Single Session of Low-dye Calcaneal Taping as a Viable Alternative to LASER Therapy for the Treatment of Plantar Fasciitis: A Randomized Controlled Trial

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ABSTRACT

Background: Due to pressures of lifestyle and survival, both the urban and rural sections of society cannot give enough time for follow-up, thereby compelling many individuals to discontinue physiotherapy treatment. Treatment of plantar fasciitis (PF) requires multiple sessions and therefore falls into the scope of this problem. Taping has the advantage that it remains on the patient for multiple days and therefore negates the need for the patient's follow-up. If a single session of taping can deliver outcomes comparable to conventional LASER therapy, it would become a viable alternative solution for this problem. The aim was to compare and analyze the change in ankle muscle strength, flexibility, dorsiflexion, range of motion, and foot function in individuals with PF between the taping and LASER group.

Materials and methods: Sixty-one participants diagnosed with PF were randomly allocated into a study and control group. The study group received a single session of low-dye calcaneal taping while the control group received five sessions of LASER therapy. Both the groups received a home exercise program. A pre- and post-intervention assessment of all the variables was done for both groups.

Results: A within-group analysis using the Wilcoxon signed-rank test showed a significant difference in all the variables in both the laser and taping group ($p < 0.05$). A between-group analysis using the Mann-Whitney U test showed no difference in outcomes between the taping and laser groups ($p > 0.05$).

Conclusion: A single session of taping can provide comparable outcomes as a conventional LASER therapy for short-term benefits in individuals with PF.

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BACKGROUND FOR THE STUDY

The current economic scenario presents unique challenges to healthcare professions, especially in developing countries. Due to pressures of lifestyle and survival, both the urban and rural sections of society cannot give enough time for follow-up.¹ This challenge is much more acute in the profession of physiotherapy as many of the treatments of physiotherapy require follow-up. The cost of follow-up treatment incurred by the patients includes incidental charges such as loss of pay, travel, loss of productivity, etc. The distance traveled for follow-up physiotherapy also becomes a major concern, especially for patients residing in rural areas. Therefore, many of the patients may prefer not to continue treatment. Management of plantar fasciitis (PF) requires multiple sessions of intervention and therefore falls into the scope of this follow-up problem.

Plantar fasciitis accounts for 11–15% of the foot symptoms among adults.² It is a degenerative process with micro-tears and fascial thickening predominating over inflammatory changes.³ The main concern in PF is heel pain during weight-bearing activities, especially walking, which is the most essential function for daily living.⁴ A widely accepted theory is that an increased weight-bearing in the foot leads to repetitive trauma or stress that can irritate the plantar fascia at its origin on the calcaneus.^{5,6} The difficulty in weight-bearing and walking caused by the irritation may result in restrictions of function, social participation, and quality of life (QoL). It could also directly result in loss of muscle strength, range of motion, and muscle flexibility, thereby compromising on

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their QoL.⁷ To preserve the physical function and QoL, it becomes essential to intervene through physiotherapy at the earliest.

Several non-surgical treatments have been recommended for PF which includes soft tissue mobilization, stretching, orthotics, night splints, taping, cryotherapy, phonophoresis, low-level LASER, and iontophoresis with dexamethasone.⁶ Kiritsi et al. investigated the effect of low-level laser therapy (LLLT) on PF through the ultrasonographic appearance of the aponeurosis and by patients' pain scores and revealed that LLLT contributes to PF healing and pain reduction.^{8,9}

Therapeutic taping is another common clinical intervention facilitating pain reduction, joint support, proprioception, and muscle tone normalization. The 2014 clinical recommendation

guidelines for PF suggests taping as an intervention that includes antipronation taping for immediate (up to 3 weeks) pain reduction and improved function for individuals with heel pain/PF.⁶ The low-dye calcaneal taping aims to decrease medial heel pressure by lifting the navicular bone.¹⁰ Podolsky and Kalichman reviewed the efficacy of different taping techniques in relieving symptoms and dysfunction caused by PF. They concluded that in the short-term, taping was beneficial in treating PF and the best evidence that existed was for low-dye taping and calcaneal taping.¹¹

Although all treatments have reputedly provided some level of relief, the final outcome, as well as the financial and personal burden imposed by each treatment, varies markedly across protocols. Any treatment that can offer comparable outcomes using less follow-up would be a welcome change in reducing the burden of both cost incurred and time.

Taping as a method of treatment has the advantage that it remains on the patient for multiple days, thereby negating the need for the patient follow-up and also provides the necessary biomechanical correction. A single session of low-dye calcaneal taping is considered in this study as the tape is retained on the patient for 5 days and is hypothesized to produce outcomes equivalent to five sessions of LASER. Biomechanically in PF, the tape raises the medial longitudinal arch, reduces the excessive pronation of the foot, and thereby promotes healing.^{10–12}

If a combination of a single session of taping and a home exercise program can deliver outcomes comparable to multiple sessions of a conventional therapy like LASER, it would become a viable alternative solution for this problem.

Hence, there is a need to determine if a single session of taping and home exercise program can be used as an alternative to multiple sessions of conventional LASER therapy and exercise program in subjects with PF.

The main objective of this study was to compare and analyze the change in hamstrings and tendo-Achilles flexibility, foot muscle strength, dorsiflexion ROM, and foot function between the taping and LASER group.

MATERIALS AND METHODS

Design

After obtaining the ethical clearance, the randomized controlled trial was conducted from February 2018 to January 2020. All patients who walked into MS Ramaiah Hospitals with PF and fulfilled the inclusion and exclusion criteria were considered for the study. Informed consent was obtained from all participants who were included in the study.

Participants

All participants were then randomly allocated into an experimental (taping) group and control (LASER) group through a computer-generated random allocation method. Participants in the age of 30–60 years who complain of medial heel pain with initial steps after a period of inactivity and worsened after prolonged weight-bearing, pain with palpation of the proximal insertion of the plantar fascia, acute to subacute pain were considered for the study.⁶ Subjects with fractures or other injuries to the lower limb, neurological deficits involving the lower limb, any systemic illness, inflammatory arthropathies, and usage of assistive devices were excluded from the study.

Intervention

Experimental group (Taping group): The low-dye calcaneal taping technique was used to tape the calcaneum and foot as the literature suggests it to be an effective method when compared with other forms of taping.

The taping area was first cleaned which was followed by the application of underwrap. The first strip was applied with no tension around the forefoot, proximal to the metatarsal heads. The second strip was applied with tension from just proximal to the lateral aspect of the fifth metatarsal head running proximally around the posterior aspect of the calcaneus finishing just proximal to the medial aspect of the first metatarsal head. Three to four further strips are then added similarly to the first strip with each strip overlying the more distal strip by $\frac{1}{2}$ the width of the tape. Tension is applied to these to support the arch and maintain foot position.¹⁰

Calcaneal Taping

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 follow the same pattern with an overlap of approximately one-third of the tape width moving in the distal direction. Piece 4 is put around the back of the heel starting distal to the medial malleolus. Piece 4 also serves as an anchor for the first three pieces.¹² The patient was asked to retain the tape for 5 days after which they were asked to return for a follow-up assessment of outcomes.

Control Group

The control group received LLLT. The wavelength of LASER that was used for treatment was 808 nm, with an output of 75 mW, at 0.3 J/cm² for a duration of 7 minutes 30 seconds. The laser was given at the medial tubercle of the calcaneus which was the tender point. The group received treatment every day for 5 days following which the post-intervention assessment was done.

Both the groups received a home exercise program that consisted of stretching of tendo-Achilles, hamstrings, and plantar fascia along with strengthening of the muscles of the foot.^{13,14} The patients were asked to do the strengthening and flexibility exercises with a frequency of once daily with each exercise being repeated 10 times.

A detailed evaluation of the participants was done pre- and post-intervention and the following outcome measures were considered for the study.

Outcome Measures

Ankle joint range of motion was assessed using the goniometer in degrees, ankle plantar and dorsiflexor strength was measured using the handheld dynamometer in Nm,¹⁵ flexibility of tendo-Achilles and hamstrings was assessed using the knee to wall test¹⁶ and sit and reach test in cm,^{17,18} respectively, and function was assessed by the foot function index.¹⁹ The assessment was done by a co-investigator who was blinded to the study. All the above parameters were assessed before and after the completion of the intervention. Individuals who were on analgesics were asked to pause their medication for the duration of the study.

Data Analysis

With an alpha error of 5% and keeping the power of the study at 80%, it was estimated that 32 patients to be included in each group.

Flowchart 1: Flow of participants through the phases of the trial **Table 1:** Demographic data

	Taping group (31)	LASER group (30)
Age (years)	42.1	44.7
Gender		
Male	10	7
Female	21	23
Side affected		
Right sided-17		Right sided-15
Left sided-14		Left sided-15

Considering dropouts, 35 was the sample size to be recruited into each group.

SPSS statistical software 23.0 was used for data analysis. Normality was assessed using Shapiro-Wilk test. As the data were not found to be normally distributed, interquartile range and non-parametric tests were used. Wilcoxon signed-rank test was used for within-group analysis and Mann-Whitney *U* test was used for the between-group analysis of flexibility, strength, range of motion, and foot function.

Significance was kept at $p < 0.05$.

RESULTS

Ninety-eight patients who fulfilled the inclusion criteria were recruited for the study. Seven were excluded as they needed to be excluded. Ninety-one subjects were randomized into taping and LASER groups. Through the course of the study, 30 subjects did not return for follow-up. Of the 61 subjects, 31 subjects were recruited to the study group and 30 to the control group. The mean age of both the groups was 42.1 and 44.7 years, respectively, with a predominance of females in both the groups (Flowchart 1 and Table 1).

Using the Wilcoxon signed-rank test for within-group analysis, it can be seen that there is a significant difference in the hamstring and tendo-Achilles flexibility, dorsiflexion ROM, dorsiflexor, and plantar flexor muscle strength and function before and after intervention in both the taping and LASER groups ($p < 0.05$) (Table 2).

Using Mann-Whitney *U* test for between-group analysis, it can be seen that there is no significant difference in the hamstring and tendo-Achilles flexibility, dorsiflexion range of motion, foot muscle strength, and foot function between the taping and LASER groups ($p > 0.05$) (Table 3).

DISCUSSION

The main objective of the study was to determine if a difference in outcomes exists between a single session of taping vs multiple sessions of conventional LASER therapy in patients with PF.

On analyzing the above results, it can be seen that there is a significant difference in flexibility, dorsiflexor and plantar flexor strength, ankle dorsiflexion ROM and foot function before and after intervention in both the taping and LASER groups ($p < 0.05$).

However, a between-group analysis showed no difference in the outcomes between the taping and LASER group indicating that a single session of taping provides comparable outcomes to five sessions of LASER therapy.

Various authors have concluded that both taping and LASER therapy are beneficial in the improvement of foot function in subjects with PF. While low-dye calcaneal taping technique is found to have caused the desired beneficial effects through biomechanical corrections, LASER therapy induces analgesic effects through pain gate modulation.

Low-dye calcaneal taping raises the medial longitudinal arch of the foot and takes the force off the plantar fascia. It also inverts the heel, thereby preventing excessive pronation of the calcaneus. The tape thereby supports the arch and controls the height of the arch.¹⁰⁻¹² This is in accordance with studies were done by Radford et al. and Hyland et al. who reported that short-term application of low-dye calcaneal taping for patients with PF was effective at reducing pain.^{10,12} However, in another study done by Holmes et al., it was observed that low-dye taping did not alter the foot mechanics though the pain was reduced.²⁰

The exact mechanisms accounting for LLLT-mediated pain relief have not been identified. Some of the previous studies described

Table 2: Comparison of flexibility, foot muscle strength, dorsiflexion ROM and foot function pre- and post-taping and LASER

Variables	Taping group			LASER group		
	Pre-median (IQR)	Post-median (IQR)	<i>p</i> value (<0.05)	Pre-median (IQR)	Post-median (IQR)	<i>p</i> value
Hamstring flexibility	10.0 (7.0–16.0)	13.0 (9.0–16.5)	<0.02	10.0 (8.5–11.8)	12.0 (9.25–13.5)	<0.001
Tendo-Achilles flexibility	6.5 (5.5–9.0)	8.0 (7.0–10.0)	<0.03	7.0 (5.25–8.5)	8.0 (7.0–11.5)	<0.001
Foot function	100 (75–108)	73 (56–86)	<0.00	103 (88.0–109.0)	73.0 (41.0–85.0)	<0.001
Dorsiflexion ROM	25 (20.00–27.3)	29 (11.00–31.3)	<0.01	25.00 (20.00–30.00)	30.00 (25.00–35.00)	<0.001
Dorsiflexion strength	33.4 (30.8–48.7)	39.4 (33.4–55.7)	<0.00	34.4 (29.8–47.7)	39.3 (34.8–46.0)	<0.02
Plantar flexor strength	60.5 (51.2–82.5)	70.6 (55.9–89.7)	<0.01	62.3 (46.7–73.1)	70.0 (51.7–82.3)	<0.02

Table 3: Comparison of flexibility, foot muscle strength, ROM, and foot function between taping group and LASER group

Variables	Mann–Whitney U	Z	<i>p</i> value
Hamstring flexibility	376.6	–1.09	<0.29
Tendo-Achilles flexibility	416.5	–0.27	<0.79
Foot function	405.5	–0.45	<0.66
Dorsiflexion ROM	323.0	–1.52	<0.128
Dorsiflexion strength	414.5	–0.52	<0.60
Plantar flexion strength	382.5	–0.991	<0.33

a series of mechanisms that include: peripheral neural blockade, enhancement of peripheral endogenous opioids, suppression of central synaptic activity, inhibition of histamine release, modulation of neurotransmitters, promotion of adenosine triphosphate (ATP) production, reduction of muscle spasm, and increased production of anti-inflammatory cytokines.^{9,21–25}

LASER therapy is also thought to stimulate fibrous tissue regeneration and repair processes. A lower plantar fascia thickness value and improvement in foot function was observed 6 weeks after LLLT in subjects with PF.^{8,26–28}

The improvement in the strength of plantar flexors and flexibility of gastrocnemius and hamstrings in both the groups ($p < 0.05$) could be attributed to the home exercise program that included stretching of the plantar fascia, gastrocnemius, and hamstrings.

The improved ROM in both groups may have occurred due to the stretching exercises for the calf muscles and Achilles tendon that was given through the home exercise program.²⁹ The strengthening exercise program of heel raises would have strengthened the plantar flexors and dorsiflexors and also contributed to the increase in tendo-Achilles flexibility and dorsiflexion ROM.¹⁴ A reduction in pain could have also helped in the normalization of gait, thereby indirectly strengthening the muscles of the foot. This is in accordance with a study done by DiGiovanni et al. who reported that a home exercise program is beneficial in the management of PF.¹³

Regarding the result on the efficacy of a single session of taping in comparison to multiple sessions of LASER therapy, it could be hypothesized that retaining the tape for a few days on the patient aids in easing off the force from the plantar fascia, thereby alleviating pain and improving foot function.

LASER therapy is an equipment-driven process that heals through fibrous regeneration and pain gate modulation and therefore needs the patient to undergo the treatment through follow-ups for a few days as a single session might not be sufficient to produce the desired effect. On reviewing the literature regarding the optimal treatment sessions of taping and LASER for short-term benefit in PF, it can be inferred that a single session of low-dye

taping is retained on the patient for 3–5 days was found to be effective.³⁰ On the contrary, lower level LASER produced the desired effect of reduced pain and improved function with 6 sessions in a span of 3 weeks.²⁶ As there were concerns of follow-up, we had altered the number of sessions to continuous therapy for 5 days and found the beneficial effect.

On analyzing the outcomes of these two methods of treatment for PF, it can be observed that a single session of taping can be used as a viable alternative to multiple sessions of LASER therapy, thereby reducing the burden of follow-up on the patient.

LIMITATIONS

There was a minimal deficiency in the sample size as the estimated sample size could not be reached due to a heavy loss to follow-ups. The tape of a few of the subjects had to be reapplied on the 2nd day as it came off. The patients were not asked to maintain a diary to determine the adherence to exercise.

Future studies are needed to determine the long-term efficacy of taping in comparison to multiple sessions of conventional treatment. It would be beneficial to use diagnostic imaging tools like ultrasound to determine the extent of healing.

CONCLUSION

It can be concluded that a single session of taping and LASER are equally effective in the short-term treatment of PF.

Since both are found to be effective it can also be concluded that a single session of low-dye calcaneal taping and home exercise program can be used as a viable short-term alternative to conventional LASER therapy and exercise program in subjects with PF, thereby reducing the cost of treatment and burden of follow-up.

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