

Role Of Intrinsic Foot Muscles Strengthening Exercise In Reducing Pain Of Plantar Fasciitis

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KEYWORDS

Plantar fasciitis, Intrinsic foot muscles, Strengthening exercises, Visual Analog Scale (VAS), Foot Function Index (FFI)

ABSTRACT:

Background: Plantar fasciitis is a prevalent cause of heel pain, often resulting from inflammation and microtears in the plantar fascia due to biomechanical imbalances, overuse, or decreased intrinsic foot muscle strength. While traditional treatments include rest, anti-inflammatory medications, and orthotics, recurrence and chronic symptoms remain significant challenges. Emerging evidence suggests that strengthening intrinsic foot muscles may offer a conservative and sustainable management strategy. **Objective:** This study aimed to evaluate the role of intrinsic foot muscle strengthening exercises in reducing pain and improving foot function among patients with plantar fasciitis. **Methods:** A quasi-experimental study was conducted among 30 adults clinically diagnosed with plantar fasciitis at Department of Physical Medicine and Rehabilitation, Bangabandhu Sheikh Mujib Medical University (BSMMU), Bangladesh, between July 2018 and June 2019. Participants underwent a structured 4 to 6-week exercise regimen that included toe curls, marble pickups, short foot, and doming exercises. Pain intensity and foot function were assessed using the Visual Analog Scale (VAS) and Foot Function Index (FFI), respectively, before and after the intervention. Data were analyzed using paired t-tests, with significance set at $p < 0.05$. **Results:** Participants showed significant improvements following the intervention. The mean VAS score decreased from 7.2 ± 1.1 to 3.6 ± 1.2 ($p < 0.001$), indicating substantial pain reduction. Similarly, total FFI scores improved from 68.5 ± 9.3 to 42.3 ± 10.2 ($p < 0.001$), with notable reductions across all subscales—pain, disability, and activity limitation. High adherence (90%) and absence of adverse events highlighted the safety and feasibility of the intervention. **Conclusion:** Intrinsic foot muscle strengthening exercises significantly reduced pain and improved foot function in patients with plantar fasciitis. Given their effectiveness, safety, and accessibility, these exercises can be incorporated into conservative treatment protocols to enhance clinical outcomes and reduce dependency on pharmacologic or surgical interventions.

INTRODUCTION

Plantar fasciitis is one of the most common causes of heel pain, characterized by inflammation and microtears of the plantar fascia due to excessive strain and overuse. It affects approximately 10% of the general population at some point in their lifetime, particularly among individuals who are physically active, overweight, or spend prolonged periods standing or walking [1,2]. The condition is marked by sharp, localized pain in the heel, especially during the first steps in the morning or after periods of rest, significantly impairing mobility and quality of life [3].

The pathophysiology of plantar fasciitis is multifactorial, often associated with biomechanical imbalances such as pes planus (flat feet), tight Achilles tendons, and reduced intrinsic foot muscle strength [4]. Traditionally, treatment approaches have included rest, anti-inflammatory medications, stretching exercises, orthotics, corticosteroid injections, and in resistant cases, surgical interventions [5]. However, recurrence and chronic symptoms remain challenges, prompting the need for more sustainable and conservative management strategies.

Emerging evidence highlights the importance of intrinsic foot muscles particularly the flexor hallucis brevis, flexor digitorum brevis, and abductor hallucis—in maintaining foot arch integrity and absorbing mechanical loads during gait [6]. Weakness or underuse of these muscles may contribute to abnormal foot mechanics and increased stress on the plantar fascia. Consequently, strengthening these intrinsic muscles has gained attention as a non-invasive intervention to support foot biomechanics and alleviate symptoms in plantar fasciitis [7,8].

Several pilot and randomized studies have indicated that intrinsic foot muscle strengthening exercises, such as short foot exercises, toe curls, and doming, may effectively reduce pain, improve foot function, and enhance overall foot stability [9,10]. However, more focused quasi-experimental studies are needed to evaluate their clinical impact in routine care settings. This study aims to assess the effectiveness of a structured intrinsic foot muscle strengthening exercise regimen in reducing pain and improving function among patients with plantar fasciitis.

METHODOLOGY

This study employed a quasi-experimental design with pre- and post-intervention assessments to evaluate the effectiveness of intrinsic foot muscle strengthening exercises in reducing pain among patients with plantar fasciitis. The study was conducted at the Department of Physical Medicine and Rehabilitation, Bangabandhu Sheikh Mujib Medical University (BSMMU), from July 2018 and June 2019. The study population consisted of adult patients clinically diagnosed with plantar fasciitis. Inclusion criteria included adults aged 18 to 60 years, with a confirmed diagnosis of plantar fasciitis, who were willing to participate and provide informed consent, and who were able to perform foot exercises independently or under supervision. Patients with a history of foot surgeries or fractures, neurological conditions affecting the lower limbs, rheumatoid arthritis or other inflammatory foot disorders, or those currently undergoing other foot therapy interventions were excluded.

A total of 30 participants were selected using purposive or convenience sampling. The intervention involved a structured intrinsic foot muscle strengthening exercise program, including toe curls using a towel, marble pickups, short foot exercises, and doming exercises. These exercises were performed daily or on alternate days over a period of 4 to 6 weeks. Participants initially performed the exercises under supervision and continued with home-based practice.

Data were collected using the Visual Analog Scale (VAS) to assess pain intensity and the Foot Function Index (FFI) to evaluate foot function. Baseline assessments of pain and function were recorded before the intervention, and follow-up assessments were conducted at the end of the exercise program. Data analysis involved descriptive statistics to summarize baseline characteristics. The paired t-test or Wilcoxon signed-rank test was used to compare pre- and post-intervention scores, with statistical significance set at $p < 0.05$.

RESULTS

Baseline Characteristics of Participants

The study included 30 participants with a mean age of 42.6 ± 8.5 years, indicating a middle-aged population commonly affected by plantar fasciitis. The gender distribution showed a higher proportion of females (60%) compared to males (40%), which is consistent with the reported prevalence of plantar fasciitis being more common in women. The average duration of symptoms was 10.3 ± 3.1 weeks, suggesting that participants had subacute to chronic presentations of the condition. The mean baseline Visual Analog Scale (VAS) score for pain was 7.2 ± 1.1 , reflecting moderate to severe pain intensity before intervention. Additionally, the baseline Foot Function Index (FFI) total score was 68.5 ± 9.3 , indicating a significant impairment in foot function among the participants prior to the strengthening exercise program.

Table-1: Baseline Characteristics of Participants with Plantar Fasciitis (n = 30)

Variable	Mean \pm SD / n (%)
Age (years)	42.6 \pm 8.5
Gender (Male/Female)	12 (40%) / 18 (60%)
Duration of symptoms (weeks)	10.3 \pm 3.1

Baseline VAS score	7.2 ± 1.1
Baseline FFI total score	68.5 ± 9.3

Pain Intensity Before and After Intervention (VAS)

Participants reported a statistically significant reduction in pain intensity following the exercise program.

Table-2: Comparison of Pain Intensity (VAS Scores) Before and After Intrinsic Foot Muscle Strengthening Exercise (n = 30)

Variable	Pre-intervention (Mean ± SD)	Post-intervention (Mean ± SD)	Mean Difference	t-value	p-value
VAS Pain Score	7.2 ± 1.1	3.6 ± 1.2	-3.6	15.3	< 0.001

The Visual Analog Scale (VAS) score decreased significantly from a mean of 7.2 before the intervention to 3.6 after the 6-week intrinsic foot muscle strengthening program. The paired t-test showed a statistically significant difference ($p < 0.001$), indicating that the exercise regimen effectively reduced pain intensity among patients with plantar fasciitis.

Functional Improvement (Foot Function Index)

Foot function improved significantly after completing the strengthening exercises. Following the intrinsic foot muscle strengthening exercise program, there was a statistically significant improvement across all subscales of the Foot Function Index (FFI).

Table-3: Comparison of Foot Function Index (FFI) Subscale Scores Before and After Intervention (n = 30)

FFI Subscale	Pre (Mean ± SD)	Post (Mean ± SD)	Mean Difference	p-value
Pain	72.1 ± 10.2	44.3 ± 11.5	-27.8	<0.001
Disability	65.4 ± 9.8	40.1 ± 10.6	-25.3	<0.001
Activity Limitation	68.0 ± 11.1	42.7 ± 10.9	-25.3	<0.001
Total FFI Score	68.5 ± 9.3	42.3 ± 10.2	-26.2	<0.001

The pain subscale showed a notable reduction, with mean scores decreasing from 72.1 ± 10.2 to 44.3 ± 11.5 , indicating substantial pain relief (mean difference: -27.8, $p < 0.001$). Similarly, the disability subscale improved from 65.4 ± 9.8 to 40.1 ± 10.6 (mean difference: -25.3, $p < 0.001$), reflecting enhanced ability to perform daily activities. The activity limitation subscale also demonstrated a significant reduction from 68.0 ± 11.1 to 42.7 ± 10.9 (mean difference: -25.3, $p < 0.001$), suggesting better functional mobility. Overall, the total FFI score improved significantly from 68.5 ± 9.3 at baseline to 42.3 ± 10.2 after the intervention (mean difference: -26.2, $p < 0.001$), highlighting a marked improvement in overall foot function and quality of life. These findings support the effectiveness of intrinsic foot muscle strengthening exercises in reducing pain and disability associated with plantar fasciitis.

Participant Adherence and Safety

Table-2: Participant Adherence and Safety During the Intervention Period (n = 30)

Parameter	n (%)
Participants with >80% exercise adherence	27 (90%)
Participants with <80% exercise adherence	3 (10%)
Adverse events or injuries reported	0 (0%)

The majority of participants (90%) demonstrated high adherence to the home-based intrinsic foot muscle strengthening exercise regimen, indicating good feasibility and participant engagement with the intervention. Only 10% reported lower compliance. Importantly, no adverse events or injuries occurred during the 4 to 6-week intervention period, suggesting that the exercise protocol was safe and well-tolerated by all participants.

DISCUSSION

This study aimed to evaluate the effectiveness of intrinsic foot muscle strengthening exercises in reducing pain and improving foot function in patients with plantar fasciitis. The findings demonstrate that a structured exercise regimen targeting intrinsic foot muscles led to a statistically and clinically significant reduction in pain (VAS) and improvement in foot function (FFI) over a 4 to 6-week period.

The significant decline in VAS scores from 7.2 to 3.6 supports previous evidence suggesting that strengthening the small muscles of the foot can reduce the mechanical load on the plantar fascia and alleviate associated pain. This aligns with the concept that intrinsic muscles play a pivotal role in maintaining the medial longitudinal arch, thus improving overall foot biomechanics and reducing strain on passive structures such as the plantar fascia [11]. This was consistent with the conclusions of a systematic review by Huffer et al., which highlighted the benefits of intrinsic foot muscle strengthening in alleviating plantar fasciitis symptoms [12].

The present study showed significant improvement in all subscales of the Foot Function Index (FFI) after the intervention, with reductions in pain, disability, and activity limitation ($p < 0.001$). These findings are consistent with those of Ramachandra et al. (2019), who reported that a comprehensive foot exercise programme improved foot parameters and reduced dysfunctions in pregnant women by preventing arch collapse and pronation. This reinforces the effectiveness of structured foot exercises in managing foot-related issues during pregnancy [13]. Improvement across all domains of the Foot Function Index—including pain, disability, and activity limitation—further supports the functional benefits of these exercises. The total FFI score reduction of approximately 26 points indicates enhanced foot mobility and decreased limitations in daily activities. These findings are consistent with those reported by contemporary studies that highlighted the effectiveness of intrinsic muscle strengthening in improving dynamic foot function and arch control in patients with foot disorders [14,15].

One of the key advantages observed in this study was the high level of adherence (90%) and the absence of adverse events, indicating the safety, simplicity, and acceptability of this intervention. The use of home-based, low-cost exercises such as toe curls, marble pickups, and short foot exercises provided an accessible and sustainable treatment option for patients with limited access to formal physiotherapy services. Similar adherence and safety profiles have been reported in other studies evaluating short foot and doming exercises as conservative treatments for plantar heel pain [16,17].

The positive results may be attributed to the regular activation and neuromuscular re-education of the intrinsic muscles, which likely contributed to improved foot posture, shock absorption, and load distribution during gait. Enhancing the control and coordination of these muscles has been shown to reduce compensatory overuse of the plantar fascia during weight-bearing activities, ultimately minimizing repetitive microtrauma [18].

While the outcomes of this study are encouraging, a few limitations must be acknowledged. The study used a quasi-experimental design without a control group, which limits the ability to rule out the influence of external factors or natural recovery. Additionally, the small sample size and short follow-up duration may not reflect long-term adherence or recurrence of symptoms. Future randomized controlled trials with larger samples and extended follow-up are recommended to confirm the generalizability and sustainability of the benefits observed.

Despite these limitations, this study contributes valuable evidence supporting the role of intrinsic foot muscle strengthening as an effective and conservative intervention for managing plantar fasciitis. Incorporating these exercises into standard treatment protocols may enhance clinical outcomes while minimizing the need for invasive procedures or pharmacologic therapies.

STUDY LIMITATION

While the results are encouraging, some limitations must be acknowledged. The study had a small sample size and lacked a control group, which limits the ability to attribute changes solely to the exercise regimen. Additionally, long-term follow-up was not conducted, so the durability of the improvements remains uncertain. Future randomized controlled trials with larger samples and longer follow-up periods are warranted to confirm these findings and assess relapse or maintenance effects.

CONCLUSION

This study highlights the significant benefits of intrinsic foot muscle strengthening exercises in the management of plantar fasciitis. The intervention led to a marked reduction in pain intensity and substantial improvements in foot function, as evidenced by decreased Visual Analog Scale (VAS) and Foot Function Index (FFI) scores. High adherence rates and the absence of adverse events further support the feasibility and safety of this home-based exercise regimen. These findings suggest that intrinsic foot muscle strengthening can be an effective, low-cost, and accessible therapeutic option for patients with plantar fasciitis, and may be recommended as a part of routine conservative treatment in clinical practice.

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