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EFFECT OF ANKLE PNF AND SHORT FOOT EXERCISES ON PAIN AND MOBILITY AMONG INDIVIDUALS WITH PLANTAR FASCIITIS

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ABSTRACT

Background: Plantar fasciitis (PF) is a common cause of heel pain, often leading to reduced mobility and functional limitations. Various rehabilitation techniques, including proprioceptive neuromuscular facilitation (PNF) and Short Foot Exercises (SFE), have been explored to alleviate pain and improve mobility in affected individuals. Therefore, the aim of this study is to investigate the effect of ankle PNF and short foot exercises on pain and mobility among individuals with plantar fasciitis. **Methodology:** A quasi-experimental study was conducted on individuals diagnosed with plantar fasciitis. Participants were assigned to two groups: experimental group performed ankle PNF and short foot exercises, while the control group was engaged with conventional training. Pain levels were assessed using the Numeric Pain Rating Scale (NPRS) and mobility was measured using the Range of Motion assessments before and after the intervention. **Result:** The study revealed significant improvements in pain reduction and mobility in individuals with plantar fasciitis after 4 weeks of Short Foot Exercises and Ankle PNF. NPRS mean value of decreased from 6.93 to 2.93, indicating reduced pain, while goniometer mean value increased from 7.60 to 12.46, showing improved mobility. **Conclusion:** Ankle PNF and short foot exercises are effective in reducing pain and improving mobility in individuals with plantar fasciitis. A combination of both interventions could be recommended for comprehensive management of plantar fasciitis.

KEYWORDS: Plantar fasciitis, Proprioceptive Neuromuscular Facilitation, Short Foot Exercise.

INTRODUCTION

Plantar fasciitis, also known as jogger's heel, tennis heel, or policeman's heel, is a prevalent soft tissue condition characterized by inflammation and degeneration of the plantar fascia. Patients often report excruciating morning pain that subsides within 30-45 minutes. Key risk factors include limited ankle dorsiflexion, middle age, biomechanical issues like tight Achilles tendons, Pes cavus, and Pes planus, as well as obesity, which affects 70% of people, and prolonged weight-bearing activities.[1] Plantar fasciitis is a prevalent condition causing heel pain, characterized by inflammation of the plantar fascia, a thick tissue band connecting the heel bone to the toes, which plays a crucial role in maintaining the foot's arch and absorbing shock during weight-bearing activities. This condition primarily affects middle-aged and older individuals, often resulting from activities involving prolonged standing, repetitive stress, and overuse, leading to micro-trauma and degeneration of the plantar fascia.[2] A classic indicator of plantar fasciitis is the sharp pain experienced during the initial steps in the morning, often accompanied by stiffness. Prolonged standing can also trigger pain. In its early stages, plantar fasciitis typically presents with temporary discomfort that subsides with rest. Weight-bearing activities, such as running, jogging, walking, and extended standing, can exacerbate inflammation. Pain and soreness may also radiate to the medial arch. Relief can be found through applying heat, massage, and avoiding weight-bearing activities.[3]

Plantar Fasciitis (PF) is a prevalent condition among active individuals, with incidence rates ranging from 4.5% to 10.0%.[4] The significance of plantar fasciitis is

underscored by a substantial increase in research publications on this topic. A recent systematic review of foot and ankle literature trends revealed that plantar fasciitis was the second-most frequently published topic in prominent general medicine journals between 2000 and 2017. A PubMed search yielded over 1,600 results for "Plantar Fasciitis" as of February 2021, with 636 publications emerging between 2015 and 2021. Notably, the number of systematic reviews and meta-analyses on plantar Fasciitis topics is steadily growing. One such review summarized the prevalence and incidence of plantar fasciitis, revealing that it most commonly affects individuals between 40 and 60 years old, accounting for 15% of foot injuries in the general population, with no significant gender difference. This condition can impact both athletic and non-athletic populations.[5] Plantar fasciitis is believed to result from excessive accumulated tension at the plantar fascia's enthesis, leading to repetitive tensile loading and prolonged strain, which causes micro-tears in the fascia. This triggers a chronic inflammatory response as the body attempts to heal the damaged tissue, perpetuating the condition.[6] Plantar fasciitis alters the distribution of forces and loads during walking, affecting ankle joint biomechanics and leading to compensatory changes in gait mechanics, characterized by aberrant ankle movements and increased joint stress. This can result in decreased mobility, altered alignment, exacerbated ankle instability, and impaired dynamic balance.[7] The plantar fascia is composed of three bands of dense connective tissue that originate from the medial tubercle of the calcaneus and extend distally to attach to the base of each proximal phalanx. The plantar fascia tightens during the late stance to toe-off phases of gait, creating tension that elevates and supports the medial longitudinal arch. This mechanism, known as the windlass mechanism, enables the foot to function as a rigid lever for forward propulsion. Repetitive strain leads to micro-tearing, triggering a repair response. Histological analysis reveals thickening and fibrosis of the plantar fascia, along with collagen necrosis, chondroid metaplasia, and calcification.[8] To assess the presence of plantar fasciitis using the windlass test.[9]

Proprioceptive Neuromuscular Facilitation (PNF) is a widely used technique in exercise and sports to enhance overall function. Ankle PNF, in particular, emphasizes the importance of timing to harmonize and synchronize the internal and external muscle movements of the foot.[10] Proprioceptive Neuromuscular Facilitation (PNF) theories offer a promising approach to enhancing postural balance and stability. As a therapeutic strategy, PNF aims to stimulate neuromuscular responses by targeting the proprioceptive sense response mechanism. This technique encompasses various methods designed to stimulate proprioception, ultimately improving the responsiveness of neurological and muscular systems. In the context of exercise and sports, PNF is utilized as a stretching method to increase flexibility, strength, balance, and joint mobility. Furthermore, the timing emphasis in ankle PNF has been refined to synchronize and strengthen the movement patterns of both intrinsic and extrinsic foot muscles.[11]

The Short Foot Exercise (SFE) is a therapeutic technique that targets strengthening the intrinsic foot muscles. This exercise can benefit both individuals with normal feet and those with flat feet, by activating the intrinsic muscles and potentially preventing navicular drop.[12] In cases of flatfoot deformity, Short foot exercises are employed to strengthen the intrinsic foot muscles (IFMs), thereby maintaining the medial longitudinal arch (MLA). Notably, Okamura's research demonstrated that Short foot exercises can decrease Foot Posture Index (FPI)values.[13] It involves contracting the intrinsic foot muscles to pull the first metatarsophalangeal joint towards the calcaneus, thereby elevating the medial longitudinal arch without toe flexion. Research has shown that short foot exercises significantly increases activation of the abductor hallucis muscle, making it a valuable exercise for IFM strengthening. Although Short foot exercises has gained popularity only recently, within the past decade, its effectiveness has been well-established.[14] In recent years, the Short foot Exercise (SFE) has emerged as a popular method for enhancing postural stability and strengthening the plantar muscles. The short-foot posture is characterized by an increased medial longitudinal arch, which improves the foot's biomechanical position. This exercise increases the medial longitudinal arch by contracting the intrinsic foot muscles (IFM) without over activating extrinsic muscles like the tibialis anterior and gastrocnemius. Patients can actively perform Short foot Exercise under weight-bearing conditions. Recent studies have shown that Short foot Exercise is effective in sports and rehabilitation for flat-footed patients, improving balance, stability, and intrinsic foot muscles strength for adequate medial longitudinal arch support. A four-week training program focusing on intrinsic foot muscles recruitment yielded similar results, enhancing dynamic standing balance.[15]

MATERIALS AND METHODS

This study was a Quasi experimental study aimed to explore the effect of ankle PNF and short foot exercises on pain and mobility among individuals with Plantar Fasciitis. The Participants for the study were selected based on the inclusion and exclusion criteria. The inclusion criteria include male and female individuals who were positive for windlass test from age 40 to 60 years with plantar area pain and morning stiffness. All participants were explained about this study, 30 patients who fulfilled the inclusion and exclusion were selected for the study. The subjects were randomly divided into 2 groups. That is group A and group B each group consists of 15 subjects.

- **GROUP A** (15 patients) was given ankle PNF and Short foot exercises.
- **GROUP B** (15 patients) followed regular conventional training.

The level of pain and mobility was evaluated at the beginning and at the end of 4 weeks training with Numerical Pain Rating Scale (NPRS) and goniometer. The subject willing to participate was asked to sign the informed consent. The procedure was explained before proceeding the study. All patients were followed up and guided by the same physiotherapist in all sessions.

SPECIAL TEST: The windlass test was conducted using both weight -bearing and non -weight bearing techniques. The test has a sensitivity of 32 % and a specificity of 100 % for diagnosing plantar fasciitis.

➢ **WEIGHT BEARING (WB) TECHNIQUE**

The patient stands at the edge of a step with their toes hanging off. The examiner passively dorsiflexes big toe while the patient maintains their weight on the affected foot.

POSITIVE TEST: Pain at the medial heel or along the plantar fascia. The method simulates real-life loading condition on the plantar fascia.

➢ **NON-WEIGHT BEARING TECHNIQUE**

POSITIVE TEST: The patient sits or lies supine with the foot in a neutral position. The examiner stabilizes the ankle and passively dorsiflexes the big toe. Pain along the plantar fascia, indicating tightness or irritation. This method isolates the plantar fascia without weight bearing stress. The windlass test helps in confirming plantar fasciitis by reproducing symptoms associated with fascia tightness and inflammation.

TREATMENT PROTOCOL

GROUP A – Ankle proprioceptive neuromuscular facilitation (PNF) and Short foot exercises)

This group received treatment that focused on strengthening their intrinsic foot muscles.

Table 1: Training Schedule: Reps /Sets Over 4 Weeks.

EXERCISES	TRAINING PROGRAM (NO SETS/REPS)			
	WEEK - 1	WEEK - 2	WEEK – 3	WEEK - 4
DORSIFLEXION/ PLANTARFLEXION EXERCISES	2/10	3/10	4/10	5/10
TOE CURL EXERCISES	2/10	3/10	4/10	5/10
PERONEAL STRENGTHENING EXERCISES	3/5	4/5	5/5	6/5
SYSTEMATIC STABILIZATION	3/5	4/5	5/5	6/5
REPEATED CONTRACTION	3/5	4/5	5/5	6/5

GROUP B – CONVENTIONAL TRAINING

Participants in this group followed conventional training protocol. Contrast bath therapy was given by alternating between warm water for 3-4 minutes and cold water for 1 minute, repeating the cycle 3-4 times daily and ending with cold water. High-impact activities can be replaced with lowimpact exercises to reduce stress on the foot. Daily Rest and ice application, using an ice pack for 15-20 minutes daily. Furthermore, incorporating gentle foot movements into the daily routine. All the subjects were advised to use soft heel foot wear, not to stand for long time and not to walk bare foot

RESULT

The data collected from the Individuals where tabulated and entered in MS excel spreadsheet. The pre and post mean values of NPRS and goniometric measurements values was calculated, assessed and tabulated. The data analysis was done by using SPSS software.

The result of this study proved that the experimental group which received Short foot exercises and ankle PNF for plantar fasciitis for duration of 4 weeks showed an improvement in pain reduction and mobility. The statistical analysis showed significant improvement in NPRS values and goniometric measurement values.

The experimental group showed an increased value in the post- test with an average. pre- test values for NPRS us 6.93, were as the post-test value is 2.93, which showed that there is a reduction in pain value after training.

The pre- test value for Goniometer measurement is 7.60.whereas the post- test value is 12.46 which showed there is an improved mobility after training for individuals with plantar fasciitis.

Table 2: Pre and post test values of nprs score in experimental group.

Group A	Pre-Test		Post-Test		t-Test	p-value
	MEAN	SD	MEAN	SD		
NPRS	6.93	1.27	2.93	1.27	59.0	0.000*

This table shows Mean value, SD, T value and significant value for the pre and post experimental group of NPRS score. The table is significant on the P value in <0.05.

Table 3: Pre and post test values of nprs score in control group.

Group B	Pre-Test		Post-Test		t-Test	p-value
	MEAN	SD	MEAN	SD		
NPRS	6.73	1.10	7.20	1.21	1.70	0.000*

This table shows Mean value, SD, T value and significant value for the pre and post Control group of NPRS score. The table is significant on the P value in <0.05.

Both groups show a highly significant difference between pre-test and post-test NPRS scores, indicating the effectiveness of the interventions.

Table 4: Pre and post test values of goniometer score in experimental group.

Group A	Pre-Test		Post-Test		t-Test	p-value
	MEAN	SD	MEAN	SD		
NPRS	7.60	2.03	12.47	2.42	8.97	0.0001*

This table shows Mean value, SD, T value and significant value for the pre and post experimental group of goniometer score. The table is significant on the P value in <0.05.

Table 5: Pre and post test values of goniometer score in control group.

Group B	Pre-Test		Post-Test		t-Test	p-value
	MEAN	SD	MEAN	SD		
NPRS	10.20	2.40	8.27	1.94	5.61	0.0001*

This table shows Mean value, SD, T value and significant value for the pre and post experimental group of goniometer score. The table is significant on the P value in <0.05.

Both groups show a highly significant difference between pre-test and post-test NPRS scores, indicating the effectiveness of the interventions.

DISCUSSION

This study's findings demonstrate the efficacy of combining ankle proprioceptive neuromuscular facilitation (PNF) and short foot exercises (SFE) in reducing pain and improving mobility in individuals with plantar fasciitis. The experimental group (Group A) exhibited significant pain reduction and improved ankle dorsiflexion range of motion and foot mobility compared to the control group (Group B), which received conventional training. The enhanced outcomes In Group A can be attributed to the synergistic effects of ankle PNF and short foot exercises. Ankle PNF enhances flexibility, neuromuscular control, and proprioception, while short foot exercises strengthen the intrinsic foot muscles, restoring the medial longitudinal arch and improving foot stability and function. This targeted approach addresses the underlying biomechanical factors contributing to plantar fasciitis, leading to more effective pain management and mobility restoration. The study's results highlight the importance of neuromuscular control in plantar fasciitis rehabilitation. Ankle PNF and short foot exercises improve postural control, arch stability, and shock absorption, enabling more efficient movement patterns. These findings have significant implications for clinical practice and rehabilitation strategies, suggesting that combining ankle PNF and short foot exercises may be a valuable non-invasive treatment option for plantar fasciitis. Furthermore, the results of this study suggest that the combination of ankle PNF and short foot exercises may be more effective than conventional training alone in reducing pain and improving mobility in individuals with plantar fasciitis. This may be due to the fact that ankle PNF and short foot exercises target specific biomechanical factors that contribute to plantar fasciitis, whereas conventional training may not address these factors as effectively. The findings of this study also foot exercises have implications for the prevention of plantar fasciitis. By incorporating ankle PNF and short foot exercise programs, individuals may be able to reduce their risk of developing plantar fasciitis. Additionally, these exercises may be beneficial for individuals with other foot and ankle conditions, such as Achilles tendinitis or ankle sprains. Future research should investigate the longterm effects of this intervention and explore the potential benefits of combining ankle PNF and short foot exercises with other treatments. Additionally, factors such as footwear, activity levels, and biomechanics should be considered to assess their influence on rehabilitation outcomes. While this study demonstrates the effectiveness of ankle PNF and short foot exercises, some limitations must be acknowledged. The sample size may have influenced the generalizability of the results, and long-term follow-up is needed to determine the sustainability of improvements. Nevertheless, the findings of this study provide valuable insights into the treatment of plantar fasciitis and highlight the importance of neuromuscular control in rehabilitation. The findings of this study have significant implications for clinical practice and rehabilitation strategies, and highlight the importance of neuromuscular control in plantar fasciitis rehabilitation. The clinical implications of this study are significant. The results suggest that clinicians should consider incorporating ankle PNF and short foot exercises into their treatment protocols for plantar fasciitis. This may involve modifying existing exercise programs to include these specific exercises, or

developing new programs that incorporate ankle PNF and short foot exercises. Further research is needed to fully explore the benefits and limitations of ankle PNF and short foot exercises in the treatment of plantar fasciitis. However, the findings of this study provide a promising starting point for the development of more effective treatment protocols for this common and debilitating condition. In addition to its clinical implications, this study also highlights the importance of interdisciplinary collaboration in the development of effective treatment protocols. The study's findings demonstrate the value of combining expertise from physical therapy, orthopedics, and sports medicine to develop more effective treatment strategies for plantar fasciitis. A 2022 study by **Khisty** reavealed that the short foot exercise program surpasses conventional therapy in strengthening the medial longitudinal arch and enhancing intrinsic foot muscle activity for individuals with flexible flat feet. Research by Manali Boob et al. in 2023 showed that ankle PNF and foot core exercises can significantly improve dynamic balance and reduce pain in plantar fasciitis, with ankle PNF potentially offering greater benefits. A 2022 study by **Abha Khisty et al.** found that short foot exercises are more effective than conventional exercises in activating the medial longitudinal arch and improving foot function in individuals with flat feet. Overall, the results of this study provide a significant contribution to the existing literature on the treatment of plantar fasciitis. The findings highlight the importance of neuromuscular control in rehabilitation and demonstrate the efficacy of combining ankle PNF and short foot exercises in reducing pain and improving mobility in individuals with plantar fasciitis

CONCLUSION

In conclusion, the findings of this study demonstrate the efficacy of ankle Proprioceptive Neuromuscular Facilitation (PNF) and short foot exercises in alleviating pain and improving mobility among individuals with plantar fasciitis. The significant improvements in pain reduction and functional mobility observed in this study highlight the potential benefits of incorporating these exercises into rehabilitation programs for individuals with plantar fasciitis. This study emphasizes the importance of targeted exercises in managing plantar fasciitis and underscores the critical role that physiotherapists play in designing customized rehabilitation programs tailored to the unique needs of patients. Ultimately, this research contributes to the growing body of evidence supporting the use of conservative management strategies, including exercise therapy, in the treatment of plantar fasciitis.

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