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COMPARISON OF INTRINSIC VERSUS EXTRINSIC FOOT MUSCLE STRENGTHENING ON PAIN AND FUNCTION IN PLANTAR FASCIITIS: AN EXPERIMENTAL STUDY.

Physiotherapy

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ABSTRACT

Background: Plantar fasciitis is a prevalent condition affecting 10% of the general population, particularly active working adults aged 25 to 65. This study aimed to assess the efficacy of intrinsic and extrinsic muscle-strengthening exercises in individuals with plantar fasciitis, considering age-specific responses. **Methods:** A randomized controlled trial was conducted involving 30 participants (18 females, 12 males) aged above 18, distributed into Group-A (intrinsic exercises) and Group-B (extrinsic exercises) for a 4-week intervention. Age distribution mirrored the typical age range of plantar fasciitis patients. **Results:** In participants aged above 40, intrinsic exercises demonstrated a statistically significant improvement in foot function and pain reduction compared to extrinsic exercises. No significant differences were observed in participants below 40. Overall, intrinsic exercises showed superiority in both age groups. **Conclusion:** This study highlights the importance of tailoring exercise interventions for plantar fasciitis based on age. Intrinsic exercises, particularly for individuals above 40, proved more effective in enhancing foot function and reducing pain. These findings underscore the need for individualized rehabilitation plans and warrant further research to explore long-term effects and refine treatment strategies.

KEYWORDS

Planter Fasciitis, Ultrasound, Intrinsic Exercise, Extrinsic Exercise, Foot Function Index, Numeric Pain Rating Scale.

INTRODUCTION

BACKGROUND

- Plantar fasciitis is a prevalent source of heel pain among adults. The discomfort typically results from collagen degeneration, often mischaracterized as "chronic inflammation," occurring at the point where the plantar fascia originates on the medial tubercle of the calcaneus. This degeneration shares similarities with the persistent necrosis seen in tendonosis. Tendonosis is characterized by the loss of collagen continuity, heightened levels of ground substance (the connective tissue matrix), increased vascularity, and the presence of fibroblasts, in contrast to the inflammatory cells typically associated with the acute inflammation seen in tendonitis.[1,2]
- This condition commonly results from overuse, primarily attributed to repetitive strain causing micro-tears in the plantar fascia. However, it can also manifest due to trauma or a combination of various factors. Predisposing factors include pes planus, pes cavus, restricted ankle dorsiflexion, and abnormal pronation or supination. Pes planus may increase strain at the plantar fascia's origin, while pes cavus can impose excessive strain on the heel due to inadequate foot eversion and shock absorption.
- Tightness in the gastrocnemius, soleus, and other posterior leg muscles is frequently observed in individuals with this condition, potentially altering normal walking biomechanics. While around 50% of patients may exhibit heel spurs, these spurs are not the root cause but are often present. Plantar fasciitis is commonly associated with runners and older adults, with additional risk factors including obesity, heel pad atrophy, aging, occupations involving prolonged standing, and weight-bearing activities. Although there is an association with certain seronegative spondyloarthropathies, approximately 85% of cases do not have identifiable systemic factors.[3,4]

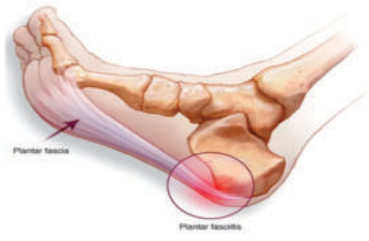


Figure 1: Diagram of Planter Fasciitis

Plantar fasciitis stands as the predominant cause of heel pain encountered in outpatient settings. While the precise incidence and prevalence across different age groups remain elusive, estimations suggest that approximately one million patient visits annually are attributed to plantar fasciitis. This condition contributes to around 10% of injuries related to running and necessitates professional medical care for 11% to 15% of all foot symptoms. It is believed to afflict approximately 10% of the general population, with the majority (83%) of affected individuals falling within the active working age group of 25 to 65 years. Bilateral presentation occurs in about a third of cases. Some literature indicates even higher prevalence rates, reaching up to 22%, particularly within populations of runners.[5,6]

- Management of plantar fasciitis involves a phased approach, with initial emphasis on conservative measures. Relative rest from the causative activity, tailored to the pain level, is recommended. Post-activity application of ice and the use of oral or topical NSAIDs can help alleviate pain.
- Patients are encouraged to modify work-related activities, and a night splint may be beneficial for those with persistent pain. Surgery is considered the final option and may involve fasciotomy through an open or endoscopic approach. However, it's important to note that surgical release does not guarantee a successful outcome. Potential complications include nerve injury, plantar fascia rupture, and flattening of the longitudinal arch. Careful consideration of the risks and benefits is imperative when contemplating surgical intervention for plantar fasciitis.[7,8,9]

Methodology

Study Place

OPD of Venus Institute of Physiotherapy, Bhoyan Rathod, Gandhinagar and Hi-Tech Multispecialty Hospital, Gandhinagar

Study Duration

4 weeks

Study Design

- Exprimental Study

Inclusion Criteria

1. Patients willing to participate
2. Both male and female subjects
3. Age between 25-60 years
4. Diagnosed with Plantar Fasciitis

Exclusion Criteria

1. Subjects with neurological disorders affecting the foot
2. Subjects with any previous heel or foot surgeries
3. Subjects with Peripheral Vascular disease
4. Subjects with pain at great toe and not around heel pain.

MATERIALS REQUIRED

Intervention

Intervention Group

1. Group A (Intrinsic Foot Muscle Strengthening + Ultrasound)
Participants will engage in a structured program including exercises such as toe curls, big toe extension *(Figure : 10)*, marble pick-up, towel gathering curls*(Figure : 9)*, toe spread, and tennis ball exercises. Each exercise is designed to target intrinsic foot muscles.
The intervention will include ultrasound therapy in addition to the exercise regimen.

2. Group B (Extrinsic Foot Muscle Strengthening + Ultrasound)
Participants in this group will follow exercises focused on extrinsic foot muscle strengthening, including calf muscle stretch*(Figure :5)*, resisted plantar flexion*(Figure : 6)*, foot supination-sitting, foot adduction, hip external rotation-side lying, and hip abduction.

Similar to Group A, participants in this group will receive ultrasound therapy *(Figure : 12)* as part of the intervention.

Exercise Protocol

Each exercise session will consist of 10–20 repetitions.
Participants will perform the exercises three times per day.

Figure 2 : Calf Muscle Stretching

Figure 3 : Resisted Plantar Flexion

Figure 4: Resisted Inversion Of Foot

Figure 5 : Abduction Of Foot Finger

Figure 6 : Towel Gathering (Curls) Exercise

Figure 7 : Big Toe Extension Exercise

Figure 8 : Big Toe Extension Exercise

Figure 9 : Apply Ultrasound Therapy

Outcome Measures

1. Foot Function Index (FFI) [13]

The FFI is a self-administered index comprising 23 items categorized into three subscales: pain, disability, and activity limitation. Participants rate each item on a scale from 0 (no pain or difficulty) to 10 (worst pain imaginable or requiring assistance) based on their foot condition over the past week. The pain subcategory consists of 9 items, disability subcategory consists of 9 items, and the activity limitation subcategory consists of 5 items. The FFI demonstrates good test-retest reliability for both total and subscale scores (ranging from 0.87 to 0.69) and high internal consistency (ranging from 0.96 to 0.73)

2. Numeric Pain Rating Scale (NPRS) [14]

The NPRS is a unidimensional measure of pain intensity in adults, comparable to the visual analogue scale (VAS). Administered verbally or graphically for self-completion, it employs a 10-point numeric scale ranging from 0 (no pain) to 10 (worst pain imaginable). Participants indicate the numeric value on the segmented scale that best describes their pain intensity. Higher scores signify greater pain intensity. The NPRS exhibits high test-retest reliability in literate and illiterate patients with rheumatoid arthritis (r=0.96 and 0.95, respectively). Additionally, for construct validity, the NPRS correlates highly with the VAS in patients with chronic pain conditions (ranging from 0.86 to 0.95). The scale provides a reliable and valid measure of pain intensity.

Data Collection

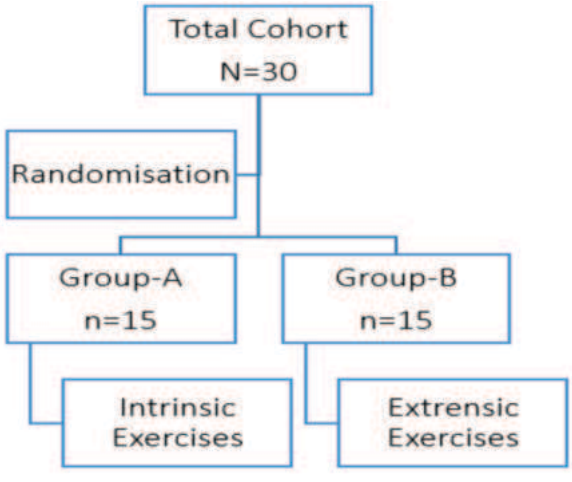
Data of all the patients were collected a data collection form.

Statistical Analysis

Descriptive statistics will be employed for demographic data, and inferential statistics will be used to compare changes in FFI and NPRS scores between the two intervention groups. The significance level will be set at $p < 0.05$.

RESULTS

This study involved a total of 30 patients diagnosed with plantar fasciitis were randomly allocated into two groups, Group-A and Group-B, each prescribed a distinct type of exercise regimen aimed at muscle strengthening—Intrinsic and Extrinsic, respectively—for a duration of 4 weeks. Among the total population, 18 patients were female and 12 were male, spanning ages from 18 to 59 years.



Baseline Characters

Table 1: Age group of Study Population

Age Group	Group-A		Group-B	
	Number	Percentage	Number	Percentage
20-29 Years	2	13.33%	2	13.33%
30-39 Years	6	40.00%	7	46.67%
40-49 Years	4	26.67%	6	40.00%
50-59 Years	3	20.00%	0	0.00%

The participant distribution across different age groups in Groups A and B, engaged in intrinsic and extrinsic exercises, respectively, reveals interesting insights. In the 20-29 age group, both groups have an equal representation of 13.33%. In the 30-39 age range, Group A constitutes 40.00% of participants, slightly less than the 46.67% in Group B. The 40-49 age group sees 26.67% in Group A compared to 40.00% in Group B. Notably, in the 50-59 age group, Group A has 20.00% representation, while Group B has none. These demographic variations underscore the importance of considering age differences in the interpretation of intervention outcomes, as the efficacy of intrinsic and extrinsic exercises may vary across different age cohorts.

Comparative Analysis of Group-A and Group-B

Table 2: Post-Baseline Full Set Descriptive Data (Group-A vs Group-B)

Post-Baseline Full Set Descriptive Data (Group-A vs Group-B)								
	Foot Function Index (FFI)				Numeric Pain Rating Scale (NPRS)			
	Group-A	Group-B	CFB	%CFB	Group-A	Group-B	CFB	%CFB
N	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Minimum	90.00	120.00	11.00	10.09	3.00	4.00	0.00	0.00
Maximum	110.00	138.00	38.00	40.00	5.00	6.00	3.00	100.00
Mean	99.07	126.90	27.87	28.57	3.67	4.73	1.07	32.78
SD	6.46	5.66	7.90	9.09	0.62	0.80	1.03	33.85
SEM	1.67	1.46	2.04	2.04	0.16	0.21	0.27	8.74
P-value	<0.0001				<0.05			
Note: CFB- Change From Baseline/ %CFB- Percentage Change From Baseline								

In the post-baseline full set analysis comparing Group-A (Intrinsic Exercises) to Group-B (Extrinsic Exercises), significant differences are observed in both the Foot Function Index (FFI) and Numeric Pain Rating Scale (NPRS). In terms of FFI, Group-A exhibited a mean score of 99.07, significantly lower than Group-B's mean of 126.90, resulting in a substantial change from baseline (CFB) of 27.87 and a percentage change (%CFB) of 28.57%. This indicates that participants in Group-A experienced a more significant improvement in foot function compared to Group-B. In the NPRS, Group-A also showed a lower mean pain score of 3.67 compared to Group-B's 4.73, resulting in a CFB of 1.07 and a %CFB of 32.78%. While both groups experienced improvements in pain, Group-A demonstrated a larger reduction. The statistical significance for both FFI and NPRS differences is indicated by p-values of <0.0001 and <0.05, respectively. These results suggest that intrinsic exercises (Group-A) may be more effective in improving foot function and reducing pain compared to extrinsic exercises (Group-B).

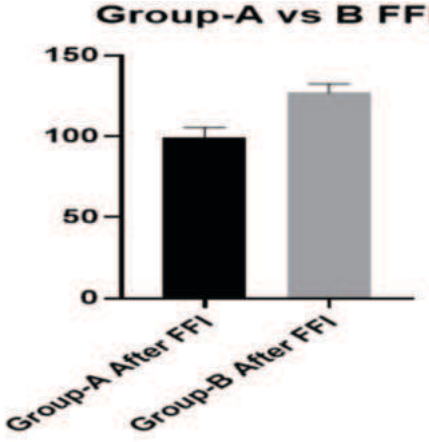


Figure 11: Post-Baseline Full Set Descriptive Data (Group-A vs Group-B)

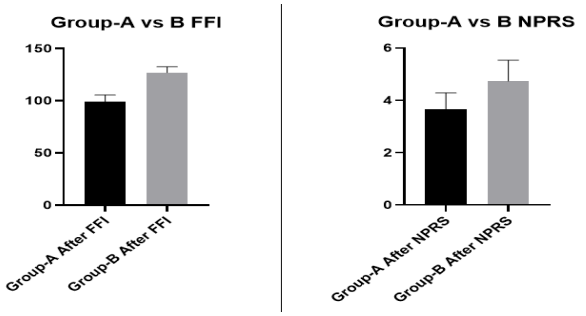


Figure 12: Post-Baseline Full Set Descriptive Data (Group-A vs Group-B)

DISCUSSION

Comparison with Previous Studies

The present study significantly contributes to our understanding of the relevance of intrinsic and extrinsic muscle strengthening in individuals diagnosed with plantar fasciitis [10]. The research cohort comprised a total of 30 participants, all above the age of 18, which aligns with the demographic characteristics of plantar fasciitis patients, a condition that notably affects around 10% of the general population. Within this demographic, a substantial majority consists of active working adults aged between 25 and 65 years, with a peak incidence occurring in the 40 to 60 years age range and a higher prevalence in women compared to men. Remarkably, a similar age distribution was observed in the present study, with the majority falling between the ages of 30 and 49[11].

Building on existing literature, a prior study involving 36 individuals focused on comparing the effectiveness of exercises targeting extrinsic and intrinsic foot muscles in enhancing the medial longitudinal arch, particularly in adolescents with flat feet. In this investigation, Group 1 engaged in intrinsic muscle exercises, while Group 2 performed extrinsic muscle exercises. The outcomes of this study resonate with the findings of the present research, where the group undertaking intrinsic exercises exhibited a statistically significant improvement compared to the group assigned extrinsic exercises for managing plantar fasciitis. These parallel results further support the notion that intrinsic exercises may be more effective than their extrinsic counterparts in addressing the complexities of plantar fasciitis. The implications of these findings are particularly relevant in informing targeted intervention strategies for individuals grappling with this prevalent foot condition [12].

CONCLUSION

In conclusion, the comprehensive analysis of participants undergoing intrinsic (Group-A) and extrinsic (Group-B) exercises, particularly when stratified by age, reveals noteworthy findings. Both intrinsic and extrinsic interventions resulted in statistically significant improvements in foot function and pain levels, with Group-A consistently demonstrating a more pronounced effect across various parameters. When examining age-specific data, the distribution of participants varies, with Group-B having a higher representation in the 30-39 age group, while Group-A displays a more balanced distribution across the 30-39, 40-49, and 50-59 age groups. Notably, Group-A consistently outperforms Group-B in improving foot function and reducing pain, especially among participants above 40 years. These results underscore the potential efficacy of intrinsic exercises, particularly for individuals above 40 years old, in enhancing foot function and alleviating pain. However, the diverse age distribution emphasizes the need for careful consideration of age-related factors in interpreting and applying these intervention outcomes. Further research and exploration of age-specific responses to intrinsic and extrinsic exercises would contribute to a more nuanced understanding of their effectiveness in improving foot health.

Limitations

- Despite the insightful findings, it is important to acknowledge several limitations in this study. Firstly, the relatively small sample size within each age group may limit the generalizability of the results to broader populations.
- The unequal distribution of participants across age groups could introduce potential bias, especially in the 50-59 age range where Group-B lacks representation. Additionally, the study's duration and follow-up period are crucial factors to consider, as they may

impact the long-term sustainability of the observed improvements. The lack of a control group or alternative intervention group further limits the ability to attribute the observed changes specifically to intrinsic or extrinsic exercises.

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