

Effectiveness of Strengthening Exercise Program to Reduce Pain Intensity and Improve Temporospacial Gait Parameters for Patients with Plantar Fasciitis

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I. Introduction

Plantar Fasciitis is also known as inferior heel pain; which is most common among foot pain. It is usually seen in sports that include long- standing, running and non-athletes like medical professionals whose occupation require prolonged weight-bearing. Patients with plantar fasciitis may present with pain and tenderness located inferior to the plantar fascia which includes gradual, insidious onset, pain and stiffness that worsen in the morning or after prolonged weight bearing that affects activities of daily living.¹ Patients with plantar fasciitis tend to walk slowly to avoid pain and are risk for developing antalgic gait which results in loss of muscle strength and flexibility. They may also have myofascial restrictions and muscle stiffness or tightness.²

Several treatment techniques are used for patients with plantar fasciitis among which they prefer non-surgical or conservative management. It may include rest, anti-inflammatory drugs, shoe inserts stretching exercises, shoe wear modification and physiotherapy. Conservative Physiotherapy management include icing, massage, stretching, mobilization, therapeutic ultrasound therapy, taping and strengthening etc. There are many studies which shows benefits of stretching, mobilization, ultrasound on plantar fasciitis but there is insufficient efficacy in shorter period.²

Plantar fasciitis has several risk factors which affects the biomechanical structure and function of patients. Tightness in the Achilles tendon and plantar fascia can cause weakness in foot and ankle strength.^{3,4} Patients with plantar fasciitis found to have weakness in various muscles such as Ankle evertors (peroneus brevis and longus), Toe flexors (flexor hallucis longus and brevis, flexor digitorum longus and brevis), intrinsic and extrinsic muscles of the foot which may result in the recurrent symptoms of plantar fasciitis.² Dorsiflexors act eccentrically to prevent the foot on the ground during heel strike. Plantar flexors helps in foot flat and heel off and as the body moves intrinsic muscles activate to convert the foot into an increasingly rigid structure. Ankle invertors and evertors has its own role in midstance and mid swing phases of gait. Weakness to these musculature can cause Antalgic gait which is common in Plantar fasciitis patients. The strengthening exercise program includes ankle evertor exercise, toe curls, ankle invertor exercise, and heel raise exercise which improves strength of the weaken foot musculature.⁵ Rathleff and et al (2014) concluded a study that High load strength training improves the function of plantar fasciitis within 3 months of follow up⁶.

Several studies showed positive impact of strengthening, stretching with ultrasound on plantar fasciitis within long period . This study aimed to investigate the effectiveness of strengthening exercise program to reduce pain and temporospacial gait parameters within 4 weeks in patients with plantar fasciitis.

II. Methodology

A single blind, Interventional study design is used in this study. The study was performed from October 2020 to February 2021 in Mangalore. The study protocol was approved by Institutional Ethical Committee (AJEC/REV/115/2021).

PARTICIPANTS

Study participants were recruited from October 2020 through February 2021. Patients with Unilateral and Bilateral Plantar Fasciitis who have the history of heel pain during the few steps or after prolonged weight bearing activities for more than 1 month are included in this study. The inclusion criteria includes pain with tenderness on palpation at the calcaneum, positive Windlass Test, age group 20-30, Occupation prolonged standing with both gender. The participants were excluded : if they are diagnosed with Achilles Tendinopathy, Acute ankle sprain, Tarsal tunnel syndrome, Systematic diseases such as Rheumatoid arthritis, Fibromyalgia or neuropathy, neurological diseases, Previous foot surgery, Loss of plantar foot sensation. Among 56 eligible participants 7 were excluded due to inability to follow the time period. The sample size is calculated in order to expect a difference of 35% in reduction of pain into the groups at 1 month follow up assuming 95% confidence interval and 80% the sample size for estimated study is 28 in each group. Hence the total of 56 individuals will be included in the study.

$$n = \frac{[Z1-\alpha/2+Z1-\beta]^2 [P1(1-P1)+P2(1-P2)]}{(P1-P2)^2}$$

EVALUATION

The researcher recruited the participants according to inclusion criteria. The participants were asked about their pain using Visual Analogue Scale (VAS) which was valid and reliable ⁷ for the patients with plantar fasciitis. The temporospatial gait parameters were evaluated with Inch tape and stop watch. The participants stood at a platform and were asked to walk with barefoot. The temporospatial gait parameters includes cadence (step/min), stride length (m), step length(m), step width(m).

PROCEDURE

Participants were recruited as Group A with strengthening (n=28) and Group B with therapeutic ultrasound therapy (n=28). Participants were asked to grade their pain intensity with Visual Analogue Scale (VAS) and temporo-spatial gait parameters before the treatment. Participants were treated as Group A with Strengthening and Group B with therapeutic Ultrasound for 4 weeks. Post-Treatment, VAS and temporo-spatial gait parameters were recorded for decrease in the pain intensity and improvement in gait parameters.

The strengthening exercise program consist of a toe curl exercise, ankle evtor exercise, ankle invertor exercise, plantar flexion exercise , dorsi flexion exercise and heel raise exercise. The starting level of each exercise was selected by the physical therapist, evaluating performance of the participants. The exercise progression also based on the individual achievement of the previous level of progression. For the ankle evtor and invertor exercise, additional level of weight cuffs was placed at each level. The heel raise exercise progressed by its starting position; initially both feet with hand support which progresses to both feet without hand support, single foot with hand support, and single foot without hand support. The plantar flexion and dorsiflexion exercises are performed against the resistance initialy with the hand later against the weight cuffs.

Therapeutic ultrasound therapy with a 50% pulse mode at a frequency of 1.0 MHz and intensity of 1.5 W/cm² was applied to the participants in Group B for 5 minutes with a slow circular motion on the most painful area of the heel.

STATISTICAL ANALYSIS

Chi square is used to test the significant difference in reduction of pain and improve temporospatial gait parameters between the 2 groups. Pre and post treatment of strengthening and ultrasound group is measured with t-test.

GROUP A

Strength exercise for 4 weeks
Parameters: Toe curl exercise,
Ankle evtor exercise,
ankle invertor exercise, Plantar flexion
exercise, Dorsi flexion exercise, Heel raise exercise.
Sample size: n=28



Pain intensity: VAS



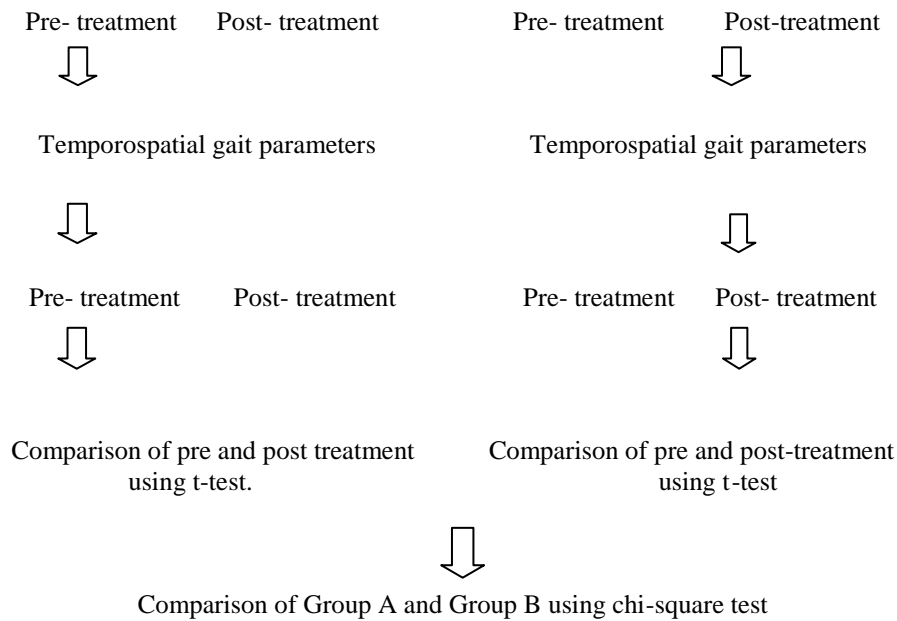
GROUP B

Therapeutic Ultrasound for
Parameters: 50% pulse
mode at a frequency of
1.0 MHz and intensity
of 1.5 for 5 minutes
Sample size: n=28



Pain intensity: VAS





III. Results

Table 1.1 Comparison of pre and post treatment of strengthening and ultrasound using t-test

	Strengthening (M±SD)		Ultrasound (M±SD)		t- Test		p- Value**	
	Pre-test	Post-test	Pre-test	Post-test	Strengthening	Ultrasound	Strengthening	Ultrasound
VAS*	7.14±0.93	0.39±0.62	7.35±0.78	1.53±0.96	34.316	42.616	0.000	0.000
Temporospatial gait parameters								
1.Cadence	96.5±7.5	107.9±7.05	97.7±8.04	85.3±10.18	-12.774	-7.117	0.000	0.000
2. Stride length	84.3±9.6	92.8±8.06	88.6±10.1	51.17±6.23	-9.6222	-15.947	0.000	0.000
3. Step length	47.1±7.9	56.4±6.60	51.17±6.23	54.92±5.74	-9.108	-10.456	0.000	0.000
4. Step width	7.71±2.20	7.83±2.14	7.55±1.88	7.60±1.92	-2.553	-1.800	0.01	0.083

*VAS- visual analogue scale, ** p-value- p<0.05

CHI-SQUARE TEST

Table 1.2 Comparison of strengthening and ultrasound group using Chi-square test

	Chi- square value (Strengthening+ultrasound)	p- value**
VAS*	10.053	0.261
Temporospatial gait parameters		
1.Cadence	217.389	0.349
2.Stride length	289.333	0.200
3. Step length	167.222	0.255
4.Step width	112.387	0.169

*VAS- visual analogue scale, ** p-value- p<0.05

IV. Discussion

Plantar fasciitis (PF) is the common cause for heel pain which affects people with sedentary lifestyle and athletic population due to chronic overload from lifestyle. Weakness of the foot musculature may result in

the recurrent symptoms of PF due to improper functioning of the muscle and joint positioning during walking. Strengthening exercise program helps to reduce pain and increase the function of the foot with plantar fasciitis.

The present study was to determine the effectiveness of strengthening exercise program to reduce pain and improve temporospatial gait parameter within 4 weeks in patients with plantar fasciitis. For this study, patients with plantar fasciitis were allocated to two groups to receive physical therapy treatment with strengthening or therapeutic ultrasound therapy. In our results, the post-treatment of VAS in ultrasound group shows 1.53 ± 0.96 and strengthening group gives 0.39 ± 0.62 . The post-treatment of cadence in ultrasound group shows 85.3 ± 10.18 and strengthening group shows 107.9 ± 7.05 . Stride length in ultrasound group after treatment shows 51.17 ± 6.23 and in strengthening group after treatment shows 92.8 ± 8.06 . Step length in ultrasound group after treatment shows 54.92 ± 5.74 and strengthening group after treatment shows 56.4 ± 6.60 . Step width in ultrasound group after treatment shows 7.60 ± 1.92 and strengthening group after treatment shows 7.83 ± 2.14 . From table 1.1, strengthening exercise program showed much enhancement in reducing pain and to improve temporospatial gait parameters within 4 weeks as compared to therapeutic ultrasound group.

Both the groups tended to have slight increase in reduction of pain within 1 week-follow up. The therapeutic ultrasound therapy has placebo effect on the patients with plantar fasciitis where strengthening exercise program gives beneficiary effect on reducing the pain and improving the function. Within the 3rd week of follow-up, patients in the strengthening group appeared to have slight improvement in temporospatial gait parameters while ultrasound group doesn't showed much difference. Participants in the strengthening group showed significant improvement in reducing the pain, increasing the cadence, stride length and step length. The strengthening exercise improved the condition of the participants but they didn't attain normal range in terms of cadence within 4 weeks time period.

Rathleff and et al (2014) conducted a study on High-load strength training improves outcome in patients with plantar fasciitis: A randomized controlled trial with 12-month follow-up. This study focused on strengthening exercise program and concluded that High- load strength training may aid in a quicker reduction in pain and improvement in function⁶.

Yigal Katzap and et al (2018) did a study on Addictive effect of therapeutic ultrasound in the treatment of plantar fasciitis: A Randomized controlled trial. The study concluded that therapeutic ultrasound did not improve the efficacy of conservative treatment for plantar fasciitis⁸.

The limitations of this study are as follows; First, the study did not differentiate between unilateral and bilateral types of plantar fasciitis. Secondly, Longterm follow-up is inconvenient for the participants. Third, We couldn't assess weight and height of the participants. Obesity may cause plantar fasciitis.

V. Conclusion

Both the strengthening exercise program and therapeutic ultrasound therapy could reduce the pain and improve temporospatial gait parameters in patients with plantar fasciitis within 4 weeks. There were no differences in the testing parameters between the strengthening and ultrasound groups.

CONFLICT OF INTEREST

There is no potential conflict of interest relevant to this article was reported.

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