

Efficacy of Targeted Achilles Tendon Stretching Compared to Calf Muscle Stretching in Individuals with Plantar Heel Pain

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ABSTRACT

Background: Plantar fasciitis is one of the most common causes of heel pain and functional limitation in adults. Tightness of the gastrocnemius–soleus complex and Achilles tendon increases tensile stress on the plantar fascia, contributing to persistent symptoms. Stretching interventions are widely recommended; however, comparative evidence between calf stretching and Achilles tendon stretching remains limited.

Objective: To compare the effectiveness of calf muscle stretching and Achilles tendon stretching in reducing pain and improving functional ability in individuals with plantar fasciitis.

Methods: A randomized comparative study was conducted on 50 participants (aged 25–45 years) diagnosed with plantar fasciitis and positive windlass test. Participants were randomly allocated into two groups: Group A (n = 25) received calf muscle stretching, and Group B (n = 25) received Achilles tendon stretching. Both groups followed a supervised stretching protocol (30–40 seconds hold, 3 repetitions, 5 days per week) for four weeks. Pain intensity was measured using the Visual Analog Scale (VAS), and functional disability was assessed using the Foot Function Index (FFI). Statistical analysis was performed using paired and independent t-tests with significance set at $p < 0.05$.

Results: Both groups demonstrated significant improvements in VAS and FFI scores after four weeks ($p < 0.001$). However, the Achilles tendon stretching group showed significantly greater reductions in post-treatment VAS ($t = 3.908$, $p < 0.001$) and FFI ($t = 5.690$, $p < 0.001$) compared to the calf stretching group. Percentage reduction in pain and disability was higher in the Achilles stretching group (VAS: 51.27%; FFI: 57.00%) than in the calf stretching group (VAS: 26.11%; FFI: 24.78%).

Conclusion: Both stretching techniques were effective in reducing pain and improving function in patients with plantar fasciitis. However, Achilles tendon stretching demonstrated superior outcomes and may be recommended as a more effective conservative management strategy.

Keywords: Plantar fasciitis, Achilles tendon stretching, calf stretching, heel pain, Foot Function Index, Visual Analog Scale.

INTRODUCTION

The human foot is a complex biomechanical structure designed to provide stability, mobility, and shock absorption during weight-bearing activities. It consists of 26 bones, 33 joints, and numerous muscles, tendons, and ligaments that function synergistically to maintain balance and locomotion (Boyd, 1992).

The plantar fascia, a thick fibrous connective tissue originating from the medial tubercle of the calcaneus and inserting into the metatarsal heads, plays a critical role in supporting the medial longitudinal arch and maintaining foot biomechanics.

During gait, the plantar fascia contributes to dynamic arch stabilization through the windlass mechanism, wherein dorsiflexion of the toes increases fascial tension, elevating the arch and enhancing propulsion efficiency. Biomechanical studies suggest that the plantar fascia withstands substantial tensile loads during weight-bearing, highlighting its importance in structural integrity and energy conservation (Wang et al., 2016).

Plantar fasciitis is one of the most common causes of heel pain, accounting for approximately 80% of heel pain cases and affecting nearly 10% of individuals during their lifetime. It is characterized by pain at the medial calcaneal region, particularly during the first steps after prolonged rest. Although historically considered an inflammatory condition, current evidence indicates that plantar fasciitis represents a degenerative process (fasciosis) marked by microtears, collagen disorganization, and myxomatous degeneration rather than acute inflammation (Martin et al., 2014).

Several intrinsic and extrinsic risk factors contribute to the development of plantar fasciitis, including obesity, prolonged standing, excessive running, limited ankle dorsiflexion, tightness of the Achilles tendon, and biomechanical abnormalities such as pes planus or pes cavus (Schepesis et al., 1991). Increased body mass index has been consistently associated with plantar fasciitis in non-athletic populations.

Conservative management remains the primary approach for plantar fasciitis. Among various interventions, stretching of the calf muscles and Achilles tendon has been widely recommended to reduce plantar fascia tension, improve ankle dorsiflexion, and decrease pain. However, comparative evidence regarding the relative effectiveness of calf stretching versus Achilles tendon stretching remains limited.

Therefore, the present study aims to evaluate and compare the effectiveness of calf stretching and Achilles tendon stretching in patients diagnosed with plantar fasciitis over a four-week treatment protocol.

METHODOLOGY

A randomized comparative study was conducted on 50 participants (25 males and 25 females) aged 25–45 years diagnosed with plantar fasciitis and positive windlass test. Participants were recruited according to predefined inclusion and exclusion criteria, and written informed consent was obtained.

Subjects were randomly allocated into two groups ($n = 25$ each): Group A received calf muscle stretching, and Group B received Achilles tendon stretching. Both groups followed a supervised stretching protocol for 4 weeks (5 days per week).

Pain intensity was assessed using the Visual Analog Scale (VAS), and functional disability was measured using the Foot Function Index (FFI). Assessments were conducted at baseline (Day 1) and at the end of Week 4.

All participants performed a 5-minute warm-up of active ankle dorsiflexion and plantarflexion prior to intervention. Group A performed wall calf stretching (30–40-second hold, 3 repetitions), while Group B performed active towel Achilles tendon stretching with the knee extended (30–40-second hold, 3 repetitions). A 30-second rest interval was provided between repetitions.

Data were analyzed using SPSS version 20.0. Paired t-tests were applied for within-group comparisons and independent t-tests for between-group comparisons. Statistical significance was set at $p < 0.05$.

STATISTICAL AND ANALYSIS

A total of participants were allocated into two groups: Calf Stretching Group and Achilles Tendon Stretching Group. Baseline demographic and clinical characteristics are presented in Table 1. There were no statistically significant differences between groups at baseline in terms of age ($p = 0.272$), height ($p = 0.335$), weight ($p = 0.738$), BMI ($p = 0.076$), pre-treatment VAS ($p = 0.919$), or pre-treatment FFI ($p = 0.074$), indicating homogeneity between groups before intervention. However, significant differences were observed in post-treatment outcomes. The Achilles tendon stretching group demonstrated significantly lower post-treatment VAS scores ($t = 3.908, p < 0.001$) and FFI scores ($t = 5.690, p < 0.001$) compared to the calf stretching group.

Table 1. Descriptive statistics of various variables in patients treated with calf stretching and Achilles tendon stretching

Variables	Patients treated with calf stretching		Patients treated with Achilles tendon stretching		t- value	p-value
	Mean	SD	Mean	SD		
Age(years)	35.28	7.10	33.08	6.89	1.111	0.272
Height (cm)	168.68	12.30	171.84	10.59	0.973	0.335
Weight (kg)	74.84	16.24	73.32	15.71	0.336	0.738
BMI (kg/m ²)	26.05	3.17	24.51	2.81	1.815	0.076
VAS (pre-treatment)	6.28	1.54	6.32	1.21	0.102	0.919
FFI(pre -treatment)	86.84	21.08	76.56	18.59	1.828	0.074
VAS (post-treatment)	4.64	1.52	3.08	1.28	3.908	<0.001
FFI (post -treatment)	65.32	23.43	32.92	16.17	5.690	<0.001

Table 2. Paired sample t-test analysis showed a significant reduction in VAS scores from pre-treatment (6.28 ± 1.54) to post-treatment (4.64 ± 1.52), $t = 3.782, p < 0.001$. Similarly, FFI scores significantly decreased from 86.84 ± 21.08 to 65.32 ± 23.43 ($t = 3.413, p < 0.001$). This indicates that calf stretching produced statistically significant improvement in pain and functional disability.

Table 2. Descriptive statistics of various variables in pre- and post-treatment in patients treated with calf stretching.

Variables	Pre-treatment calf stretching		Post-treatment calf stretching		t- value	p-value
	Mean	SD	Mean	SD		
VAS	6.2800	1.54164	4.6400	1.52425	3.782	<0.001
FFI	86.8400	21.08846	65.3200	23.43025	3.413	<0.001

Table 3. A highly significant reduction in pain and disability was observed in this group. VAS scores reduced from 6.32 ± 1.21 to 3.08 ± 1.29 ($t = 9.147, p < 0.001$). FFI scores decreased from 76.56 ± 18.59 to 32.92 ± 16.17 ($t = 8.855, p < 0.001$). This demonstrates substantial improvement in both pain and foot function following Achilles tendon stretching.

Table 3. Descriptive statistics of various variables in pre- and post-treatment in patients treated with Achilles tendon stretching.

Variables	Pre-treatment Achilles tendon stretching		Post-treatment Achilles tendon stretching		t-value	p-value
	Mean	SD	Mean	SD		
VAS	6.3200	1.21518	3.0800	1.28841	9.147	<0.001
FFI	76.5600	18.59453	32.9200	16.17076	8.855	<0.001

Table 4. showed the descriptive statics of various variables in between patients treated with calf stretching and achilles tendon stretching. Statistically significant differences ($p < 0.001$) where found in VAS post treatment and FFI post treatment group. However patients treated with achilles tendon stretching had higher decrement rate in VAS (51.27%) and FFI (57.00%) than the patients treated with calf stretching (26.11% and 24.78% respectively).

Table 4. Descriptive statics of various variables listed in table in between patients with calf stretching and patients with Achilles tendon stretching

Variables	Patients treated with calf stretching		Patients treated with Achilles tendon stretching		t- value	p- value
	Mean	SD	Mean	SD		
VAS (pre-treatment)	6.28	1.54	6.32	1.21	0.102	0.919
VAS (post-treatment)	4.64	1.52	3.08	1.28	3.908	<0.001
FFI(pre -treatment)	86.84	21.09	76.56	18.59	1.828	0.074
FFI (post -treatment)	65.32	23.43	32.92	16.17	5.690	<0.001
VAS % decrement	26.11%		51.27%			
FFI %decrement	24.78%		57.00%			

The Achilles tendon stretching group demonstrated a greater percentage reduction compared to the calf stretching group. The between-group comparison of post-treatment values confirmed that Achilles tendon stretching was statistically superior in reducing pain and improving functional outcomes ($p < 0.001$).

RESULTS

A total of participants were divided into two groups: the Calf Stretching Group and the Achilles Tendon Stretching Group. At baseline, there were no statistically significant differences between the two groups with respect to demographic and clinical variables. The mean age in the calf stretching group was 35.28 ± 7.10 years, while in the Achilles tendon stretching group it was 33.08 ± 6.89 years ($p = 0.272$). Similarly, no significant differences were observed in height ($p = 0.335$), weight ($p = 0.738$), BMI ($p =$

0.076), pre-treatment VAS scores ($p = 0.919$), or pre-treatment FFI scores ($p = 0.074$), confirming baseline comparability between groups.

Within-group analysis revealed significant improvements in both groups following intervention. In the calf stretching group, the mean VAS score significantly decreased from 6.28 ± 1.54 pre-treatment to 4.64 ± 1.52 post-treatment ($t = 3.782$, $p < 0.001$). Similarly, the mean FFI score reduced significantly from 86.84 ± 21.08 to 65.32 ± 23.43 ($t = 3.413$, $p < 0.001$), indicating significant reduction in pain and functional disability.

In the Achilles tendon stretching group, greater improvements were observed. The mean VAS score significantly decreased from 6.32 ± 1.21 pre-treatment to 3.08 ± 1.29 post-treatment ($t = 9.147$, $p < 0.001$). Likewise, the mean FFI score reduced from 76.56 ± 18.59 to 32.92 ± 16.17 ($t = 8.855$, $p < 0.001$), demonstrating marked improvement in both pain and foot function.

Between-group comparison of post-treatment outcomes showed statistically significant differences favoring the Achilles tendon stretching group. Post-treatment VAS scores were significantly lower in the Achilles group compared to the calf stretching group ($t = 3.908$, $p < 0.001$). Similarly, post-treatment FFI scores were significantly lower in the Achilles tendon stretching group ($t = 5.690$, $p < 0.001$).

Percentage reduction analysis further supported these findings. The Achilles tendon stretching group demonstrated a 51.27% reduction in VAS and a 57.00% reduction in FFI, whereas the calf stretching group showed a 26.11% reduction in VAS and a 24.78% reduction in FFI.

Overall, while both interventions were effective in reducing pain and improving functional status, Achilles tendon stretching demonstrated significantly superior outcomes compared to calf stretching.

DISCUSSION

Plantar fasciitis is a common musculoskeletal disorder and a leading cause of heel pain. Although it is often self-limiting, persistent symptoms significantly impair functional mobility and quality of life. Biomechanically, tightness of the gastrocnemius–soleus complex and Achilles tendon reduces ankle dorsiflexion, increasing tensile stress on the plantar fascia during weight-bearing activities. This altered mechanics may elevate strain at the calcaneal insertion, contributing to symptom persistence (Gill, 1997; Prakash & Misra, 2004).

The present study aimed to compare the effectiveness of calf stretching and Achilles tendon stretching in patients with plantar fasciitis. Both interventions resulted in improvement in pain and functional outcomes after four weeks of treatment. However, Achilles tendon stretching demonstrated superior results compared to calf stretching. Statistically significant differences were observed in post-treatment VAS ($t = 3.908$, $p < 0.001$) and FFI scores ($t = 5.690$, $p < 0.001$). Additionally, the decrement rate in VAS (51.27%) and FFI (57.00%) was greater in the Achilles stretching group than in the calf stretching group (26.11% and 24.78%, respectively).

These findings are consistent with previous research indicating that limited ankle dorsiflexion and Achilles tendon tightness are key contributing factors in plantar fasciitis (Digiovanni, 2006). Stretching the Achilles tendon likely reduces plantar fascia tension by improving ankle flexibility and restoring normal biomechanics during gait. Prior studies have also demonstrated positive outcomes with stretching-based interventions (Pfeffer, 1999; Mohamed, 2015), supporting the role of structured stretching protocols in conservative management.

The improvement observed in this study may be explained by the biomechanical relationship between the Achilles tendon and plantar fascia, both of which attach to the calcaneus. Increased flexibility of the

Achilles tendon decreases excessive traction on the plantar fascia, thereby reducing pain and improving function. While some studies suggest that plantar fascia-specific stretching may provide additional short-term benefits (Sweeting, 2011; Wang, 2016), the present findings reinforce the clinical effectiveness of Achilles tendon stretching as a simple, cost-effective intervention.

Patient compliance emerged as an important factor influencing outcomes. Non-adherence to daily stretching may reduce therapeutic effectiveness. Therefore, proper patient education and supervision are essential to optimize results. Surgical intervention remains a last-resort option for chronic cases unresponsive to conservative care for at least 12 months. Given the potential complications and variable satisfaction rates following plantar fasciotomy (Gill, 1997; Conflitti, 2004), maximizing non-operative treatment strategies such as structured stretching protocols is strongly recommended.

CONCLUSION

Achilles tendon stretching can significantly reduce global measures of pain and disability for patients with plantar fasciitis. This study provides an effective, inexpensive, and straight forward treatment protocol for the treatment of plantar fasciitis. In addition, compliance may have affected the results if the patients did not perform their exercises regularly. Thus, the present study concluded that both stretching techniques reduced the pain and improved flexibility but Achilles tendon stretching was superior to calf stretching, in individuals with plantar fasciitis. There was no conclusive evidence regarding the most effective number of repetitions or frequency of stretching, or whether self or therapist applied stretches were most effective. Inclusion of stretches directly to the Achilles tendon might provide better short-term pain relief than stretching the calf stretching.

There is a need for further research regarding this topic in the form of sufficiently powered randomised controlled trials, utilizing validated outcome measures for the measurement of functional changes, blinded assessors and with both medium and long-term follow up. Future study should also examine the ankle dorsiflexion with knee flexion to assess the effects of the stretching interventions on the calf tightness. Strengthening plays an important role in the treatment of plantar fasciitis and correct functional risk factors such as weakness of intrinsic foot muscles. Plantar fasciitis is often attributable to poor intrinsic muscles strength and poor force attenuation. (Boyd et al., 1992) in their study found that strengthening exercises for intrinsic foot muscles were cited as one of the most helpful treatment in heel pain. Strong intrinsic muscles thereby help in supporting the arches of the foot. So, future study should include strengthening of intrinsic and extrinsic foot muscles along with stretching.

Limitations

The study was limited by a small sample size and short duration of follow-up. Variations in patient compliance and stretching technique may have influenced the results. Future research with larger samples, longer follow-up periods, and inclusion of plantar fascia-specific stretching protocols is warranted to strengthen the evidence base.

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