Research article

Transverse frictional massage for plantar fasciitis: a clinical pilot trial

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Objectives: To test the feasibility of a clinical trial comparing the effects of transverse friction massage (TFM) and a home exercise programme (HEP) and a HEP alone in the treatment of plantar fasciitis.
Design: Prospective, non-blinded, different subject design experimental pilot study.
Setting: Physiotherapy clinic within a community health centre clinic.
Participants: Twenty-four participants (14 females) aged 43–77 years ($X = 58$), with plantar fasciitis of greater than 4 weeks duration.
Interventions: Six treatment sessions of TFM in the first 4 weeks for the experimental group together with a HEP for 6 weeks. The control group was given a HEP only for 6 weeks.
Main outcome measures: Visual Analogue Pain Scale (VAPS) and a Lower Extremity Functional Scale (LEFS) measured on assessment and every 2 weeks for 6 weeks.
Results: Subjects demonstrated a reduction in both outcome measures for pain at the end of the 6-week treatment ($P < 0.05$), but there was no statistically significant difference between the two groups. The outcome measures were found to be suitable for subjects with plantar fasciitis and the methodology appropriate for the research design chosen.
Conclusion: This study has demonstrated the feasibility of a clinical trial for the treatment of plantar fasciitis with TFM and a HEP. A retrospective power calculation suggests that recruitment of more than 274 patients would be required to achieve an 80% chance of a clinically significant difference being detected between these two groups ($\alpha = 0.05$). It is recommended that another pilot study with a longer follow-up is carried out first prior to any full-scale studies.

Keywords: Plantar fasciitis, Pilot study, Transverse friction massage, Home exercise programme

Introduction

Plantar fasciitis is a common and often disabling complaint and is estimated to account for up to 15% of all foot symptoms in adults.[1] It is one of the most frequent complaints of chronic rear foot heel pain seen by primary health care providers[2] and can often be a challenge for the therapist to treat successfully.[3] Transverse friction massage (TFM) has been cited as a possible treatment technique for plantar fasciitis but evidence is mostly anecdotal.[4–7]

Plantar fasciitis is usually a repetitive microtrauma overload injury of the attachment of the plantar fascia at the inferior aspect of the calcaneus.[8] Occasionally, plantar fasciitis occurs as part of an inflammatory arthropathy or spondylarthropathy, but this should be apparent on general assessment.

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The injury has been described as an enthesopathy of the origin of the plantar fascia due to excessive traction[9] causing partial tearing which leads to chronic inflammation.[10–12]

Plantar fasciitis is generally considered to be a self-limiting condition.[1,13,14] However, the time taken for the symptoms to resolve is highly variable[15] with patients taking anything between 6 and 18 months to recover.[4] Plantar fasciitis frequently responds to a broad range of conservative therapies,[2,9,16–19] the most common approach combining one or more types of treatments into a therapeutic regime.[20]

A tight Achilles tendon or contracted plantar fascia places increased stress on the inflamed fascia during gait[17] and is a predisposing factor for chronic plantar fasciitis.[2] Stretching of the calf muscle and plantar fascia and strengthening of the intrinsic muscles of the foot[16,17,20] are two simple treatments for plantar fasciitis. TFM is a specific type of connective tissue massage applied precisely to the soft-tissue structures.[21–23]

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The use of TFM in the treatment of plantar fasciitis has not been previously tested. The aim of this pilot study was to test the feasibility of a randomized clinically controlled trial comparing the effects of adding TFM to a standard home exercise programme (HEP) in the treatment of plantar fasciitis.

Design

This research was a prospective non-blinded, different-subject design experimental pilot study that examined the relationship between TFM and a HEP in the treatment of plantar fasciitis. The aim was to analyse the relationship, identify possible pit-falls and difficulties, and lay the groundwork for a future larger randomized controlled trial.

Sample selection

Subjects who on assessment were diagnosed with plantar fasciitis and satisfied the set inclusion and exclusion criteria (Table 1) were admitted to this research study.

Plantar fasciitis was confirmed if the subjects had pain in the inferior aspect of the heel, particularly aggravated when taking the first steps after sleep or when rising from sitting to standing after more than an hour.[1,15,18,24–27]

Randomization

Following informed consent subjects were then assigned to an experimental (Group E) or control (Group C) group in a sequential order starting with the experimental group.

Setting

The study was undertaken at one of the Physiotherapy Clinics situated within the Primary Health Care Department, Malta.

Table 1 Inclusion and exclusion criteria for study

Inclusion criteria	Exclusion criteria
Age >18 years	Signs and symptoms of systemic inflammatory disease
Duration of symptoms >4 weeks	Malignant disease
Diagnosis of plantar fasciitis	Immunosuppressed patient
Signed informed consent form	Neurological signs
	Lower-limb symptoms from a lumbar spine lesion
	Previous heel surgery
	Heel injected in the last 6 months
	Signs and symptoms of local arthritis
	Nerve entrapment syndrome in heel/ankle
	Infection in foot/ankle
	Pregnant
	On oral steroids
	On oral antibiotics
	On anticoagulants

Interventions

Home exercise programme

All subjects received a standard protocol of treatment consisting of a HEP. This HEP was clearly explained on the first assessment (Week 0) (Fig. 1) and a printed sheet outlining the exercises was given to each participant. These exercises consisted of stretching exercises for the calf muscle and the plantar fascia and strengthening exercises for the intrinsic muscles of the foot.

The subjects were asked to perform a non-weight-bearing calf muscle stretch in lying and were asked to apply the stretch *before* putting their feet on the ground and weight-bearing after sleep. This stretch was applied with the leg of the painful side extended and the contra lateral leg held in a comfortable position. The subjects were instructed to hold each end of a towel and place it around the ball of the foot and while holding the subtalar joint in neutral pull the towel towards the trunk until slight discomfort was noted in the posterior calf. The stretch was held for 30 seconds with three repetitions on each leg and the whole process repeated three times everyday.[5,28–30]

The previous calf muscle stretch was followed by another non-weight-bearing stretch applied in sitting *before* the subject put any weight on the leg. Subjects

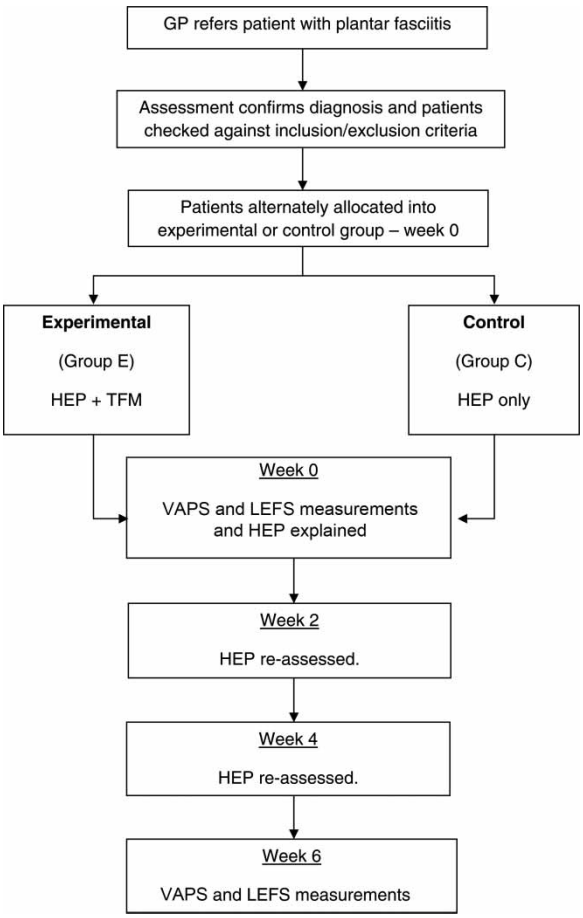

Figure 1 Flowchart describing management of subjects.

were instructed to cross the affected leg over the contra-lateral leg and using the hand on the affected side pull the toes backwards towards the shin until a stretch was felt in the arch of the foot. They were asked to hold the stretch for 30 seconds and to repeat the stretch three times with three repetitions per day.[11,31]

Towel curls and toe tapping exercises were given to strengthen the intrinsic muscles of the foot which lie proximal to the plantar fascia. Subjects were asked to apply the toe curl exercise for ten times each leg and the toe tapping exercise for 5 minutes in total. These strengthening exercises were done once daily for the total duration of the study, i.e. 6 weeks.

Additionally, the subjects were told to apply ice for 10 minutes three times daily after stretching exercises. The HEP was re-assessed at Week 2 and Week 4.

Transverse friction massage

The experimental group received an additional treatment consisting of TFM. The frictions were applied by manual pressure directly to the origin of the plantar fascia using a repetitive back-and-forth motion, transversely across the affected structure with adequate sweep to cover the affected area and sufficient depth to produce mechanical stretching of the underlying structure.[32,33] The patient was positioned in half-lying and the great toe kept in dorsiflexion throughout the application so as to maintain a stretch to the plantar fascia (Fig. 2).

The experimental group received six sessions of TFM during the first 4 weeks of treatment with a minimum interval of 48 hours between treatment sessions.[33,34]

Study procedure

The assessments and treatments on all the subjects in the study were carried out by the author who is a senior physiotherapist and a member of the Society of Orthopaedic Medicine. In the event that a patient had bilateral plantar fasciitis, both heels were given the same identical treatment, but data were only collected from the most painful side that was as stated by the patient on the first assessment. The protocol for this pilot study gained ethical approval from the Institute of Health Care Research Ethics Committee, University of Malta.

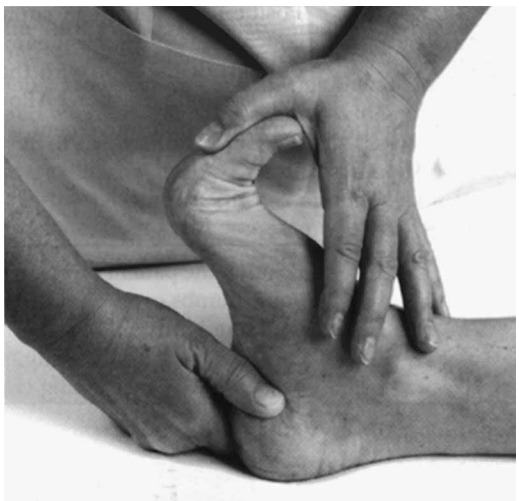

Figure 2 TFM of the plantar fascia.
Source: **Kesson and Atkins.[33]**

Data collection

Demographic data consisted of age, gender, weight, height, affected side, and duration of symptoms. Subjects were also asked about any relevant past medical history, current pain relieving medication, and any previous treatment.

The objective measurements consisted of a Visual Analogue Pain Scale (VAPS) and a Lower Extremity Functional Scale (LEFS), which were collected on four occasions at two-weekly intervals starting with Week 0 and ending with Week 6, as shown in Fig. 1.

VAPS measurements were taken in two different situations

1. Pain felt when taking the first steps after arising from sleep (VAPS1).
2. Pain felt when standing after sitting for more than an hour (VAPS2).

Participants were verbally instructed to indicate the intensity of pain by marking a 100 mm non-hatched line anchored with terms describing the extremes of pain intensity.

LEFS is a 20-item, region-specific, self-report measure conceived to assess the lower-extremity functional status of patients with a spectrum of lower-extremity problems.[35,36] The participants rated the difficulty they experienced in performing 20 activities on a 5-point scale from zero (extreme difficulty or unable to perform activity) to four (no difficulty). The maximum score is 80 points with a high score denoting less limitation of activity.

Data analysis

Statistical analysis was used since sufficient subjects were recruited. Demographics were compared between treatment groups using Pearson chi-squared tests for categorical variables and Mann–Whitney *U* tests for quantitative variables. A two-tailed *P* value of <0.05 was considered as statistically significant. Data were analysed by using the Statistical Package for the Social Sciences (SPSS) v.15 (SPSS Inc., Chicago, IL, USA).

Results

Twenty-seven subjects with plantar fasciitis were referred to the physiotherapy clinic during the data collection period of this pilot study. Of these, two subjects did not meet the inclusion criteria and one subject

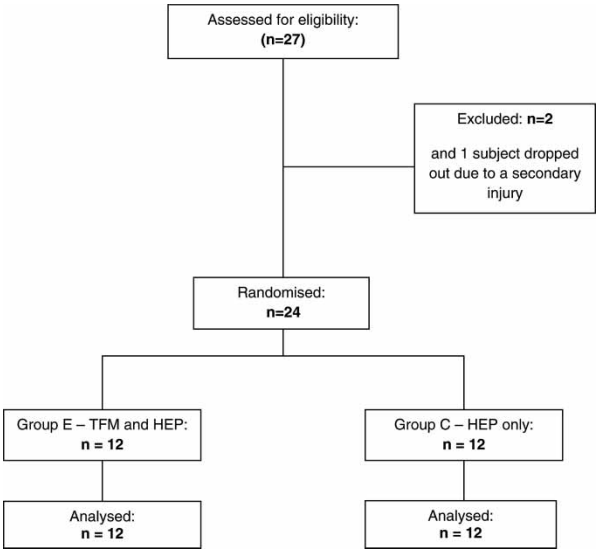

Figure 3 Flow diagram of the data collection process.

in the experimental group withdrew from the study (between Week 0 and Week 2) due to a secondary injury (ankle sprain) (Fig. 3). Since only baseline data had been collected for this subject it was decided to omit the subject's data completely from the data analysis. Twenty-four subjects (12 in each group) completed the study.

Demographic data showed that the two groups were comparable in age, gender, weight, body mass index, side affected, and duration of symptoms. The only reported statistically significant difference was in height ($P = 0.011$).

The three outcome measures of VAPS 1 (pain when weight bearing after sleep), VAPS 2 (pain on standing after sitting for an hour), and the LEFS were analysed using the Mann–Whitney *U* test since the data were found to have a non-parametric distribution.

Outcome measure 1: VAPS1

There was no major difference in average mean scores on initial assessment (control = 52.4, experimental = 49.6), but both groups showed similar decreased scores at Week 6 (control = 24.9, experimental = 23.5).

When comparing the outcomes between the two groups, there was a significant difference ($P < 0.05$) in VAPS1 score at Week 4 ($P = 0.015$) (see Fig. 4 and Table 2), with Group E showing a higher mean score (41.8) when compared with Group C (18.5).

This difference between the groups was not maintained at Week 6 with an increase in the mean score of Group C and a decrease in mean score of Group E resulting in similar results at Week 6 ($P = 0.875$).

Outcome measure 2: VAPS2

Fig. 5 shows the comparison of mean VAPS2 scores over the course of the 6 weeks. Both groups show a decrease in average pain scores during treatment.

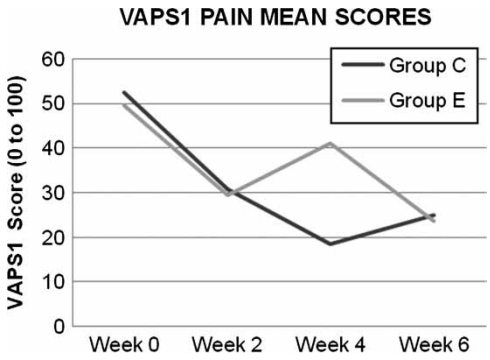

Figure 4 Comparison of mean scores for VAPS1 pain for duration of treatment (Week 0 to Week 6).

Table 2 Mean scores, standard deviation and *P* values for VAPS1 scores – pain perceived by the patient during the first few steps after waking up from sleep

	Group E		Group C		
	Mean	SD	Mean	SD	*P* value*
Week 0	49.58	21.93	52.42	34.59	0.898
Week 2	29.33	24.30	30.75	24.33	0.944
Week 4	41.08	26.90	18.50	21.31	0.015
Week 6	23.50	21.38	24.92	30.86	0.875

*Two-tailed significance at 95% confidence interval.

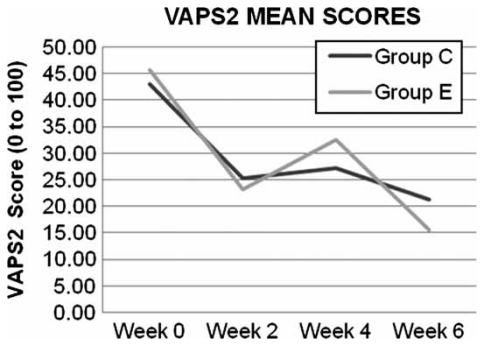

Figure 5 Comparison of mean scores for VAPS2 for duration of treatment.

Table 3 Mean scores, standard deviation, and *P* values for VAPS2 scores – pain perceived by the patient when standing up from sitting for more than an hour

	Group E		Group C		
	Mean	SD	Mean	SD	*P* value
Week 0	45.67	28.08	43.00	22.09	0.921*
Week 2	23.08	21.65	25.25	14.33	0.541*
Week 4	32.42	24.09	27.25	22.43	0.660*
Week 6	15.50	11.73	21.33	21.30	0.618*

*Exact significance (two-tailed) Mann–Whitney *U* test.

When comparing the outcomes between the two groups, at Week 6 both groups showed a decrease in mean pain scores when compared with Week 2 with the experimental group reporting a lower mean average score (Group E = 15.50: Group C = 21.33). This was not statistically significant ($P = 0.618$) – see Table 3.

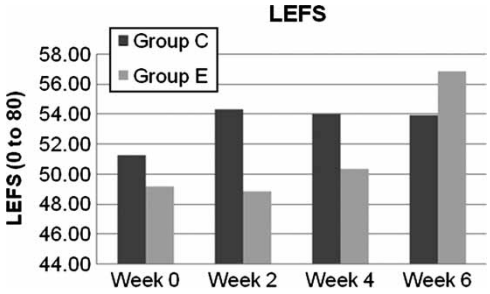

Figure 6 Data for LEFS comparing both groups from Week 0 to Week 6.

Table 4 Mean scores, standard deviation, and *P* value for LEFS

	Group E		Group C		
LEFS	Mean	SD	Mean	SD	*P* value
Week 0	49.17	11.35	51.25	9.25	0.853*
Week 2	48.88	9.48	54.33	6.80	0.163*
Week 4	50.33	7.63	54.00	6.78	0.181*
Week 6	56.83	7.66	53.92	8.33	0.324*

*Exact significance (two-tailed) Mann–Whitney *U* test.

Outcome measure 3: LEFS

Fig. 6 depicts the mean LEFS scores for the experimental and control groups from Week 0 to Week 6. Both groups reported a marginal increase in functional scores with Group E showing a slightly higher improvement over the 6 weeks of treatment (Group E = 56.83: Group C = 53.92) – see Table 4. This difference between the two groups was not statistically significant ($P = 0.32$).

Discussion

This pilot study was the first to compare the benefits of TFM and a HEP with a HEP only in the treatment of plantar fasciitis. The data showed that both groups reported a significant decrease in pain scores and a slight non-significant trend to improved functional score at the end of the 6-week treatment period. Our study did not include a control group receiving no specialized treatment, but there is evidence that stretching exercises change the outcome for plantar fasciitis,[18,31,38] suggesting that both our regimes were efficacious. This pilot study showed that both groups benefited from the respective treatments given and at the end of the study there was only a minimal difference in outcome measures between both groups.

In the comparison between outcomes of the two groups, no statistically significant differences in VAPS1, VAPS2, and LEFS were reported at the end of the treatment period. Only a more extensive trial in terms of numbers and follow-up duration might identify some separate effect of TFM. An improvement in mean scores VAPS1 was recorded in both groups at the end of the treatment time-window (6 weeks). Similar scores were recorded at baseline (Group E: 50; Group C: 52) and at the end of the treatment (Group E: 24; Group C: 25). A statistically significant difference was noted at Week 4 with the TFM group reporting an increase in the mean pain score ($\overline{X} = 41$ mm) and the HEP group reporting a corresponding decrease as well as the lowest mean score for the whole 6 weeks ($\overline{X} = 18.5$ mm). This might have resulted from the fact that TFM was applied for six sessions in the first 4 weeks. The aim of the TFM is to stretch and mobilize fibrous adhesions and tight scar tissue[37] and this increase in flexibility might have coincided with an increase in pain felt on first-step following sleep. However, this increase in symptoms was not reported in the second outcome measure (pain after standing when sitting for more than an hour) and was not maintained by Week 6.

Three subjects in each group experienced a complete or almost complete resolution of pain, whereas two subjects in each group reported an increase in pain felt on first step by the end of the 6 weeks: when there is an unexpected reaction to treatment it raises further questions, such as whether these cases had an inflammatory enthesitis. This was not found in our cases. Although all the subjects were advised on footwear and asked to minimize on painful activities, there was no attempt at recording their daily weight-bearing patterns and activities. Furthermore, the HEP was given at baseline and the patient was asked to continue with the exercises and ice for the rest of the 6 weeks with assessments at Weeks 2, 4, and then 6. No attempt at monitoring compliance was made even if the subjects were asked about the HEP at each two-weekly assessment appointment. Some subjects might have not followed the advice given or might have increased their weight-bearing activities.

Baseline data of first-step pain as measured by a 100 mm VAS was compared with previous studies on plantar fasciitis. Some researchers reported higher mean scores at baseline.[1,38–40] On the other hand, a recent pilot study reported an average score of 51 mm on first-step pain[30] and another in-depth investigation revealed mean scores of 54–64 mm in a sample of 90 subjects,[41] which compare favourably with the mean baseline VAPS (1) score for both groups in this study ($\overline{X} = 51$ mm). Another recent study[42] noted an even lower mean baseline pain score of 40/41 mm in both the experimental and control groups but the authors did not specify whether the pain measured was first-step pain after sleep.

Similar results were obtained on measurement of pain felt when standing after sitting for more than an hour (VAPS2). Both groups improved at the end of the 6-week treatment period with the experimental group obtaining a mean score ($\overline{X} = 15.5$ mm) which

was lower than the control group ($\overline{X} = 21$ mm). This difference was, however, not statistically significant. One subject in each group experienced a complete resolution of pain and two subjects in each group reported an almost complete resolution (VAPS2 pain score <5 mm). In contrast to the first-step pain discussed above, there was no increase in symptoms felt at Week 4 in the TFM group. It could be inferred that the TFM treatment given in the experimental group had an effect on the first step pain (VAPS1) and not on the standing up from sitting/resting for more than an hour pain (VAPS2). However, no explanation for this can be given by the author.

The results of the third outcome measure produced a marginally higher LEFS score for the experimental group at the end of the treatment period. Data analysis showed that this group reported a higher increase in score from baseline to the end of the treatment period (Group E: 7.67; Group C: 2.67). This result was in close proximity but still less than the recommended minimal clinically important difference of 9 points.[35] Furthermore, a high number of subjects in the control group (50%) showed a negative outcome in their LEFS score when compared with the experimental group (25%). The above results might suggest a trend towards the group receiving TFM in addition to a HEP obtaining better outcome scores in terms of LEFS, but the results were not statistically significant.

The use of ice as an adjunct to other therapies is common in the treatment of plantar fasciitis.[11,28,30,31] In line with other studies on plantar fasciitis, subjects were asked to apply ice for pain relief during the 6 weeks of data collection. This pilot study did not attempt to gather any information on the effects of ice therapy in the treatment of plantar fasciitis and therefore its direct benefits or otherwise remain unknown. In a frequently mentioned study[11,31] on the treatment of plantar fasciitis using a specific stretching technique (with a 2-year follow-up), ice was recommended as part of the treatment.

Limitations

The findings in this pilot study need to be interpreted in light of a number of study limitations. First, this study is a pilot clinically controlled trial with a small sample giving no conclusive result. Second, this pilot study had no proper control group, since two types of treatment were being compared. This seems to be a recurrent problem with a recent meta-analysis stating that none of the studies investigated had a proper control group.[43]

Blinding is an essential element in a randomized controlled trial in order to minimize bias and failure to reduce blinding could lead to inflated estimates of effects.[44] The nature of the treatments involved in this trial meant that blinding of the physiotherapist and participants was not possible. However, future studies might consider having a separate person or persons recording and analysing the data.

During the course of this study, it became apparent that the technique used for TFM resulted in fatigue of application on the part of the physiotherapist. The frictions were applied by the author as taught by the Society of Orthopaedic Medicine using the thumb of one hand to impart the frictions while stretching the plantar fascia with the other hand by maintaining toe dorsiflexion.[33] This one-handed technique resulted in considerable effort on the part of the operator to maintain depth during the treatment session. This may have resulted in a non-uniform application of the technique during the 10-minute sessions. Possibly, it might be preferable to use both thumbs to apply the TFM and stabilize the heel with the rest of the fingers in order to impart a deeper and more controlled pressure.

The application of TFM is based on clinical judgement and no method was found to quantify or measure the application of frictions. The patient was asked to report any increase or decrease in pain during the 10-minute session and the depth of the frictions was then adapted accordingly.

A major reason for conducting a pilot study is to determine initial data for the primary outcome measure in order to perform a sample size calculation for a larger trial.[45] The data collected in this study provided adequate information to calculate the minimum amount of subjects needed to be able to conduct a full randomised controlled trial. Using a minimal clinical difference of 9 mm[46] at a significance level (alpha) of 5% and beta at 20 (80% power) a minimum of 137 subjects in each group are needed to run a full-scale study. It is estimated that if an identical design is used it would take approximately 3 years to achieve that number of subjects. The data collection period could be decreased by recruiting subjects from other health clinics and by training other physiotherapists in applying the TFM technique.

Conclusion

Most subjects showed a reduction in pain scores and an increase in average function score at the end of the 6-week treatment period but there was not enough evidence to determine the usefulness of TFM in addition to a standard treatment protocol for the management of plantar fasciitis. The findings offer support for the use of an exercise programme as a stand-alone treatment in the management of plantar fasciitis.

This pilot study has shown that the chosen methodology is suitable for a study of subjects with plantar fasciitis. Both interventions were acceptable and no

adverse effects were reported. No problems were encountered with sampling and recruitment and the outcome measures chosen were appropriate for this sample population. The main limitations involved a short follow-up period and a lack of blinding.

Recommendations

Further study may include the following changes:

1. *Better use of a control group*. Since ethically it is not possible to withhold treatment to a patient the researcher could adopt a 'wait-and-see' approach and then commence any treatment once the data of the study have been collected or treat the subjects in both groups with a non-physiotherapeutic treatment altogether such as NSAIDs or analgesics.
2. *Minimization of research bias*. In future trials, researcher bias could be minimized by asking another clinician to collect the data.
3. *Better randomization*. This can be achieved by asking the subjects to pull out a paper with the concealed treatment allocation from a box. This would strengthen the validity of the study.
4. *A longer follow-up period*. This pilot study compared the results of two interventions at the end of a 6-week treatment period. Other studies on plantar fasciitis have collected data at the end of Week 8,[11] Week 14,[30] 2 years,[31] and 5 years.[42] Data collection at 12 weeks or more would have provided more information on the theory that TFM are used to release unwanted adhesions and provide a longer-lasting mobilizing effect.
5. *Use only VAPS1 as an outcome measure for pain*. The data from this study showed that both the VAPS1 and VAPS2 scores decreased at the end of the treatment period in the two groups. Results at the end of the study were similar for both VAPS scores. For this reason, future studies might opt not to include VAPS2 as an outcome measure and use VAPS1 only as a primary outcome measure.

Prospective trials might also examine the effects of different combination of treatment modalities. Despite widespread opinion that the success of conservative care for the treatment of patients with plantar fasciitis requires a combination of treatment modalities, there is no consensus about which treatments are the best or the most effective and there is inconsistency in the treatments provided.

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