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Original Research Article

Effect of Calcaneal Taping on Pain, Pressure Pain Threshold & Function in Subjects with Chronic Plantar Fasciitis: A Randomized Clinical Trial

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ABSTRACT

Background: Plantar fasciitis (PF) is an inflammatory disorder of the foot, usually at the calcaneal attachment of plantar aponeurosis and is most commonly due to overuse. It is the most common foot condition treated by healthcare providers. Physical therapists have various treatment approaches to relieve the symptoms of plantar heel pain, including taping methods for which there exists little evidence.

Objectives: The purpose of this study was to find out the effectiveness of calcaneal taping with supervised exercises on pain, pressure pain threshold and function in subjects with chronic plantar fasciitis.

Methods: Thirty-one (31) subjects were randomly assigned into 2 groups. Subjects in Group-A (n=16) received 4 sessions of calcaneal tapping along with supervised exercise and moist heat packs whereas subjects in Group-B (n=15) received 4 sessions of supervised exercise and moist heat packs for two sessions per week in two weeks.

Outcome Measures: Visual analogue scale (VAS) for pain intensity, pressure pain threshold (PPT) for tenderness and foot function index for function was assessed at baseline and at the end of 4weeks of intervention.

Results: Baseline values of all outcome parameters were homogenous ($p>0.05$). Significant difference was found after four sessions of treatment in Group-A for pain and function ($p<0.05$), whereas in Group-B significant difference found in all outcome measures ($p<0.05$). Between Group comparison has shown insignificant differences ($p>0.05$) for all outcome measures.

Conclusion: This study demonstrated that calcaneal taping along with supervised exercise & moist heat packs have effective role in improving pain & function.

Key Words: Plantar Fasciitis, Visual analogue scale (VAS), Pressure pain threshold, Foot function index, Calcaneal tapping.

INTRODUCTION

Plantar fasciitis (PF) is defined as a localized inflammation and degeneration of the proximal plantar aponeurosis. [1] It is one of the most common causes of heel and foot pain, accounting for 15% of all foot pathologies. [2] Rome et al. (2001) reported that plantar fasciitis accounts for 15% of all adult foot complaints requiring professional care and is prevalent in both nonathletic and athletic populations. [3]

The plantar fascia is a thick fibrous connective tissue which originates at the medial tuberosity of the calcaneus and inserts into the plantar plates of the metatarsophalangeal joints, the base of the

proximal phalanges and the sheaths of the flexor tendons. [2] The plantar fascia acts like a bowstring to maintain and provide support for the longitudinal arch of the foot and to assist with dynamic shock absorption. [2] The plantar fascia plays an important role in providing foot support and rigidity throughout the gait cycle. The specific pathologic features responsible for any patient's symptoms are not well understood. [4]

However, it is suggested that the normally resilient fascia becomes stiffened and prone to re-injury, thus setting up a vicious cycle of persistent pain. There are various etiological factors resulting in plantar fasciitis: they are classified as biomechanical, environmental and anatomical. Biomechanical factors are abnormal joint mechanics, tight posterior musculature and resultant decreased range of motion. Individuals with poor foot biomechanics that stresses plantar fascia are commonly diagnosed with plantar fasciitis. [5] Excessive pronation is a commonly cited risk factor for developing plantar heel pain. [2] Excessive pronation is caused by plantar flexion and adduction of the talus during weight bearing, causing the calcaneus to evert. Individuals most prone to plantar heel pain are middle-aged women, obese individuals, athletes and male runners. [2] Men and women with poor gait mechanics that include excessive pronation with resultant loss of plantar fascia extensibility are common risk factors for plantar fasciitis symptoms. Patients initially presents with plantar heel pain, typically complain of pain during the first few steps they take in the morning and/or their first few steps after prolonged rest. [2] Riddle DL et al. (2003) observed that individuals with a body mass index (BMl) >30 kg/m^2 had an odds ratio of 5.6 for plantar fasciitis compared to those with a BMI <25 kg/m^2. They observed that risk of plantar fasciitis increases as the range of ankle dorsiflexion decreases. [6]

Numerous nonsurgical treatments have been used to relieve the symptoms associated with heel pain. These include rest, exercise (stretching and strengthening), external support (Orthosis, night splints and taping), electrotherapeutic modalities (Cryotherapy, Ultrasound with and without Phonophoresis) and Nonsteroidal Anti-inflammatory medications through Iontophoresis or injections.

Strengthening exercise of intrinsic foot muscle and ankle plantar flexors plays an important role in the rehabilitation of plantar fascitis by correcting the functional limitation of the foot. Strengthening exercise control the foot pronation which further help in the gait cycle and weight bearing activities. Nonsurgical interventions mainly focuses on relieving the symptoms associated with plantar heel pain; however, orthosis and taping techniques address the underlying problem of poor foot biomechanics.

There are various types of taping techniques available to treat plantar fasciitis. Taping as an intervention for the treatment of plantar fasciitis has been used for at least last 70 years. Rigid taping, also called the athletic taping, is commonly used by Physical therapists. This is composed of a non-stretch, rigid tape with a high tensile strength and a zinc oxide adhesive, used with cover roll stretch, a non-latex material placed down on skin to help protect from the more abrasive Leuko-tape. Martin et al. (2014) has indicated strong evidence in favour of use of taping for patients with PF symptoms. [7]

Till date, there have been few studies investigating the acute effects of attempting to control the position and alignment of the calcaneus through the use of taping. [2] Therefore, this study was designed to investigate the effects of calcaneal taping on pain, pressure pain threshold and function in subjects with chronic plantar fasciitis.

MATERIAL & METHODS

Subjects: This Pre-test - post-test study design included subjects who visited National Institute for Locomotor Disabilities, (Divyangjan), Kolkata, India,

between March, 2018 to February, 2019 with a complaint of foot pain. Scientific and Ethical approval was taken from the Institute Ethical Committee (IEC). Inclusion criteria were both male and female subjects with chronic plantar fasciitis of 20 to 40 years of age, pain on 1st step upon walking, with symptoms durations more than three months, tenderness at the medial calcaneal tuberosity and VAS score between 3-8.

The subjects were excluded if they had any contraindications to the use of tape (allergy or intolerance), previous history of surgery or steroid injection for plantar fasciitis in the past 3 months, history of any pain in ankle due to some other cause & ankle or foot fracture, metabolic diseases like diabetic neuropathy, gout etc, vascular diseases like DVT, Buerger's disease etc, retro-calcaneal bursitis, calcaneal spur, musculoskeletal deformity of lower extremity like CTEV, pes-cavus etc, neurological disorders like tarsal tunnel syndrome, foot drop etc, local Skin disorder and psychiatric disorder or un co-operative subjects.

Procedure:

Total 92 subjects were screened according to inclusion/exclusion criteria. 35 subjects fulfilled the inclusion criteria and they were explained in detail about the study. After obtaining informed consent subjects (n=35) were randomly assigned into two groups by convenient sampling. Subjects were not aware about their group allocation and the research question. Group-A (n=18) subjects has received calcaneal taping, supervised exercise & moist heat pack for two sessions per week in two weeks (Total four sessions). Subjects in Group B (n=17) has received supervised exercise and moist heat pack for two sessions per week in two weeks (Total four session). The data for pain intensity, pressure pain threshold (tenderness) and functional status were taken at pre-intervention and at the end of two weeks of treatment (post intervention data). Total 4 subjects were dropped out from the study, two subjects each from Group-A and Group-B.

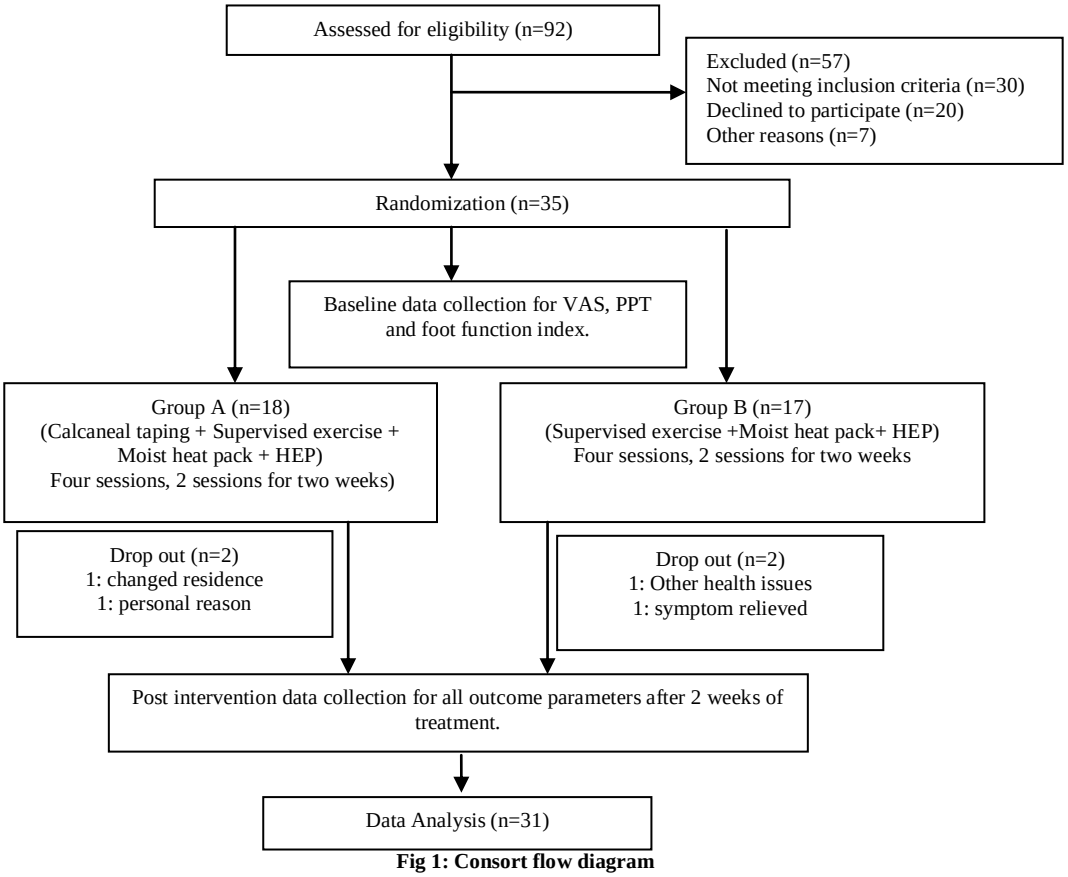

Fig 1: Consort flow diagram

MEASUREMENT OF OUTCOME PARAMETERS:

The measurement of pain intensity was done by using visual analogue scale (VAS). Evidence supports the reliability and validity of this scale across many populations. [8] VAS is a straight horizontal line of fixed length usually of 10cm. A brief explanation was given to all subjects about the measurement procedure. Subjects were asked to mark a line on the scale according to the status of their pain after activity and the distance of the marked line was measured from left hand side of the line (zero value) at pre-intervention and post intervention after two weeks of treatment.

Pressure-pain threshold (PPT) was measured by an algometer at pre-intervention and post intervention after two weeks of treatment. This instrument is having good reliability and validity. [9] The subjects were explained about the measurement procedure prior to administration of the algometer and not allowed to see the algometer in any moment. The tip of the algometer was positioned perpendicularly on a specific point. By pushing the algometer, the force applied to that area gradually increased. As soon as the subject experienced a painful sensation, they said "stop" and the algometer were released immediately. Force (in Kg) was then recorded from the display. The individual test was administered three times with 30 second rest period between each trial to reduce learning error and the averages of three consecutive measurements were taken as the best value.

Foot function index (FFI) was used to measure the impact of foot pathology on function in terms of pain, disability and activity restriction. FFI has good test- retest reliability and internal consistency of 0.87 and 0.96 respectively. [10] Subjects were explained about all the items of FFI and requested to tick on the questionnaire on the day of evaluation & again at the end of two weeks of treatment session. The differences between these two data were studied to evaluate the pre & post-intervention status of the subjects.

INTERVENTIONS:

Pre heated moist heat (MHP) pack was wrapped in towel with three to four folds and it was applied over the affected foot for 15 minutes [11] with the subjects seated in high sitting position on a wooden chair. After MHP, Plantar fascia specific stretching exercise was administered to all subjects. Subjects were in crossed sitting position with the affected leg over the contra lateral leg. The therapist then applied stretch force distal to the metatarsophalangeal joints on the affected side, pulling the toes upward toward the shin until a stretch was felt in the sole of the foot. Therapists held this stretch for ten seconds and repeated it for ten times in one set. [12] Then intrinsic foot muscle strengthening exercises which included towel curl and marble pickup exercise was performed by all subjects in high sitting position on a chair with feet resting on towel, flat on the floor. They were asked to draw towel toward themselves by crunching the toes. They were instructed to keep the heel in contact with the floor throughout the procedure and repeat it ten times. [13] Few marbles and a bowl were placed on the floor and the subjects were asked to pick each marble up with their toes & place it in the bowl. This was performed ten times in one set. MHP and all the above exercises were administered for all subjects in Group-A and Group-B under the supervision of an experienced therapist.

Calcaneal Taping:

An experienced therapist specially trained in rigid taping techniques applied the calcaneal taping with the subjects in long sitting position on a treatment couch for all subjects in Group-A. Cover-Roll stretch bandage was applied to a pre-cleaned & dry skin surface and then covered with Leuko-tape. After applying the Cover-Roll, four pieces of Leuko-tape was applied. Piece-1 was applied just distal to the lateral malleolus, pulling the calcaneus medially and was attached to the medial aspect of the

foot distal to the medial malleolus. Pieces-2 and 3 followed the same pattern with overlap of approximately one third of the tape width moving in the distal direction. Piece-4 went around the back of the heel starting distal to the lateral malleolus, wrapping around the posterior aspect of the calcaneus and anchoring distal to the medial malleolus. Piece-4 also served as an anchor for the first 3 pieces [2] (twice/wk).

Statistical Analysis:

Statistical package for the social sciences (SPSS) version 23 software was used for analysis of the collected data. Independent-t test was used to determine the normal distribution of data. Paired sample t-test were used to analyze the within group variables for VAS, PPT & FFI. Unpaired sample t-test were used to analyze the between group variables for VAS, PPT & FFI. These tests were applied at 95% confidence interval with α value set at 0.05. The results were taken to be significant if P-value <0.05.

RESULTS

In this study 31 (Thirty one) subjects, 25 females and 6 males were evaluated with chronic plantar fasciitis and were randomly divided into two groups (Group-A & Group-B)

Analysis of demographic details (Age, BMI, VAS, PPT and FFI) has revealed that there was statistically insignificant difference between Group-A & Group-B at baseline (Age: p=0.549, BMI: p=0.790, VAS: p=0.372, PPT: p=0.845 and FFI: p=0.734) (Table-1). This shows that both the groups were homogenous at baseline.

Table-1: Demographic and Baseline Details

Variables	Group-A (n=16)	Group-B (n=15)	t-value	p-value
Male	03	03		
Female	13	12		
Age	32.00±6.13	30.±4.19	0.607	0.549
BMI	24.95 ±3.94	24.49 ±5.35	0.269	0.790
VAS	6.56 ±1.65	7.15±1.97	-0.908	0.372
PPT	3.80 ± 0.53	3.86 ±0.88	-0.197	0.845
FFI	127.06±38.01	131.73 ±37.75	-0.343	0.734

Paired sample t- test was used for intra group analysis of VAS, PPT & FFI. Intra group comparison revealed that there is reduction of pain intensity in both the groups. Pain intensity decreased from 6.56±1.65 to 4.29 ± 1.62 in Group-A and from 7.15 ± 1.97 to 4.83 ± 1.99 in Group-B. This reduction was statistically significant in both the groups (Table-2).

Analysis of pressure pain threshold showed that the PPT value has increased in Group-A from 3.80 ± 0.53 to 4.20 ± 1.07 and in Group-B from 3.86 ± 0.88 to 4.52 ± 0.82. The change in Group-B was statistically significant whereas in Group-A it was insignificant (Table-2).

A decrease in FFI value was found in Intra group analysis. It has decreased from 127.06 ± 38.01 to 102.94 ± 33.68 in Group-A and from 131.73 ± 37.75 to 97.13±31.76 in Group-B. This decreased FFI score was statistically significantly in both the groups (Table-2).

Table-2: Intra group comparison of outcome parameters

Variables		Pre intervention	Post intervention	t-value	p-value
VAS (in cm)	Group-A(n=16)	6.56±1.65	4.29±1.62	4.52	0.000
	Group-B(n=15)	7.15±1.97	4.83±1.99	3.62	0.003
PPT (in kg)	Group-A(n=16)	3.80± 0.53	4.20±1.07	-1.819	0.089
	Group-B(n=15)	3.86± 0.88	4.52± 0.82	-2.671	0.018
FFI	Group-A(n=16)	127.06±38.01	102.94±33.68	7.443	0.000
	Group-B(n=15)	131.73±37.75	97.13±31.76	4.300	0.001

An Independent sample t-test was used for inter group analysis of VAS, PPT & FFI. It was observed that mean difference of VAS, PPT & FFI showed statistically insignificant result between the two groups for all the outcome parameters as shown in Table-3 (p>0.05).

Table-3: Inter group comparison of outcome parameters at post intervention.

Variables	Group-A (n=16)	Group-B (n=15)	t-value	p-value
VAS	4.29±1.62	4.83±1.99	-0.82	0.42
PPT	4.20±1.07	4.52± 0.82	-0.91	0.37
FFI	102.94±33.68	97.13±31.76	0.49	0.63

DISCUSSION

Plantar fasciitis is the most frequently reported cause of foot and heel pain. Plantar fasciitis is a common chronic overuse injury of the plantar fascia. This study examined effectiveness of calcaneal taping with supervised exercises and supervised exercises alone on pain intensity, pressure pain threshold and function in subjects with chronic plantar fasciitis. Pain intensity measured on VAS and PPT measured by algometer has revealed significant reduction in both the groups and among these Group-A subjects showed more reduction than Group-B.

The possible explanation for improvement in both groups could be attributed to stretching exercise program, moist heat pack and instructions given to the subjects on the first day of intervention. Sweeting D et al (2011) [14] noted strong evidence for decreasing pain at 1-week follow-up, inconclusive results for change in level of disability and evidence that taping can have an additional benefit when added to a stretching program. Their finding supports the results of this study.

The exact mechanism of the efficacy of stretching in the management of plantar heel pain are unclear, but they may be related to a decrease in tension over the plantar fascia or decrease of risk factors, such as tightness of the gastrocnemius and soleus muscles and restricted ankle dorsiflexion. Therefore, the current study supports that stretching of the plantar fascia is effective for improving pain, tenderness and function, at least in the short term, in patients with plantar heel pain.

Kumar R et al (2017) [15] concluded that self-stretching can help in correcting the functional risk factors (tightness of achilles tendon and fibrotic changes of plantar fascia) seen in chronic plantar fasciitis subjects. Similarly, stretching of the plantar fascia may lead to increase elasticity of the plantar fascia thereby restoring the windlass mechanism so that the tissue tension is reduced.

Salam & Elhafz (2011) [16] conducted a study for 3-weeks period in patients with plantar fasciitis and in that study anti-pronation (low-Dye) taping was found to reduce pain and improve function. Calcaneal taping might have worked at the proprioceptive level, where the tape might have provided a sensation of position awareness of the foot. Taping might have also changed the foot mechanics by which pain was significantly decreased in Group-A. Hyland R.M et al. (2006) [5] stated that calcaneal taping prevent excessive pronation and maintain a more neutral position presumably helps control the height of the medial longitudinal arch, thus taking the force off the plantar fascia and it was found to be more effective tool for the relief of plantar heel pain. These mechanisms could explain the more reduction of pain in the taping group.

In the treatment of PF, taping is used to biomechanically control tensile forces generated through the plantar fascia (Hunt et al., 2004). This is achieved as immobilisation with taping shortens the distance between origin and insertion of the plantar musculature and fascia; this decreases stress and tensile force along the plantar plate protecting the plantar fascia.

A possible reason for statistically insignificant improvement in PPT values (Tenderness) in Group-A may be due to application of rigid taping reduced the elongation of plantar fascia during stretching exercise thus leading to persistence of tenderness. Gulpinar D et al (2017) [17] has reported that shoulder rigid taping had no effect on shoulder position sense in Australian football players. They believe that rigid taping mechanically reduced Glenohumeral internal rotation (GIR) and total rotation range of motion (ROM) because of its non-elastic property. Due to the restrictive effect on shoulder motion, they do not suggest using rigid taping with the aim of improving GIR and ROM in prevention programs for overhead athletes.

Reduction in FFI scores were found in both the groups and reduction in pain intensity might have improved the functional activity and ability. This was supported by van de Water and Speksnijder (2010) [18] who reported inconclusive results for change in level of disability in the short term, however, strong evidence was found for decreasing pain at 1-week follow-up. They concluded that taping can have an additional benefit when added to a stretching program in plantar fascitis.

Corroborating the findings of all the outcome parameters it was observed that the addition of calcaneal taping with stretching exercise and moist heat pack did not resulted any superior outcome as compared to stretching exercise and moist heat pack alone in the treatment of chronic plantar fasciitis.

CONCLUSION

This study demonstrated that calcaneal taping along with supervised exercise & moist heat pack has an efficacy in improving pain & function. But, while comparing it with supervised exercise & moist heat pack alone insignificant result have been found. Thus, it can be concluded that there is no added benefits of rigid calcaneal taping in plantar fascitis than supervised exercises and moist heat pack applied together.

***Limitations and Suggestions*:**

The result of the present study need to be viewed in light of several limitations such as: short duration of study, small sample size, lack of follow up, absence of true control group and non blinding etc.

A similar multicentre, double blinded, randomized trials may be conducted in future with large sample size & long term periodic follow up on present hypothesis to improve the validity and generalizability of the results.

Conflict of Interest: None

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