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EFFECT OF POSITIONAL RELEASE TECHNIQUE AND ACTIVE RELEASE TECHNIQUE IN SELECTIVE BIOMECHANICAL CHANGES AND FUNCTION OF FOOT AMONG SUBJECTS WITH PLANTAR FASCIITIS- A PILOT STUDY

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ABSTRACT

Background: Heel pain interferes with everyday activities is often caused by plantar fasciitis. We evaluated the impact of symptoms on people's quality of life. Characterizing the primary functional limitations and determining the frequency of moderate to severe PF symptoms in patients receiving treatment at particular institutions in Kollam district, Kerala.
Methods: The study was designed as an experimental, comparative pre–post type and was conducted at ACS Hospital at Chennai and PNNM Hospital, Kollam, Kerala, on subjects clinically diagnosed with plantar fasciitis. A total of 15 subjects within the age group of 30-60 years were selected using a simple random sampling method (lottery method) and equally divided into three groups of five participants each. The overall study duration was three months, during which the intervention was administered for one month. The treatment was administered for 30 minutes per day, three days per week, and for a total of four weeks. Follow-up measurements were taken after eight weeks to evaluate the sustained effects of the intervention.. The collected data were analyzed using dependent t test, ANOVA and post hoc to evaluate the outcomes of the study.
Results: Group A showed better outcomes compared to Groups B and C after the follow-up. Group A had the lowest mean fascia thickness (4.20 mm), highest pain pressure threshold (4.96 kg/cm²), and lowest FFI score (29.60%), indicating better functional recovery. In contrast, Group C showed the highest fascia thickness (5.02 mm), lowest pain threshold (2.32 kg/cm²), and highest disability (44.80%). X-ray pitch angle was lowest in Group A (16.54°) and highest in Group C (18.04°).
Conclusion: The intervention in Group A was found to be more effective in reducing fascia thickness, improving pain tolerance, and enhancing foot function in plantar fasciitis patients compared to Groups B and C.

KEYWORDS: Plantar fasciitis, Foot Function Index, X-ray pitch angle, Pressure algometry, Ultrasound fascia thickness.

INTRODUCTION

Plantar fasciitis (PF) is a chronic degenerative disorder involving the plantar aponeurosis and remains one of the most frequent causes of inferior heel pain among adults. It is clinically characterized by localized pain and tenderness at the medial calcaneal tubercle, particularly during the first few steps in the morning or after periods of rest. The plantar fascia, a dense fibrous connective tissue originating from the medial tubercle of the calcaneus and extending to the proximal phalanges, plays a crucial role in maintaining the integrity of the medial longitudinal arch and contributing to efficient foot biomechanics during gait[1].

Histopathological studies indicate that plantar fasciitis represents a degenerative fasciosis rather than a purely inflammatory condition. Microscopic features such as collagen disorganization, fibroblast proliferation, and mucoid degeneration, with minimal inflammatory infiltration, support its classification as a fasciopathy rather than “fasciitis” in the traditional sense[2,3]. This degeneration results from repetitive tensile overload and microtrauma occurring at the calcaneal enthesis, leading to a failed healing response.

From a biomechanical perspective, the plantar fascia functions as a dynamic stabilizer of the foot, supporting the arch and enabling energy storage and release during locomotion. During the stance phase of gait, particularly from heel strike to midstance, the fascia elongates as the arch flattens, acting as a tension-bearing structure that assists in shock absorption. As the gait progresses toward toe-off, dorsiflexion of the metatarsophalangeal joints activates the windlass mechanism, in which the plantar fascia tightens around the metatarsal heads, elevates the arch, and transforms the foot into a rigid lever for propulsion[4,5]. This cyclical tightening and relaxation regulate the transition of the foot from a mobile adapter to a stable propulsive unit, ensuring efficient load transfer through the lower kinetic chain.

Disruption of these normal biomechanical processes results in abnormal load distribution across the plantar fascia, setting the stage for Pathomechanical stress. In individuals with excessive pronation, prolonged flattening of the medial arch maintains the fascia in a stretched position, leading to repetitive tensile strain and microtears near its calcaneal origin.

Conversely, in pescavus (high-arched) feet, the rigidity of the arch limits shock absorption, concentrating stress at the heel and increasing fascial tension[6]. Limited ankle dorsiflexion due to tightness in the gastrocnemius–soleus complex further alters gait mechanics, forcing compensatory pronation and increasing strain on the fascia[7].

Other contributing factors include malalignment of the subtalar or midtarsal joints, leg-length discrepancy, and altered lower-limb kinetics, all of which influence the magnitude and direction of ground reaction forces transmitted to the heel. These mechanical alterations contribute to chronic microtrauma, progressive collagen degeneration, and eventual fascial thickening. Over time, the plantar fascia loses its capacity to maintain arch stability, perpetuating a cycle of mechanical overload and tissue failure.

Epidemiologically, plantar fasciitis affects approximately 10% of the general population, with peak incidence between 40 and 60 years of age. It is particularly prevalent among athletes, military personnel, and individuals engaged in occupations involving prolonged standing or walking[8]. The disorder represents nearly 11–15% of all foot-related clinical presentations, with significant implications for mobility and quality of life.

METHODOLOGY

Study Design: The study followed an experimental comparative design with a pre- and post-test approach to evaluate the effectiveness of interventions in subjects with plantar fasciitis. A total of 15 participants aged 40–60 years were recruited and randomly allocated into three groups, with five subjects in each

Inclusion criteria: Age between 40–60 years, both genders, subjects diagnosed with plantar fasciitis for more than 12 weeks, and willingness to provide informed consent.

Exclusion criteria: Acute plantar fasciitis, dermatitis, diabetes, congenital foot deformities, corticosteroid injection in the heel within the past 3 months, neurological pain (e.g., sciatica), history of foot fracture, and patients under medication.

Study Setting: The study was conducted at A.C.S. Medical College & Hospital, Velappanchavadi, Chennai, Tamil Nadu, India. Participants were selected using a simple random sampling technique (lottery method) to minimize selection bias and ensure equal representation across groups. The overall duration of the study was three months.

Ethical Clearance: Approved by the Institutional Ethics Committee of A.C.S. Medical College & Hospital (Approval No. 1494/2024/IEC/ACSMCH Dt. 11.12.2024). The study adhered to the ethical standards of the 1964 Helsinki Declaration and its later amendments. Written informed consent was obtained from all participants.

Conflict of Interest: The authors declare no conflicts of interest. No financial, personal, or professional relationships influenced the conduct or outcomes of this research.

Funding: This study did not receive any specific grant and was conducted as part of academic requirements in physiotherapy.

Intervention Protocol: Each intervention was administered for 30 minutes per session, three times per week, for four weeks. Follow-up measurements were conducted after eight weeks to determine long-term effects.

Outcome Measures and Measurement Tools: Pain – Pressure algometry, Plantar fascial thickness – Ultrasonography, Calcaneal pitch angle – X-ray, Foot function – Foot Function Index

Procedure: Participants diagnosed with plantar fasciitis were briefed on the study and interventions, and consent was obtained. Demographic data, affected side, and symptom duration were recorded. Pain, fascial thickness, calcaneal pitch angle, and foot function were assessed pre- and post-intervention. All participants received their respective treatments for 30 minutes, 3 days a week, for 4 weeks, with a follow-up at 8 weeks. The data were analyzed to evaluate treatment outcomes.

Group A – Active Release Technique (ART): Performed in long sitting with the ankle in plantar flexion (shortened fascia). Deep manual pressure was applied over the trigger point while the subject actively moved the ankle from plantar flexion to dorsiflexion. Fifteen repetitions were performed for 10 minutes, three times a week for four weeks.

Group B – Positional Release Technique (PRT): With the patient prone, gentle mechanical pressure was applied to the tender point using a fingertip. The foot was positioned in plantar flexion, with gentle fine-tuning posteriorly, superiorly, and laterally for 90 seconds with 3 repetitions (270 sec total), maintaining at least 70% pain reduction. Total 10 minutes per session, 3 days a week for 4 weeks.

Group C – Plantar Fascia Stretching: In supine position, the therapist grasped the heel and metatarsal region (keeping the subtalar joint neutral) and applied gentle pressure toward the shin until a stretch was felt in the plantar fascia. The stretch was held for 30 seconds, followed by 30 seconds rest, repeated 10 times.

Common Intervention for All Groups: All participants received cryotherapy in the form of ice pack application for 10 minutes, followed by intrinsic foot muscle strengthening exercises, which included calf raises (with emphasis on toe push-off), toe spread and squeeze, and marble pickup.

Statistical Analysis: Data normality was verified using the Shapiro–Wilk test, indicating normal distribution ($p > 0.05$). Hence, parametric tests were used — Paired t-test, Repeated Measures ANOVA, and Tukey post hoc test — to analyze the pre- and post-test values among the three groups.

RESULTS

Demographic Data Analysis: Total 15 samples were selected for this study, then randomly divided in to 5 samples in each Group A, B and C

Table: 1 Age on Groups A, B and C

GROUP	AGE					MEAN
A	45	57	43	50	55	50.0
B	53	49	56	54	44	50.6
C	50	44	59	52	45	50.2

Table: 2 Genders on Groups A, B and C

Group A-Gender	Group B-Gender	Group C-Gender
F	F	F
M	M	F
F	F	F
F	M	M
F	F	F

Table 3: Paired t-Test (Pre vs. Post) Group A

	Variables	Paired Differences					t	df	Sig (2-tailed) P value
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Low	Up			
Pair1	X ray-Pitch angle Pre test Post - test	2.00	.70	.31	1.12	2.88	6.32	4	.003
Pair2	Fascia Thickness Pre-test Post-test	1.02	.08	.03	.91	1.12	27.26	4	.001
Pair3	Pressure Algometry - Pre-test – Post-test	2.92	.92	.41	4.07	1.76	7.03	4	.002
Pair4	FFI (%) – Pre-test Post- test	22.8	1.92	.86	20.41	25.18	26.50	4	.001

Table 4: Paired t-Test (Pre vs. follow up) Group A

Variables	Paired Differences					t	df	Sig(2-tailed) P value
	Mean Diff.	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair 1. X-ray Pitch angle - Pre-test X-ray Pitch angle - Follow up	2.26	0.68	0.30	1.41	3.10	7.42	4	.002
Pair 2. USG Fascia Thickness - Pre-test - USG Fascia Thickness – Follow up	1.20	0.10	0.04	1.07	1.32	26.83	4	.001
Pair 3. Pressure Algometry - Pre-test - Pressure Algometry - Follow up	3.26	0.87	0.39	4.34	2.17	8.31	4	.001
Pair 4FFI (%) - Pre-test - FFI (%) – Follow up	27.0	2.91	1.30	23.37	30.6	20.70	4	.001

Table 5: Paired t-Test (Pre vs. Post) Group B

Variables	Paired Differences					t	df	Sig(2-tailed
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair 1 X-ray Pitch angle - Pre-test - X-ray Pitch angle - Post test	0.98	0.31	0.13	0.59	1.36	7.03	4	.002
Pair 2 USG Fascia Thickness - Pre-test - USG Fascia Thickness - Post test	0.66	0.20	0.09	0.40	0.91	7.11	4	.002
Pair 3 Pressure Algometry - Pre-test - Pressure Algometry - Post test	1.12	0.49	0.22	1.73	0.50	5.09	4	.007
Pair 4 FFI (%) - Pre-test - FFI (%) - Post test	9.00	5.701	2.55	1.92	16.07	3.53	4	.024

Table 6: Paired t-Test (Pre vs. Follow up) Group B

Variables	Paired Differences					t	df	Sig (2-tailed
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair 1 X-ray Pitch angle - Pre-test - X-ray Pitch angle - Follow up	1.26	0.33	0.15	0.84	1.67	8.38	4	.001
Pair 2 USG Fascia Thickness - Pre-test - USG Fascia Thickness – Follow up	0.78	0.22	0.10	0.49	1.06	7.64	4	.002
Pair 3 Pressure Algometry - Pre-test - Pressure Algometry - Follow up	1.32	0.49	0.22	1.9	0.70	6.00	4	.004
Pair 4 FFI (%) - Pre-test - FFI (%) - Post test	12.4	6.02	2.69	4.91	19.88	4.60	4	.010

Table 7: Paired t-Test (Pre vs. post) Group C

Variables	Paired Differences					t	df	Sig (2-tailed
	Mea n	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair 1 X-ray Pitch angle - Pre-test - X-ray Pitch angle - Post test	0.38	0.13	0.05	0.21	0.54	6.51	4	.003
Pair 2 USG Fascia Thickness - Pre-test - USG Fascia Thickness - Post test	0.20	0.07	0.03	0.11	0.28	6.32	4	.003
Pair 3 Pressure Algometry - Pre-test - Pressure Algometry - Post test	0.48	0.08	0.03	0.58	.376	12.82	4	.000
Pair 4 FFI (%) - Pre-test	9.60	1.51	0.67	7.71	11.48	14.15	4	.000

- FFI (%) - Post test								

Table 8: Paired t-Test (Pre vs. Follow up) Group C

Variables	Paired Differences					t	df	Sig(2-tailed
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair 1 X-ray Pitch angle - Pre-test - X-ray Pitch angle - Follow up	0.56	0.15	0.06	0.37	0.74	8.25	4	.001
Pair 2 USG Fascia Thickness - Pre-test - USG Fascia Thickness - Follow up	0.30	0.07	0.03	0.21	0.38	9.48	4	.001
Pair 3 Pressure Algometry - Pre-test - Pressure Algometry - Follow up	0.64	0.11	0.05	0.78	0.49	12.55	4	.001
Pair 4 FFI (%) - Pre-test - FFI (%)- Follow up	12.0	1.87	0.83	9.67	14.32	14.34	4	.001

Table 9: Repeated measures ANOVA of X-ray pitch angle in group A, B and C

VARIABLE	R SQUARE	F VALUE	P VALUE	SIGNIFICANCE
GROUP A –X ray pitch angle	0.92	47.00	<0.001	**
GROUP B -X ray pitch angle	0.94	57.85	<0.001	**
GROUP X ray pitch angle	0.93	52.17	<0.001	**

Table 10: Repeated measures ANOVA of Fascial thickness in group A, B and C

VARIABLE	R SQUARE	F VALUE	P VALUE	SIGNIFICANCE
GROUP A –Fascial thickness	0.99	661.3	<0.001	**
GROUP B -Fascial thickness	0.93	54.56	0.0001	****
GROUP C-Fascial thickness	0.95	70.00	0.0001	****

Table 11: Repeated measures ANOVA of pressure algometry in group A, B and C

VARIABLE	R SQUARE	F VALUE	P VALUE	SIGNIFICANCE
GROUP A Pain Algometry	0.97	144.7	<0.0001	****
GROUP B Pain Algometry	0.94	58.82	<0.0001	****
GROUP C Pain Algometry	0.89	31.37	<0.0002	***

Table 12: Repeated measures ANOVA of FFI in group A, B and C

VARIABLE	R SQUARE	F VALUE	P VALUE	SIGNIFICANCE
GROUP A FFI	0.99	425.0	<0.0001	****
GROUP B FFI	0.98	198.3	<0.0001	****
GROUP C FFI	0.82	17.70	0.001	**

Table 13: Post Hoc Analysis

Dependent Variable	(I) Group	(J) Group	Mean Difference	Std. Error	Sig.	95% Confidence Interval	
						Higher Bound	Lower Bound
X-rayPitch angle	A	B	-1.40	1.39	.589	-5.12	2.32
		C	-1.50	1.39	.546	-5.22	2.22

Follow up	B	A	1.40	1.39	.589	-2.32	5.12
		C	-.100	1.39	.997	-3.82	3.62
	C	A	1.50	1.39	.546	-2.22	5.22
		B	.100	1.39	.997	-3.62	3.82
USGFascia Thickness Follow up	A	B	-.540	.22	.082	-1.14	.064
		C	-.820	.226	.009	-1.42	-.215
	B	A	.540	.226	.082	-.06	1.144
		C	-.280	.226	.456	-.88	.324
	C	A	.820	.226	.009	.21	1.424
		B	.280	.226	.456	-.32	.884
Pressure Algometry - Follow up	A	B	2.02	.517	.005	.63	3.400
		C	2.64	.517	.001	1.25	4.020
	B	A	-2.02	.517	.005	-3.40	-.639
		C	.620	.517	.476	-.760	2.000
	C	A	-2.64	.517	.001	-4.02	-1.259
		B	-.620	.517	.476	-2.00	.760
FFI (%) - Follow up	A	B	-13.00	5.41	.080	-27.45	1.45
		C	-15.20	5.41	.039	-29.65	-.740
	B	A	13.00	5.41	.080	-1.45	27.45
		C	-2.20	5.41	.914	-16.65	12.25
	C	A	15.20	5.41	.039	.740	29.65
		B	2.20	5.41	.914	-12.25	16.65

Demographic Data Analysis: The mean age of participants in Group A and Group B was 50 years, while the mean age of Group C was 51.5 years. With respect to gender distribution: Group A and C includes 4 females and 1 male while group B has 2 males, 3 females.

Group A: Comparison between Pre-test and Post-test

Paired t-test shows statistically significant improvements across all outcome measures when comparing pre-test and post-test values.

X-ray pitch angle showed a mean difference of 2.00, with t= 6.32 and p = 0.003, indicating a significant improvement in foot alignment.

Plantar fascial thickness measured by ultrasonography showed a mean difference of 1.12, with t = 27.26 and p = 0.001, reflecting a highly significant reduction in fascial thickness.

Pressure algometry values showed a mean difference of 2.92, with t= 7.03 and p = 0.002, signifying a significant improvement in pain threshold.

Foot Function Index (FFI %) showed a mean difference of 22.80, with t= 26.50 and p = 0.001, confirming a very strong and statistically significant improvement in functional status. Collectively, these findings indicate that the intervention produced meaningful structural, symptomatic, and functional improvements in patients with plantar fasciitis in Group A.

Group A, Comparison between Pre-test and Follow-up

X-ray pitch angle demonstrated a mean difference of 2.26, with t= 7.42 and p = 0.002, confirming a significant improvement in foot alignment that was maintained at follow-up.

Plantar fascial thickness demonstrated a mean difference of 1.20, with t = 26.83 and p = 0.001, indicating a highly significant and consistent reduction in fascia thickness over time.

Pressure algometry demonstrated a mean difference of 3.26, with t= 8.31 and p = 0.001, reflecting a significant and sustained improvement in pain threshold.

Foot Function Index (FFI %) demonstrated a mean difference of 27.0, with t= 20.70 and p = 0.001, confirming that the functional gains observed post-intervention were well maintained at follow-up.

Collectively, these findings suggest that the therapeutic effects achieved in Group A were significant immediately after intervention and also sustained during the follow-up period, demonstrating both short-term and long-term effectiveness.

Group B, Comparison between Pre-test and Post- test

In Group B, the paired t-test comparing pre-test and post-test values revealed statistically significant improvements across all outcome measures

X-ray pitch angle demonstrated a mean difference 0.98 (t = 7.03, p = 0.002), indicating a significant improvement in foot posture after treatment.

Plantar fascia thickness demonstrated a mean difference of 0.66 (t = 7.11, p = 0.002), suggesting reduced inflammation and swelling.

Pressure algometry demonstrated a mean difference 1.12 (t = 5.09, p = 0.007), reflecting a higher pressure pain threshold and effective pain relief.

Foot Function Index (FFI) demonstrated a mean difference of 9.00 (t = 3.53, p = 0.024), indicating enhanced functional ability and reduced disability following the intervention.

Overall, these findings demonstrate that the treatment produced significant improvements in both structural and functional outcomes in Group B.

In Group B, Comparison between Pre-test and follow-up

X-ray pitch angle showed a demonstrated a mean difference of 1.26, t = 8.38, p = 0.001), indicating sustained or enhanced structural correction.

Plantar fascia thickness demonstrated a mean difference 0.78, t = 7.64, p = 0.002), reflecting long-term maintenance of reduced inflammation.

Pressure algometry demonstrated a mean difference 1.32, t = 6.04, p = 0.004), confirming persistent and improved pain relief.

Foot Function Index (FFI%) demonstrated a mean difference 12.4, t = 4.60, p = 0.010), demonstrating enhanced functional ability over time.

Paired t-test analysis for Group B comparing pre-test and follow-up values demonstrated significant and sustained improvements across all outcome measures.

Group C, Comparison between pre-test and post-test

Paired t-test analysis for Group C the comparison of pre-test and post-test values demonstrated significant improvements across all outcome measures.

The X-ray pitch angle demonstrated a mean difference 0.38, t = 6.5, p = 0.003, indicating a significant improvement in foot posture after treatment.

Plantar fascia thickness demonstrated a mean difference 0.2, t = 6.32, p = 0.003, indicating structural improvement.

Pressure algometry demonstrated a mean difference 0.48, t = 12.82, p = 0.0001, reflecting better pain tolerance.

Foot Function Index (FFI%) demonstrated a mean difference 9.60 , t = 14.15, p = 0.0001, denoting improved functional status.

Collectively, these findings suggest that the intervention produced meaningful short-term clinical benefits in terms of structure, pain, and function.

In Group C, Comparison between Pre-test and follow-up

The X-ray pitch angle showed a mean difference 0.56, t = 8.25, p = 0.001, indicating a significant improvement in foot posture after treatment.

Plantar fascia thickness demonstrated a mean difference of 0.30, t = 9.48, p = 0.001, indicating structural improvement.

Pressure algometry demonstrated a mean difference of 0.64, t = 12.55, p = 0.001, reflecting better pain tolerance.

Foot Function Index (FFI demonstrated a mean difference of 12.00, t = 14.34, p = 0.001, denoting improved functional status.

These results imply that the therapeutic effects were immediate after treatment and also sustained over time, reinforcing the long-term efficacy of the intervention.

Repeated measures ANOVA

The repeated measures ANOVA revealed statistically significant improvements across all outcome measures.X-ray pitch angle, plantar fascial thickness, pressure pain threshold, and Foot Function Index all three groups shows p < 0.0001, p < 0.001 p < 0.0002 and p < 0.0001respectively.

Post hoc turkey test

X-ray pitch angle, there is no significant differences were observed between the A, B and C groups (p > 0.05).

Plantar fascia thickness, Group A compared to Group C (p = 0.001 there is sig difference), no significant differences were found between Group A and B (p = 0.08) or between Group B and C (p = 0.45).

Pressure algometry values were significantly higher in Group A compared to both Group B (p = 0.01) and Group C (p = 0.00), indicating superior improvement in pain threshold, while the difference between Group B and C was not significant (p = 0.47).

Foot Functional Index (FFI%), in Group A showed a significantly greater reduction compared to Group C (p = 0.03), with a non-significant trend toward improvement compared to Group B (p = 0.08). Group B and C no sig diff with p value 0.91

Group A demonstrated the greatest improvements overall, based on mean difference in X-ray pitch angle, plantar fascial thickness, pain threshold and Functional status, compared to Groups B and C.

Groups B and C also showed significant changes, though the magnitude of improvement was lower than in Group A.

DISCUSSION

The present study compared the effects of Active Release Technique (ART), Positional Release Technique (PRT), and Plantar Fascia Stretching (PFS), all combined with foot strengthening and cryotherapy, in individuals with plantar fasciitis. Significant improvements were observed in pain threshold, plantar fascial thickness, foot function, and X-ray calcaneal pitch angle across all three groups, with ART producing the greatest overall improvements, followed by PRT and stretching. These results highlight the superiority of manual myofascial release approaches, particularly ART, in producing both structural and functional recovery in plantar fasciitis.

In the present study, Group A (ART) showed the highest magnitude of improvement across all parameters—pain (Δ=2.92, t=7.03, p=0.002), plantar fascial thickness (Δ=1.12, t=27.26, p=0.001), calcaneal pitch angle (Δ=2.00, t=6.32, p=0.003), and functional index (Δ=22.80, t=26.50, p=0.001)—with benefits sustained at follow-up.

These results are consistent with Dar et al. (2024)9, who compared ART and post-isometric relaxation among traffic police wardens with plantar fasciitis and found ART produced greater pain relief and functional gains. Similarly, Jain et al. (2022)10 demonstrated that ART was more effective than PRT in improving pain and flexibility in gastro-soleus trigger points.

While earlier studies primarily focused on pain and function, the present research extends these findings by showing that ART also induces measurable structural changes, such as reduced plantar fascial thickness and improved foot alignment on radiographic evaluation. This indicates that ART not only provides symptomatic relief but also promotes tissue remodeling and biomechanical correction, a contribution not clearly documented in earlier works.

In Group B (PRT), significant improvements were observed in all outcome measures (pain threshold Δ=1.12, p=0.007; fascial thickness Δ=0.66, p=0.002; FFI Δ=9.0, p=0.024; calcaneal pitch Δ=0.98, p=0.002) with sustained gains at follow-up.

These findings support those of Abaraogu et al. (2020)11, who reported that PRT effectively reduced pain in patients with tension-type headaches, and Ijphy (2017)12, which demonstrated its efficacy in improving pain and function in cervicogenic headache. Although these studies focused on different conditions, both confirmed that PRT effectively normalizes muscle tone and relieves myofascial restriction, consistent with the present findings.

However, our study adds new insight by demonstrating that PRT can also produce quantifiable structural benefits, including reduced plantar fascial thickness and improved foot alignment. This structural evidence has been scarcely reported in previous literature, suggesting that the combined use of PRT with strengthening and cryotherapy may potentiate long-term biomechanical correction in plantar fasciitis.

Group C (stretching) also exhibited statistically significant improvements in all parameters, though to a lesser extent than ART and PRT. The FFI improved by 9.60 points, pain threshold increased by 0.48 kg/cm², and fascial thickness reduced by 0.20 mm post-intervention.

These findings are in agreement with Radford et al. (2007)13, who demonstrated that plantar fascia–specific stretching yielded significant pain reduction and improved functional outcomes, and Sweeting et al. (2011)14, who also reported improved disability and pain scores with stretching.

However, previous studies mainly emphasized subjective symptom relief, whereas the current research provides evidence of objective structural recovery, including reduced fascial thickness and increased calcaneal pitch angle, indicating improved arch mechanics. Thus, this study confirms that regular plantar fascia stretching contributes not only to symptom improvement but also to restoration of normal tissue architecture.

Cryotherapy and intrinsic foot muscle strengthening were common interventions across all groups and contributed to overall pain and functional improvements.

Our results align with Bala Subramanian et al. (2019)15 and Rupareliya&Shukla (2021)16, who reported that cryotherapy and cryostretch produce significant analgesic effects in plantar fasciitis. Similarly, Mickle et al. (2016)17 and Rathleff et al. (2015)18 demonstrated that foot muscle strengthening enhances arch stability, posture, and functional performance.

The current findings extend this evidence by showing that when combined with targeted manual therapy, these adjunct treatments also contribute to structural restoration—specifically, reduced plantar fascial thickness and improved calcaneal pitch angle, highlighting their role in comprehensive rehabilitation.

Pressure Algometry: The present study confirmed that pressure algometry is a sensitive tool for detecting clinical change in pain threshold, consistent with Rathleff et al. (2015)19 and Renan-Ordine et al. (2011)20, who validated its reliability in quantifying mechanical pain sensitivity following manual therapy.

Ultrasonography: Reductions in sonographic plantar fascial thickness in our study corresponded with symptom improvement, supporting the findings of Kane et al. (2001) and Mohseni-Bandpei et al. (2014)21, who emphasized ultrasound's diagnostic value and correlation with clinical outcomes.

X-ray (Calcaneal Pitch Angle): Improvements in pitch angle observed in our participants are comparable with Williams et al. (2013)22 and Duran et al. (2020)23, who found radiographic correction after conservative foot interventions, validating the use of X-ray as a biomechanical indicator.

Foot Function Index (FFI): Our results reaffirm the validity and responsiveness of the FFI in plantar fasciitis, consistent with Budiman-Mak et al. (1991)24 and Landorf& Radford (2008)25.

CONCLUSION

The findings of this study demonstrate that all three interventions, Active Release Technique (ART), Positional Release Technique (PRT), and Plantar fascia stretching, combined with Foot strengthening exercises and cryotherapy are effective in reducing pain, decreasing plantar fascia thickness, improving foot posture, and enhancing functional ability in patients with plantar fasciitis.

ART produced the most significant and sustained improvements across structural, symptomatic, and functional outcomes, followed by PRT, while conventional, although beneficial, yielded but comparatively smaller changes.

Within the group of PRT there was significant and sustained improvement across pitch angle, Fascial thickness, pain tolerance and foot function. In conventional group also there was significant difference in the outcomes.

These results suggest that manual release techniques, particularly ART, may offer more therapeutic benefits for the management of plantar fasciitis.

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