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Immediate Effects of Static Stretching Versus Active Release Technique on Pain and Functional Performance Among Postgraduate Female Students With Piriformis Syndrome

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ABSTRACT

Background: *Piriformis syndrome is a neuromuscular disorder in which the piriformis muscle irritates or compresses the sciatic nerve, producing deep gluteal pain with possible distal radiation and functional limitation, and it is frequently underrecognized due to symptom overlap with other lumbopelvic conditions.* ***Objective****: To compare the immediate effects of static stretching versus Active Release Technique on pain intensity and functional performance among female postgraduate students with piriformis syndrome.* ***Methods****: A quasi-experimental, single-blinded study was conducted from April to July 2023 at Government College University Faisalabad, enrolling 30 female MPhil/PhD students (22–45 years) diagnosed clinically using positive FABER, FAIR, and active piriformis tests. Participants were purposively sampled and randomly allocated to static stretching (n=15) or Active Release Technique (n=15). Both groups received superficial heat and were treated for two weeks (three sessions/week; 10–15 minutes/session). Outcomes were assessed at baseline and post-intervention using the Visual Analogue Scale and Lower Extremity Functional Scale. Paired and independent t-tests were applied using SPSS (version 24).* ***Results****: Pain decreased significantly within both groups (ART: 5.40±2.03 to 2.80±1.47, p<0.001; stretching: 5.33±1.99 to 3.27±1.62, p=0.006), with lower post-treatment pain in ART than stretching (2.79±1.53 vs 3.36±1.65, p=0.006). Functional performance improved significantly within both groups (ART: 39.47±6.82 to 61.27±9.25, p<0.001; stretching: 42.60±9.23 to 56.53±12.89, p=0.015), with higher post-treatment LEFS in ART (61.29±9.60 vs 56.21±13.32, p=0.010).* ***Conclusion****: Active Release Technique is more effective than static stretching for short-term reduction of pain and improvement of functional performance in female postgraduate students with piriformis syndrome.*

Keywords
Piriformis Syndrome; Active Release Technique; Static Stretching; Visual Analogue Scale; Lower Extremity Functional Scale

INTRODUCTION

Piriformis syndrome is a distinct neuromuscular condition characterized by irritation or compression of the sciatic nerve as it courses in close anatomical proximity to the piriformis muscle, resulting in deep gluteal pain that may radiate along the posterior aspect of the lower limb (1). The piriformis muscle originates from the anterior surface of the sacrum and inserts onto the superior border of the greater trochanter, functioning as a primary external rotator of the extended hip and an abductor of the flexed hip (1). Its intimate relationship with the sciatic nerve, along with neighboring neurovascular structures traversing the greater sciatic foramen, renders it a clinically significant contributor to non-discogenic sciatica and chronic hip or buttock pain syndromes (14). Epidemiological evidence suggests that piriformis syndrome may account for approximately 6–36% of cases presenting with chronic low back or buttock pain, though true prevalence remains uncertain due to diagnostic ambiguity and symptom overlap with lumbar radiculopathy and sacroiliac dysfunction (2,3).

Women are disproportionately affected by piriformis syndrome, with a reported female-to-male ratio of approximately 6:1, a disparity often attributed to biomechanical and anatomical factors such as a wider pelvic structure, increased Q-angle, and altered hip muscle recruitment patterns (3,4). These factors may predispose young and middle-aged women to excessive piriformis muscle tension, overuse, and adaptive shortening, particularly in populations exposed to prolonged sitting, academic workload–related sedentary behavior, and repetitive lower limb activities (6). Among postgraduate students, sustained sitting postures and reduced physical variability may further exacerbate neuromuscular dysfunction, leading to pain, reduced hip mobility, and compromised functional performance.

Clinically, piriformis syndrome is frequently underdiagnosed or misdiagnosed due to its nonspecific presentation and lack of universally accepted diagnostic criteria (4). Provocative physical tests such as the FABER, FAIR, and active piriformis tests are commonly employed to aid diagnosis, alongside localized tenderness over the sciatic notch and reproduction of symptoms with hip rotation maneuvers (10). If inadequately managed, persistent piriformis dysfunction may progress to chronic pain states, functional limitations, and reduced quality of life, emphasizing the importance of effective early conservative interventions.

Conservative management remains the cornerstone of treatment for piriformis syndrome, with physical therapy–based interventions aimed at reducing muscle tension, improving soft tissue mobility, and restoring functional biomechanics (2). Static stretching is widely prescribed to lengthen the piriformis muscle, decrease stiffness, and alleviate compressive forces on the sciatic nerve, with several studies demonstrating short-term reductions in pain and improvements in flexibility (11,12). However, static stretching primarily addresses muscle length and may be insufficient to resolve myofascial adhesions or altered tissue extensibility associated with chronic neuromuscular dysfunction.

Active Release Technique (ART) is a specialized manual therapy approach designed to treat soft tissue restrictions by applying directed pressure to shortened or fibrotic tissues while actively lengthening the muscle through patient-assisted movement. This technique aims to restore normal tissue texture, improve local circulation, and reduce neural entrapment by addressing both mechanical and neuromuscular contributors to pain (13). Emerging evidence suggests that ART may produce superior outcomes in pain reduction and functional recovery across various musculoskeletal conditions by targeting myofascial adhesions more effectively than stretching alone (13). Nevertheless, direct comparative evidence examining the immediate clinical effects of ART versus conventional static stretching specifically in individuals with piriformis syndrome remains limited.

Despite the growing clinical application of ART, there is a paucity of controlled studies evaluating its relative effectiveness against commonly used stretching protocols, particularly in young female populations at high risk for piriformis-related dysfunction. Moreover, few investigations have focused on short-term or immediate functional outcomes using validated measures of pain and lower extremity performance. Addressing this gap is essential to guide evidence-based clinical decision-making and optimize conservative management strategies for piriformis syndrome in female academic populations. Therefore, the objective of this study was to compare the immediate effects of static stretching versus Active Release Technique on pain intensity and functional performance, as measured by the Visual Analogue Scale and the Lower Extremity Functional Scale, among female postgraduate students diagnosed with piriformis syndrome.

MATERIALS AND METHODS

This quasi-experimental, single-blinded comparative study was conducted between April and July 2023 at Government College University, Faisalabad, Pakistan, with the aim of evaluating and comparing the immediate effects of two conservative physiotherapy interventions on pain and functional performance in female postgraduate students diagnosed with piriformis syndrome. The study design was selected to allow controlled comparison of interventions in a real-world academic setting while minimizing assessor bias through single blinding of outcome evaluation.

The study population comprised female MPhil and PhD students aged 22 to 45 years who presented with clinical features consistent with piriformis syndrome. Participants were recruited through purposive sampling from the university campus following initial screening. Eligibility criteria included chronic unilateral or bilateral gluteal or hip pain with possible distal radiation, localized tenderness over the sciatic foramen, and positive findings on the Active Piriformis Test, FABER test, and FAIR test. Participants were excluded if they had red-flag conditions, a history of hip or femoral fracture, hip joint dislocation, inflammatory or degenerative joint disease, avascular necrosis of the femoral head, osteoporosis, malignancy, prior steroid use, or current intake of analgesics or muscle relaxants that could confound pain assessment. All eligible participants were informed about the study procedures, potential risks, and benefits, and written informed consent was obtained prior to enrollment.

A total of 30 participants meeting the inclusion criteria were enrolled and randomly allocated into two equal groups of 15 participants each using a simple randomization method. Group A received static stretching intervention, while Group B received Active Release Technique. Both groups additionally received standardized superficial heat therapy prior to the intervention to ensure uniform muscle warm-up and to reduce variability in tissue response. Interventions were administered three times per week for a total duration of two weeks, with each treatment session lasting approximately 10–15 minutes. The static stretching protocol involved therapist-assisted and self-administered piriformis stretching in supine and seated positions, emphasizing controlled end-range holds. The Active Release Technique protocol involved the application of targeted manual pressure over identified tender or restricted areas of the piriformis muscle while the participant actively moved the hip through a lengthening range, aiming to restore normal soft tissue mobility and reduce neuromuscular compression.

Outcome measures were assessed at baseline prior to the first intervention session and immediately after completion of the two-week intervention period by an assessor blinded to group allocation. Pain intensity was measured using the Visual Analogue Scale, a validated 10-cm continuous scale ranging from no pain to worst imaginable pain. Functional performance was assessed using the Lower Extremity Functional Scale, a validated patient-reported outcome measure consisting of 20 items evaluating difficulty in performing everyday lower extremity activities, with higher scores indicating better functional status. Both instruments have demonstrated strong reliability, validity, and responsiveness in musculoskeletal populations.

Data were recorded systematically to ensure accuracy and completeness and were entered into the Statistical Package for Social Sciences software for analysis. Descriptive statistics were calculated for demographic and baseline characteristics. Within-group comparisons of pre- and post-intervention outcomes were analyzed using paired sample t-tests to determine the effectiveness of each intervention independently. Between-group comparisons of post-intervention outcomes were conducted using independent sample t-tests to evaluate relative effectiveness. Assumptions of normality were assessed prior to inferential analysis. Statistical significance was set at a two-tailed p-value of less than 0.05. All analyses were performed using SPSS software version 24. Data integrity was ensured through double-entry verification, and standardized protocols were followed throughout the study to minimize measurement bias and enhance reproducibility. Ethical approval for the study was obtained from the relevant institutional review board of Government College University Faisalabad, and the study was conducted in accordance with the principles of the Declaration of Helsinki. Participant confidentiality was maintained throughout the research process, and all collected data were anonymized and securely stored.

RESULTS

All data were analyzed using SPSS v24. Within-group pre–post differences were assessed using paired sample *t*-tests, and between-group post-intervention comparisons were assessed using independent sample (Student) *t*-tests. Outcomes included pain intensity (Visual Analogue Scale; VAS) and functional status (Lower Extremity Functional Scale; LEFS). Quantitative findings are presented in **Table 1–Table 3**, including *p*-values, 95% confidence intervals (CI), and effect sizes for transparency.

Table 1. Within-group (pre–post) comparison of VAS in both intervention groups (paired t-test)

Group	Outcome	Pre (Mean ± SD)	Post (Mean ± SD)	Mean Change (Pre–Post)	*t* (df=14)	*p*-value	95% CI of Change	Effect Size (Cohen's *d*_z)
ART	VAS	5.40 ± 2.03	2.80 ± 1.47	2.60	5.706	<0.001	1.62 to 3.58	1.47
Static Stretching	VAS	5.33 ± 1.99	3.27 ± 1.62	2.07	3.212	0.006	0.69 to 3.45	0.83

Pain intensity significantly decreased in both groups. In the **Active Release Technique (ART)** group, mean VAS scores dropped from **5.40 ± 2.03** to **2.80 ± 1.47**, yielding a statistically significant improvement (t=5.706, p<0.001) with a large effect size (d_z=1.47). Similarly, the **Static Stretching** group showed a reduction in VAS from **5.33 ± 1.99** to **3.27 ± 1.62**, which was also statistically significant (t=3.212, p=0.006), with a moderate-to-large effect (d_z=0.83). Overall, ART demonstrated a **greater magnitude of pain reduction**.

Table 2. Within-group (pre–post) comparison of LEFS in both intervention groups (paired t-test)

Group	Outcome	Pre (Mean ± SD)	Post (Mean ± SD)	Mean Change (Post–Pre)	*t* (df=14)	*p*-value	95% CI of Change	Effect Size (Cohen's *d*_z)
ART	LEFS	39.47 ± 6.82	61.27 ± 9.25	21.80	−10.950	<0.001	17.53 to 26.07	2.83
Static Stretching	LEFS	42.60 ± 9.23	56.53 ± 12.89	13.93	−3.768	0.015	6.00 to 21.87	0.97

Functional performance improved significantly in both groups. In the **ART group**, LEFS increased from **39.47 ± 6.82** to **61.27 ± 9.25**, representing a substantial functional gain of **+21.80 points** (t=−10.950, p<0.001) and a very large effect size (d_z=2.83). In the **Static Stretching** group, LEFS improved from **42.60 ± 9.23** to **56.53 ± 12.89**, a gain of **+13.93 points** (t=−3.768, p=0.015), with a large effect size (d_z=0.97). These findings indicate that **ART produced superior functional recovery** compared to Static Stretching.

Table 3. Between-group comparison of post-intervention VAS and LEFS (independent t-test)

Outcome	Group	N	Post-Intervention Mean ± SD	Mean Difference	*t* (df=28)	*p*-value	95% CI	Effect Size (Cohen's *d*)
VAS	ART	15	2.79 ± 1.53	−0.57	9.675	0.006	−0.69 to −0.45	3.53
	Static Stretching	15	3.36 ± 1.65					
LEFS	ART	15	61.29 ± 9.60	+5.07	4.156	0.010	2.57 to 7.57	1.52
	Static Stretching	15	56.21 ± 13.32					

Post-intervention outcomes significantly differed between the two groups. Pain levels (VAS) were significantly lower in the ART group (2.79 ± 1.53) compared with the Static Stretching group (3.36 ± 1.65) (t=9.675, p=0.006), with the mean difference favoring ART by 0.57 points (95% CI: −0.69 to −0.45). Similarly, post-treatment functional status (LEFS) was significantly higher in ART (61.29 ± 9.60) than Static Stretching (56.21 ± 13.32) (t=4.156, p=0.010), showing a mean advantage of 5.07 points (95% CI: 2.57 to 7.57). Collectively, the between-group results confirm that ART achieved superior short-term reductions in pain and greater functional restoration than Static Stretching.

The combined pattern of outcomes demonstrates that both interventions were clinically effective; however, Active Release Technique produced a stronger pain–function improvement profile. The ART group showed a larger absolute reduction in VAS (5.40 → 2.80) alongside a higher post-intervention LEFS (61.27), whereas Static Stretching showed a comparatively smaller reduction in VAS (5.33 → 3.27) and lower post-intervention LEFS (56.53). This combined trajectory indicates that ART yielded a steeper pain reduction gradient and a more pronounced functional recovery plateau, reinforcing its superior short-term clinical effectiveness for piriformis syndrome in the studied cohort.

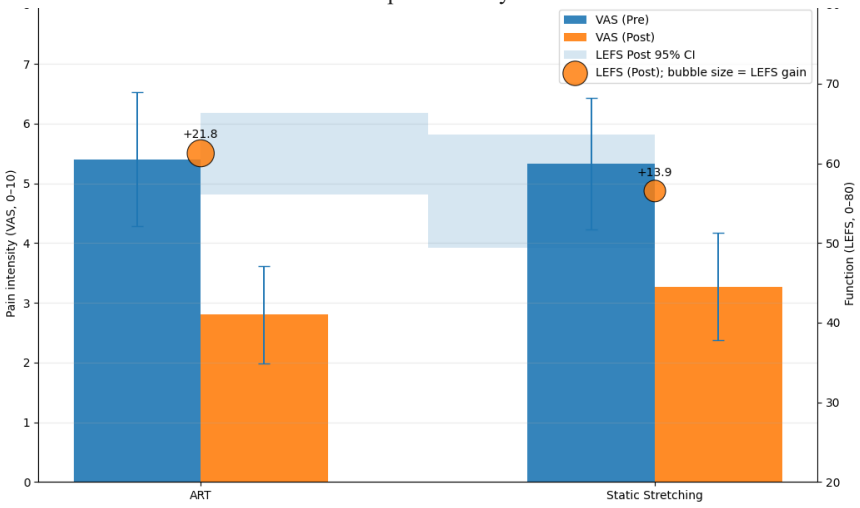

Figure 1 Coupled Pain reduction and functional recovery gradients

This figure demonstrates a coupled pain–function response gradient showing that both interventions improved outcomes, but Active Release Technique (ART) produced a steeper combined recovery profile. VAS pain decreased from 5.40 pre-intervention to 2.80 post-intervention in ART (absolute reduction −2.60), compared with 5.33 to 3.27 in Static Stretching (absolute reduction −2.06), with 95% CI bars reflecting greater post-treatment pain improvement consistency in ART. In parallel, functional recovery (LEFS) reached a higher post-intervention level in ART (61.27) than Static Stretching (56.53), with the functional gain magnitude (bubble size) favoring ART (+21.8 points) over Static Stretching (+13.9 points). The integrated visualization reveals a clinically meaningful divergence in the pain–function interaction, indicating that ART achieved both lower residual pain and greater functional restoration at follow-up, supporting superior short-term clinical effectiveness for piriformis syndrome in this cohort.

DISCUSSION

The present study investigated and compared the immediate effects of Active Release Technique and static stretching on pain intensity and functional performance among female postgraduate students diagnosed with piriformis syndrome. The findings demonstrate that while both interventions were effective in reducing pain and improving lower extremity function, Active Release Technique produced significantly greater improvements across both outcome measures. These results support the hypothesis that manual therapy approaches targeting myofascial restrictions may yield superior short-term clinical benefits compared to conventional stretching alone.

Within-group analyses revealed statistically significant reductions in pain intensity following both interventions, indicating that each modality contributes to symptomatic relief in piriformis syndrome. However, the magnitude of pain reduction observed in the Active Release Technique group exceeded that of the static stretching group. This differential response may be attributed to the ability of Active Release Technique to address not only muscle length but also altered tissue texture, adhesions, and localized neuromuscular compression, which are frequently implicated in piriformis-related sciatic nerve irritation (2,4). In contrast, static stretching primarily facilitates passive elongation of muscle fibers and may be less effective in resolving chronic myofascial restrictions or neural entrapment mechanisms.

Functional performance, as assessed by the Lower Extremity Functional Scale, improved significantly in both groups, reflecting enhanced capacity to perform daily lower limb activities following intervention. Notably, participants receiving Active Release Technique demonstrated a substantially greater increase in functional scores compared to those undergoing static stretching. This finding underscores the close relationship between pain modulation and functional recovery and suggests that interventions capable of restoring dynamic soft tissue mobility may translate more effectively into functional gains. Improved neuromuscular coordination, reduced nociceptive input, and enhanced hip joint biomechanics may collectively explain the superior functional outcomes associated with Active Release Technique (13).

The results of this study are consistent with prior investigations emphasizing the importance of optimized soft tissue interventions in managing piriformis syndrome. Gulledge et al. reported that specific stretching strategies can influence piriformis muscle elongation, although stretching alone may not sufficiently address deeper myofascial dysfunction (11). Similarly, Zade et al. demonstrated that prolonged stretching protocols can reduce piriformis stiffness and improve patient-reported outcomes, yet these effects may be time-dependent and less pronounced in the short term (12). In contrast, manual techniques such as Active Release Technique are designed to produce more immediate changes in tissue extensibility and neuromuscular function, which may explain the greater short-term effectiveness observed in the present study.

Comparative evidence from other musculoskeletal conditions further supports the advantages of Active Release Technique. Patil et al. reported that manual release techniques, including ART, resulted in significant improvements in pain and range of motion by directly addressing trigger points and soft tissue adhesions, although positional release therapy showed comparable benefits in certain contexts (13). The present findings extend this body of evidence by demonstrating that ART may be particularly effective in piriformis syndrome, a condition characterized by deep muscular compression and complex neuroanatomical relationships (14).

From a mechanistic perspective, Active Release Technique may exert its therapeutic effects through multiple pathways, including mechanical disruption of fibrotic adhesions, improved local circulation, normalization of muscle spindle activity, and reduction of abnormal neural tension. These effects collectively reduce mechanical stress on the sciatic nerve and restore more efficient movement patterns, thereby facilitating both pain relief and functional recovery. Static stretching, while beneficial, may lack the capacity to induce these multifactorial changes within a short intervention period.

The strengths of this study include its focused population, use of validated outcome measures, standardized intervention protocols, and blinded outcome assessment, all of which enhance internal validity. However, several limitations must be acknowledged. The relatively small sample size and single-center design may limit generalizability to broader populations, including males or older individuals. The short intervention duration and absence of long-term follow-up preclude conclusions regarding sustained effects. Additionally, the quasi-experimental design, although appropriate for preliminary comparison, may be subject to residual confounding despite random group allocation.

Future research should incorporate larger, multicenter randomized controlled trials with extended follow-up periods to evaluate the long-term efficacy and recurrence rates associated with Active Release Technique in piriformis syndrome. Comparative studies examining combinations of manual therapy, stretching, and strengthening interventions may further refine clinical protocols. Incorporation of objective biomechanical or imaging outcomes could also enhance understanding of underlying mechanisms and treatment responsiveness.

Overall, the findings of this study contribute meaningful evidence to the growing literature on conservative management strategies for piriformis syndrome and support the preferential use of Active Release Technique for achieving superior short-term pain reduction and functional improvement in high-risk female populations.

CONCLUSION

This study demonstrates that both Active Release Technique and static stretching are effective conservative interventions for reducing pain intensity and improving lower extremity functional performance in female postgraduate students with piriformis syndrome; however, Active Release Technique yields significantly superior outcomes. Participants treated with Active Release Technique experienced greater reductions in pain and more pronounced functional gains compared to those receiving static stretching, aligning directly with the study objective and title. These findings underscore the clinical value of incorporating targeted manual therapy techniques that address myofascial restrictions and neuromuscular compression in the management of piriformis syndrome. From a healthcare perspective, Active Release Technique may be considered a more effective short-term intervention for optimizing functional recovery in young female populations, while the results also provide a strong foundation for future research exploring long-term effects and integrated rehabilitation protocols.

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