ORIGINAL ARTICLE

INTERNATIONAL JOURNAL OF RESEARCH IN PHARMACEUTICAL SCIENCES

Published by JK Welfare & Pharmascope Foundation Journal Home Page: https://ijrps.com

A study on the efficacy of short arc foot technique for subjects with foot pain

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Article History:

Received on: 13.06.2018
Revised on: 12.09.2018
Accepted on: 14.09.2018

Keywords:

Plantar fasciitis,
Short foot exercise,
Ultrasound therapy,
Intrinsic muscles

ABSTRACT

To find the effectiveness of short foot exercise on pain with numerical pain rating scale among subjects with plantar fasciitis, to find the effectiveness of short foot exercise on muscle power with manual muscle testing among subjects with plantar fasciitis and to find the effectiveness of short foot exercise on quality of life with foot and ankle ability measure questionnaire among subjects with plantar fasciitis. 20 patients with plantar fasciitis were included using inclusion criteria. (OUTCOME MEASURE): Numerical Pain Rating Scale (NPRS) for quantifying pain. Manual muscle testing (MMT) for measuring muscle power. Foot and ankle ability measure questionnaire (FAAM) for quantifying the quality of life. Statistical analysis for outcome measures shows there is a highly significant difference noted in between Group A when compared with Group B.From the result, it has been concluded that ultrasound therapy with short foot exercise (GROUP A) is more effective than ultrasound therapy (GROUP B) in decreasing pain, improving muscle power and improving the quality of life in patients with plantar fasciitis.

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ISSN: 0975-7538
DOI: https://doi.org/10.26452/ijrps.v9i4.1699

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INTRODUCTION

The human foot complex is a strong structure containing more than 26 bones and 33 joints, along with 19 muscles and 107 ligaments, which bears the full body weight and allows locomotion. Plantar fasciitis is known as "heel pain syndrome"(Neufeld S *et al.,* 2016).

It is estimated as that at least once in a lifetime everyone will experience hell pain. There are three major risk factors for developing plantar fasciitis. It includes anatomical, biomechanical, environmental risk factors (Stecco C *et al.,* 2013). Anatomical risk factor includes pes planus, obesity, leg length discrepancy, etc. Biomechanical risk factor includes weak plantar muscles, excessive subtalar joint pronation etc. Environmental risk factors include prolonged standing, walking barefoot, prolonged weight bearing etc.

Localized tenderness at the anteromedial aspect of the calcaneus is the key factor of plantar fasciitis. Pain may be increased by doing passive dorsiflexion of the toes (Shane Mc Clint 2016).

Physiotherapy for treating plantar fasciitis is a multi-faced approach. It includes ultrasound, shoe modification, massage etc. (Headlee *et al.,* 2008). But none of the studies concentrated on Strengthening of intrinsic foot muscles which is important in plantar fasciitis.

Intrinsic muscles of the foot have several smaller muscles present on the bottom of the foot.10 intrinsic muscles present on the sole. Which act as stabilizers of arches, When these muscles go for the weakness they unable to support the foot arch (Almubarak, A *et al.,*.2012). The short foot exercise is used to build the strength of intrinsic foot muscles that support the medial arch. Short arc foot exercise contracted the intrinsic muscles of the foot,

and mainly strengthens the abductor hallucis muscle, which is an important dynamic stabilizer of the foot arch (Hashimoto, T. *et al.,* 2014). Ultrasound therapy has used extensively because of its thermal effects. It has been a treatment of choice in soft injuries (Johnson, A. *et al.,* 2015).

MATERIALS AND METHODS

A Quasi-experimental study was conducted at Saveetha medical college hospital. Scientific review board approval and ethical committee approval was obtained prior to the study. Following the ethical clearance, data collection procedure was initiated. Detailed procedure was clearly explained to the patient by providing information sheet and written informed consent was taken from all the participants. A Consecutive sampling technique used to allocate the participants equally into two groups by lottery method.

20 subjects who are diagnosed as plantar fasciitis were included in the study who fulfils the criteria. The study included those between 20 to 40 years, subjects with unilateral plantar fasciitis, windlass test +ve. The study excluded those with recent fractures/injuries in feet, recent surgeries in feet and any severe systemic illness. 10 participants in group A was given ultrasound therapy followed by short foot exercise, 10 participants in group B was given ultrasound therapy alone. Both the group subjects were assessed for pre-test outcomes of numerical pain rating scale, manual muscle testing and foot and ankle ability measure questionnaire. Following the intervention period of 2 weeks, the same tests were repeated for post-test. Duration of treatment for 2 weeks, 5 days/ week for both the group.

ULTRASOUND THERAPY

Ultrasound therapy was given to the patient in a comfortable position preferably in prone lying with pillow/ towel roll supported in anterior part of the ankle. Then it was given by moving the transducer head over the medial plantar aspect of the heel/painful region by small concentric circles. The ultrasonic gel was used as coupling media. Treatment parameters are as follows (Table-I).

Table 1: Treatment Protocol for Ultrasound Therapy

Frequency	1 MHZ
Intensity	0.8W cm^2
Duration	8 minutes
Mode	Continuous

SHORT FOOT EXERCISE

The patient was positioned in sitting and the therapist demonstrates the exercise to the patient. Then, the patients were asked to pull first metatarsal head towards the heel without flexing the great toe. Exercise protocol was given by the following parameters (Table-2).

Table 2: Exercise protocol for Short Foot Exercise

Session	1session / day
Repetitions	5 repetitions / day
Rest time	3 seconds
Hold time	6 seconds
Frequency	5 days/week
Duration	2 weeks

ULTRASOUND THERAPY

Ultrasound therapy was given to the patient in a comfortable position preferably in prone lying with pillow/ towel roll supported in anterior part of the ankle. Then it was given by moving the transducer head over the medial plantar aspect of the heel at a painful region by small concentric circles. The ultrasonic gel was used as coupling media. Treatment parameters are as follows. (same as Table-1)

RESULT

From the statistical values made with the quantitative data revealed that there is a significant difference between Group-A and Group-B.The mean value comparison of Numerical Pain Rating Scale between Group-A and Group- B was 3.10 (SD 0.88) and 5.50 (SD 0.85) respectively which has a statistically significant difference showing the intervention of Group-A is effective with a p-value of <0.0001. Post-test mean value of pain shows more reduction in Group-A. The post-test mean value comparison of MMT- hallux, toe, MP flexion between Group -A and Group-B is 4.10 (SD 0.57) and 2.70 (SD 0.48)

MMT-hallux, toe, DIP, PIP flexion between Group-A and Group- B is 4.10 (SD 0.57) and 2.40 (SD 0.52) MMT- hallux, toe, DIP, PIP extension between Group-A and Group-B is 4.20 (0.79) and 2.60 (0.52) Respectively which has a statistically significant difference showing the intervention for Group-A to be more effective with a p-value of <0.0001. Post-test mean value of muscle power improved in Group-A.

Table 3: Mean Comparison for Numerical pain rating scale (NPRS) between the two groups

Group A	Group B	t value	p-value
3.10± 0.88	5.50± 0.85	6.21	<0.0001

The post-test mean value comparison of FAAM between Group-A and Group- B is 80.00 (SD 6.09) and 64.80 (SD 7.45) respectively which has a statistically significant difference showing the intervention for Group-A to be more effective with a p-value

of <0.0001. The post-test mean value of quality of life improved in Group-A.

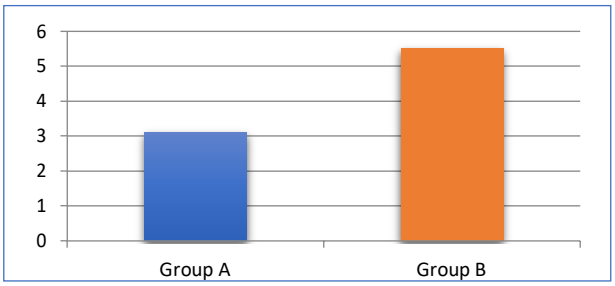

Figure 1: Graphical Comparison for NPRS between the two groups

Table 4: Mean Comparison for Manual Muscle Testing (MMT) between the two groups A & B

Parameters	Group A	Group B	t value	p-value
Hallux, Toe, MP Flexion	4.10± 0.57	2.70± 0.48	5.93	< 0.0001
Hallux, Toe, DIP, PIP Flexion	4.10± 0.57	2.40± 0.52	7.00	<0.0001
Hallux, Toe, DIP, PIP Extension	4.20± 0.79	2.60± 0.52	5.36	<0.0001

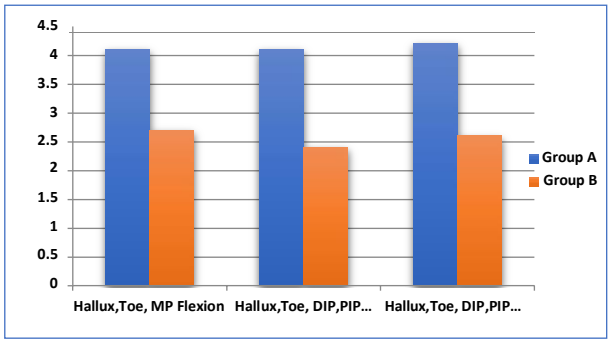

Figure 2: Graphical Comparison for MMT between the two groups

Table 5: Mean Comparison for Foot and ankle ability measure (FAAM) Questionnaire between the two groups

Group A	Group B	t value	p-value
80.00±6.09	64.80±7.45	4.99	<0.0001

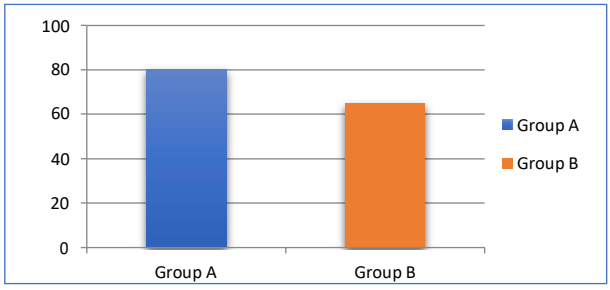

Figure 3: Graphical Comparison for FAAM between the two groups

DISCUSSION

Plantar heel pain is due to repetitive strain in the medial longitudinal arch and plantar fascia. The plantar fascia is a dense, fibrous connective tissue. It has three portions-medial, lateral and central (Latey, P. J., *et al.,* 2014). The central portion originates from the medial tuberosity of calcaneus superficial to flexor digitorium brevis, quadratus planate and abductor hallucis muscle (Miller, E., *et al.,* 2014). It runs along with medial longitudinal arch and forms individual bundles which are inserted into each proximal phalanx. It also connects to Para tendon of Achilles, intrinsic foot musculature, skin and subcutaneous tissue (Mulligan, E. P., *et al.,* 2013).

The plantar fascia acts as a static stabilizer for the longitudinal arch and also as a shock absorber. Strain in the longitudinal arch of the foot which exerts its maximal pull on the plantar fascia especially from the medial tuberosity of calcaneus. Plantar fasciitis is the inflammation of the plantar fascia and its surrounding structures. The clinical presentation of plantar fasciitis includes a gradual onset of pain in the heel region or throughout the sole of the foot which is worse in the morning or after prolonged ambulation. Other common symptoms include swelling of ankle, tenderness and limping. Conservative management of plantar fasciitis includes reducing pain, inflammation, restoring muscle strength, reducing stress on fascia and also in improving flexibility.

Medical treatment includes corticosteroids, analgesics and physical therapy treatment includes ultrasound, contrast bath for pain relief and inflammation. To reduce stress on fascia footwear modification, foot orthosis, foot strapping and tapping are used. Stretching is used to improve flexibility (Young, C. *et al.,* 2012).

But most of them are not concentrating on muscle strength. Restoration of muscle strength plays a major role in plantar fasciitis. A recent article says that foot intrinsic considered as core muscles of the foot. We all have core muscles around the spine which plays a major role in stabilizing and protecting the spine. Likewise, whenever foot intrinsic was weak and unable to support the foot they must be strengthened properly.

Weak intrinsic is a factor contributes to limited treatment success. It is assumed that pain inhibits performance of the muscle or atrophy due to disuse or prolonged accommodation. So, strengthening of intrinsic foot muscles is important in plantar fasciitis. Short foot exercise strengthens the intrinsic foot muscle mainly abductor hallucis because the muscle blends with plantar fascia. Strengthening the muscle which supports the arch indirectly

reduces the stress on the plantar fascia and also in eliminating the collapsing of the arch.

Short foot exercise stimulates the proprioceptors and cutaneous receptors which are presented at the bottom of the foot thereby increasing the afferent stimulation which is responsible for stabilization of foot and also involuntary muscle activities. The present study showed that improvement in the quality of life which is due to the reduction of pain and also improving muscle strength (Thing, J. *et al.,* 2012).

In a similar study, (Lynn SK. *et al.,* 2012) said that short foot exercise group showed a greater reduction in the mediolateral COP movement of the non-dominant legs after 4 weeks of exercise while undergoing the dynamic balance test on a force plate. There is an improvement in the integrity of the medial longitudinal arch which is due to the strengthening of intrinsic foot muscles by short foot exercise.

In contrast, (Rothermel SA *et al.,* 2004) reported that they conducted static stability test on normal healthy adults, the COP excursion velocity decreased more in traditional balance training group than in short foot exercise balance training group and control group. Traditional balance training group concentrated on maintaining balance whereas short foot exercise balance training group more concentrated on maintaining short foot exercise positions which interferes with involuntary neurological activity.

CONCLUSION

From the result, it has been concluded that Short foot Exercise has shown a significant reduction in pain and quality of life of patients with Plantar Fascitis. Hence it can be formulated that Short foot Exercise is effective in the treatment of Plantar Fascitis

CONFLICT OF INTEREST

There is no conflict of interest from other authors.

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