FAOS subgroup were calculated and compared, there was no statistically significant difference between the groups in the second and sixth weeks (Table 4). In all treatment groups, the improvement obtained at the end of treatment continued in the sixth week, and there was no significant superiority between the groups.

DISCUSSION

In the present study, in patients with unilateral PF, the home-based exercise program alone, the prefabricated heel pads, and additional peloid therapy or KT applications provided improvement in pain, functionality, and quality of life until one month after the end of treatment. No superiority was found in the evaluations between the groups.

In the literature, plantar fascia stretching exercises were shown to reduce pain and improve functional status. In a study involving 82 patients with chronic PF, patients given prefabricated soft insoles and a three-week course of celecoxib were compared with two different types of exercise.[23] Nonweight-bearing plantar fascia-specific stretching exercises were given to one group, and classical Achilles tendon stretching exercise was given to the other group. The plantar fascia-specific stretching exercise group was superior for pain, function, and patient satisfaction at the eight-week posttreatment evaluation. Later, this study was extended, and all patients were followed for two years by giving only plantar fascia-specific exercises.

A similar level of improvement was observed in all 66 patients who completed this follow-up period, including the patients included in the original Achilles tendon group from the first eight-week follow-up, and no significant difference was found between the groups.[24] While 94% of the patients reported a reduction in pain, 24% reported the need to consult a physician again.

TABLE 3
The evaluation of FAOS scores between groups and within groups

Variables	Group 1 (Peloid therapy) Mean±SD	Group 2 (Kinesiotaping) Mean±SD	Group 3 (Control) Mean±SD	Between-group analysis p^*
FAOS-symptoms				
W0	65.98±17.9	55.08±13.81	57.42±12.85	0.005
W2	82.52±12.56	76.69±11.91	75.66±12.72	0.037
W6	82.61±16.29	79.32±12.81	80.73±9.49	0.389
P^a	<0.001	<0.001	<0.001	
p^b (w0-w2)	<0.001	<0.001	<0.001	
p^b (w0-w6)	<0.001	<0.001	<0.001	
p^b (w2-w6)	0.665	0.642	0.094	
FAOS-pain				
W0	50.66±14.6	50.44±16.57	51.39±14.75	0.982
W2	69.15±16.27	69.66±15.03	69.30±14.6	0.968
W6	71.64±21.13	78.80±11.88	80.73±9.49	0.206
P^a	<0.001	<0.001	<0.001	
p^b (w0-w2)	<0.001	<0.001	<0.001	
p^b (w0-w6)	<0.001	<0.001	<0.001	
p^b (w2-w6)	0.282	<0.001	0.003	
FAOS-adl				
W0	52.17±16.16	56.08±15.97	57.93±13.75	0.414
W2	72.64±18.81	76.74±13.58	76.08±13.0	0.804
W6	80.03±14.25	82.89±8.37	83.01±7.79	0.842
P^a	<0.001	<0.001	<0.001	
p^b (w0-w2)	<0.001	<0.001	<0.001	
p^b (w0-w6)	<0.001	<0.001	<0.001	
p^b (w2-w6)	<0.001	0.054	0.009	
FAOS-sport				
W0	31.18±20.22	25.26±24.24	30.53±24.79	0.270
W2	52.90±23.98	54.34±21.69	55.92±21.49	0.786
W6	54.61±27.17	63.68±19.92	63.18±16.82	0.138
P^a	<0.001	<0.001	<0.001	
p^b (w0-w2)	0.003	<0.001	<0.001	
p^b (w0-w6)	<0.001	<0.001	<0.001	
p^b (w2-w6)	0.738	0.084	0.171	
FAOS-QoL				
W0	30.32±20.71	21.71±14.37	25.0±14.31	0.061
W2	53.95±23.22	47.53±19.58	47.04±21.0	0.387
W6	66.78±15.18	62.34±16.98	63.98±14.85	0.801
P^a	<0.001	<0.001	<0.001	
p^b (w0-w2)	<0.001	<0.001	<0.001	
p^b (w0-w6)	<0.001	<0.001	<0.001	
p^b (w2-w6)	<0.001	<0.001	<0.001	

FAOS: Foot Ankle Outcome Score; SD: Standard deviation; adl: Activities of daily living; sport: Function, sports and recreational activities; Qol: Quality of life; W0: Baseline; W2: At the end of treatment; W6: One month after treatment; W0-W2, W0-W6, W2-W6: Pre- and posttreatment differences; * Kruskal Wallis test; a Friedman test; b Wilcoxon signed rank test.

TABLE 4
Comparison of the FAOS difference scores between the groups

Variables	Group 1 (Peloid therapy) Mean±SD	Group 2 (Kinesiotaping) Mean±SD	Group 3 (Control) Mean±SD	Between-group analysis p^*
FAOS-symptoms				
W0-W2	16.54±16.24	21.62±11.17	18.23±11.07	0.241
W0-W6	16.64±19.41	24.25±14.9	23.31±13.25	0.147
W2-W6	0.094±13.61	2.63±13.53	5.076±13.76	0.268
FAOS-pain				
W0-W2	18.5±15.93	19.23±12.26	17.91±12.20	0.908
W0-W6	20.98±20.03	28.36±15.08	27.78±15.30	0.203
W2-W6	2.49+14.1	9.14±13.48	9.87±14.72	0.164
FAOS-adl				
W0-W2	20.47±15.31	20.67±14.06	18.15±14.5	0.628
W0-W6	24.11±18.40	26.82±14.35	25.08±14.08	0.723
W2-W6	3.64±18.08	6.15±13.77	9.93±13.26	0.589
FAOS-sport				
W0-W2	21.71±30.81	29.08±21.43	25.39±17.99	0.121
W0-W6	23.42±36.21	38.42±25.47	32.62±24.52	0.049
W2-W6	1.71±26.92	9.34±21.53	7.24±23.12	0.165
FAOS-QoL				
W0-W2	22.37+29.26	25.82±18.22	22.04±18.31	0.547
W0-W6	35.20+23.27	40.63±18.48	38.98±17.46	0.613
W2-W6	12.83+25.54	14.80±20.47	16.94±19.97	0.586

FAOS: Foot Ankle Outcome Score; adl: Activities of daily living; sport: Function, sports and recreational activities; Qol: Quality of life; W0: Baseline; W2: At the end of treatment; W6: One month after treatment; W0-W2, W0-W6, W2-W6: Pre- and posttreatment differences; * Kruskal-Wallis test.

In an RCT evaluating the effect of stretching and strengthening exercises on pain and temporospatial gait parameters in PF patients, 84 PF patients were randomized into a stretching exercise group and strengthening exercise group.[25] A total of eight sessions of therapeutic ultrasound, manual mobilization, and plantar fascia stretching were applied to all patients twice a week for four weeks. At the end of four weeks, patients were followed up for two months with a stretching or strengthening home exercise program. The patients were evaluated by VAS with the worst pain and morning pain levels and temporospatial gait parameters. Both strengthening and stretching exercises reduced pain and improved gait parameters, and there was no superiority between the groups in terms of all evaluation parameters. In a clinical study of 20 people evaluating the results of three-week home-based stretching exercises in PF patients, exercise reduced pain and increased muscle strength of both extrinsic and intrinsic foot muscles.[26] In a recent systematic review and meta-analysis evaluating the effect of calf stretching and plantar fascia-specific stretching exercises in PF patients, plantar fascia stretching exercises reduced VAS-pain scores with moderate to very low quality evidence.[27] In addition, in this systemic review and meta-analysis, it was concluded that plantar fascia-specific stretching was more effective than calf stretching, and the need for stronger evidence was emphasized. Both calf stretching and plantar fascia-specific stretching and strengthening exercises were given to all three treatment groups in our study, which is consistent with previous studies, and a decrease in pain and an increase in functionality and quality of life were identified. The similar improvement in the control and active treatment groups is considered to be due to the increased effectiveness of exercise therapy due to the combination of two different stretching and strengthening exercises in our study.

In a recent systemic review examining the efficacy of mechanical treatments in the treatment of PF, KT application was effective in the short term.[28] In a study evaluating the effect of low-dye taping on pain and stability in patients with PF, 30 patients with PF were divided into two equal groups. One group was given low-dye taping in addition to conservative physical therapy modalities (transcutaneous electrical nerve stimulation and infrared), while the other group was given only conservative physical therapy modalities.

In the taping group, the patients were treated three times a week for six weeks. Taping statistically significantly reduced pain, enhanced stability, and was superior to the conservative treatment group.[29] In an RCT that included 41 patients diagnosed with PF, the patients were divided into four groups of stretching of the plantar fascia, calcaneal KT, sham taping, and a control group with no treatment. Pain was evaluated with VAS, and functional activity was evaluated with the patient-specific functional scale at baseline and after one week of treatment.[30] In this study, which had a very short treatment and follow-up period, calcaneal taping was found to reduce pain more than other groups. In a recent pilot randomized controlled study published in 2022, 30 patients with PF were divided into KT and stretching exercise groups, and both KT and stretching exercise groups were compared with each other.[31] Visual Analog Scale-pain and foot disability levels of the patients were evaluated at baseline, immediately after the first treatment, and one week later. In the evaluation at the end of the first treatment, a reduction in pain was observed in all groups. An improvement in functionality was observed only in the group that received the combined treatment in the evaluation one week after treatment. The authors emphasized that these results should be supported by larger patient groups. In this study, which showed the KT application was effective, unlike the two mentioned studies, KT was applied for two weeks and was evaluated after a relatively longer follow-up. Our study suggests that giving home-based exercise and heel pads to all groups supports the efficacy of treatment in the active treatment groups. However, it should not be overlooked that the individual efficacy of these active treatments may be superimposed due to efficacy overlap.

Thermotherapeutic peloid agents are widely used for many musculoskeletal diseases and are often applied together with exercise or physical therapy.[32] Hand osteoarthritis,[18] gonarthrosis,[33] fibromyalgia syndrome,[34] chronic low back pain,[35] chronic neck pain,[36] lateral epicondylitis,[37] carpal tunnel syndrome,[38] and PF[10] are among the areas of use in treatment. Peloids may have antirheumatic and anti-inflammatory effects.[32] The sulfoglycolipids in their content absorbed through the skin play a role in the antirheumatic effect. The anti-inflammatory effect of sulfoglycolipids is associated with decreased serum interleukin (IL)-1 levels. In addition, thermal mud application increases protein synthesis and suppresses the inflammatory mediators leukotriene B4, prostaglandin E2, IL-1 beta, tumor necrosis factor-alpha, and thromboxane. Sulfur components, magnesium, manganese, iron, and humic acid are responsible for biological activity.[32,39] Repetitive sessions of hyperthermia provided by peloid therapy induce the heat shock response, cortisol increases, and extracellular heat-shock protein 72 decreases in circulation. This thermal stimulus can suppress the release of cytokines and proinflammatory mediators.[39]

The effectiveness of peloid therapy was investigated in a prospective, observational, nonrandomized study involving 80 patients with PF.[10] In addition to the heel pad, stretching exercises (plantar fascia and Achilles tendon) were given to the control group. In the peloid group, in addition to the treatments given to the control group, a total of 10 sessions of peloid were applied, 30 min per session, at 45°C for two weeks. Patients were evaluated with parameters of pain, function, and quality of life at baseline and after two weeks of treatment. Statistically significant improvements were observed for reduction in pain, and the improvement in activities of daily living in the peloid therapy group was found to be statistically superior to the control group. The results of our study are similar to the results of the previous study, but there was no difference between the groups. This could be due to the patients' high compliance with exercise and the use of the heel pad in our study, as well as the corresponding improvement that peloid therapy or KT can provide. It may also be due to the difference in the chemical content of the peloid used.

Mud/peloid therapy is a balneotherapy method frequently chosen for treating musculoskeletal diseases, similar to thermal mineral waters.[39,40] Studies show balneotherapy's usefulness for pain and osteoarthritis-related function loss, emphasizing its immune-modulating effects alongside its thermal impact.[40] Compared to other treatments, balneotherapy offers advantages such as minimal side effects, pleasant experience, safety, and improved quality of life. Additionally, it might reduce invasive interventions and analgesic drug use. However, strong evidence is needed regarding the effectiveness of balneotherapy. In this study, which is the first RCT about the efficacy of peloid therapy in PF as a degenerative and inflammatory disorder, peloid therapy was compared with KT, which is also safe, easily adopted by patients, and easily applicable as a treatment option. A similar level of clinical improvement was observed in all treatment groups, indicating that these conservative, noninvasive, and safe treatment

options can be recommended as conservative therapy for PF patients. At this point, decisions regarding treatment management can be made by considering the treatment facilities in the healthcare institution and patient preferences. However, the lack of additional benefit from peloid therapy or KT demonstrates that providing a well-structured home exercise program and insoles is sufficient for the initial conservative treatment approach in treatment-I patients.

The main limitations of the study are the lack of blinding and the absence of a placebo group. Although comparisons could be made with a sham control in studies about KT, creating a placebo-controlled group for peloid therapy and exercise could not be done due to technical and ethical concerns. However, if the active treatment groups were compared with a control group without exercise and heel pads, the pure efficacy of these treatments could be more clearly demonstrated. Other limitations of our study are the short follow-up period and the fact that plantar fascia thickness was not measured by ultrasound or magnetic resonance imaging. However, we believe that this limitation is not significant since advanced imaging is not required to guide the diagnosis or treatment of nontraumatic PF.[1] Despite all these limitations, the strengths of this study are that it was conducted in a tertiary center experienced in the rehabilitation of musculoskeletal diseases, in a patient group that was very selective in terms of inclusion and exclusion criteria, and that patient statements were questioned and recorded with an objective meticulousness. Another strength of the present study is that it is the first RCT comparing the effectiveness of peloid therapy and KT.

In conclusion, peloid therapy and KT can be recommended to patients as safe and effective options for the treatment of PF. However, in light of the results in the control group, only exercise therapy and a heel pad can be recommended for first-line conservative treatment. Randomized, placebo-controlled, blinded studies and randomized head-to-head studies with medium to long follow-up are needed to confirm the beneficial effects found in this study.

Ethics Committee Approval: The study protocol was approved by the Non-Pharmaceutical and Medical Devices Ethics Committee of KTO Karatay University (date: 15.12.2020, no: 2020/0010). 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.

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