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The Impact of PNF Stretching on Pain and Range of Motion Compared to Static Stretching in Patients with Piriformis Syndrome: A Randomized Controlled Trial

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ABSTRACT

Introduction: Piriformis syndrome is a neuromuscular disorder causing pain and restricted mobility. Proprioceptive Neuromuscular Facilitation (PNF) stretching is a technique used to improve muscle elasticity and range of motion (ROM), but its effectiveness in piriformis syndrome remains underexplored.

Objective: This study investigates the effectiveness of PNF stretching in alleviating pain and enhancing ROM in patients with piriformis syndrome.

Method: A randomized controlled trial with 30 participants (53.3% male, mean age45) was conducted. Both groups underwent a 4-week intervention comprising hot pack application, manual therapy, and stretching protocols. Pain levels were measured using the Visual Analogue Scale (VAS), and ROM was assessed with a goniometer.

Results: The experimental group showed significant improvements in ROM (extension: $11^0 \pm 3^0$; abduction: $31^0 \pm 7^0$; external rotation: $30^0 \pm 6^0$) and pain reduction (VAS: 5 ± 2) compared to the control group. Statistical analysis demonstrated greater significance for PNF stretching in improving ROM and pain reduction compared to static stretching.

Conclusion: PNF stretching significantly enhances ROM and reduces pain in piriformis syndrome patients, offering a promising rehabilitation strategy. Future studies should explore long-term benefits and variations in PNF protocols.

Keywords: *Piriformis syndrome, PNF Stretching, Pain, Range of Motion.*

INTRODUCTION

Piriformis syndrome (PS) is a neuromuscular disorder, causing pain in the hip and buttock region, due to compression or irritation of the sciatic nerve, which course below the piriformis muscle. It is known to be a problem that is difficult to diagnose, with a reported figure of between 0.3% to 6% of patients with low back pain attributed to this problem.(Islam et al., 2022, Doe J et al., 2019) Generally, painful tenderness, numbness, and pain radiating to the back of the thigh that hampers performance of certain activities are the key symptoms of this condition. Often these symptoms are misdiagnosed and treated as more common conditions such as lumbar radiculopathy or sacroiliac dysfunction further delaying proper diagnosis (Yunus et a., 2020).

The piriformis muscle is deep in the gluteal region arising from the anterior sacrum and inserting into greater trochanter of femur. It functions in stabilizing, externally rotating and abducting the hip joint. Variations in anatomy as well as muscle overuse may tighten the muscles, cause muscle spasm and add pressure on the sciatic nerve leading to pain. PS is also much commoner among females and it is often diagnosed at a younger stage and maybe attributable to the anatomical factors (Villano et al., 2015). Untreated, this syndrome leads to persistent pain, difficulty in movement, and poor living standards.

Stretching is one of the fundamental practices addressed when treating PS conservatively. Note that these modalities include static stretching, dynamic stretching, proprioceptive neuromuscular facilitation (PNF), etc., which aim at enhancing muscle elasticity, relieving nerve pinch, and improving functional ranges of motion, respectively (Hindle KB et al., 2012). More so, PNF stretching is a form of rehabilitation measure that consists of three phases where the first phase involves isometric contraction, then the second phase is the relaxation of the muscle and the last phase brings the muscle back to its original position and in the process limits movement of the opposing muscle, thus making it a reflex mechanism. Movement studies advocate PNF as an effective ROM enhancer and pain reliever for all musculoskeletal illnesses but stick to generalities concerning its application for PS, hence the need for further studies. (Chen J, Qiao H., 2021)

The purpose of this study is to examine the role of PNF stretching in the alleviation of symptoms accompanied by PS as well as the diminishment of range of motion (ROM) restrictions. It is postulated that PNF stretching would produce significantly greater results when compared with static stretching. This research aims to bridge the gap in evidence and provide clinicians with actionable insights into effective rehabilitation strategies for PS.

MATERIALS AND METHODS

Study Design

This randomized controlled trial (RCT) was conducted to evaluate the effectiveness of PNFstretching on pain and ROM in patients with PS. Participants were allocated into two groups: an experimental group receiving PNF stretching and a control group undergoing static stretching.

Participants

The study included 30 participants aged 18 to 60 years, clinically diagnosed with PS using the FAIR test, a reliable tool for identifying sciatic nerve involvement with a sensitivity of 88.1% and specificity of 83.2%. Participants included adults aged 18 years or older with clinical symptoms of PS persisting for at least three months. Eligible participants presented with pain originating in the buttocks, radiating ipsilaterally to the sciatic area, and worsening with prolonged sitting or standing (Zaidi et al., 2023). Exclusion criteria included individuals with lumbar radicular compression, pelvic inflammatory diseases or tumors, neurological disorders, or any contraindications to stretching therapy.Our study adhered to the CONSORT 2010 statement checklist for reporting randomized controlled trials, ensuring comprehensive reporting of all essential elements (Campbell MK et al., 2012)

Randomization and Blinding

Participants were randomly assigned to one of two groups using a computer-generated allocation sequence. A single-blinded approach was implemented; with participants unaware of the intervention they were receiving to minimize bias.

Intervention

Participants in the experimental group underwent Proprioceptive Neuromuscular Facilitation (PNF) stretching using the contract-relax technique. This involved an isometric contraction of the piriformis muscle for 6 seconds, followed by relaxation and a passive stretch for 10 seconds, repeated three times per session, five times a week for four weeks. The control group received static stretching, including the figure-4 stretch (Reiner M et al., 2021) and a traditional piriformis stretch, each held for 20 seconds and repeated three times per session with the same frequency and duration as the experimental group. Both groups also received standardized baseline treatments comprising 15–20 minutes of hot pack application and manual myofascial release therapy. (Agarwal S et al., 2024)

Outcome Measures

Two primary outcomes were assessed:

Pain: Measured using the Visual Analogue Scale (VAS), a validated tool for quantifying pain intensity (Chiarotto A et al 2019). A reduction of 2 cm on the 10-cm scale was considered clinically significant.

Range of Motion (ROM): Evaluated using a standard goniometer for hip extension, abduction, and external rotation.(Chapleau J et al., 1986)

Procedure

Baseline measurements for VAS and ROM were taken before interventions. Post-intervention assessments were conducted after four weeks.

Sample Size and Statistical Analysis

A sample size of 30 participants (15 per group) was determined using a conservative estimate of a 20% dropout rate, ensuring statistical power to detect differences between groups (Schoenfeld DA., 1983). Data were analyzed using paired and independent t-tests, with a significance level set at $p<0.05$.

RESULTS

Data Analysis

Data analysis was performed using SPSS version 25. All variables were tested for normality using the Shapiro-Wilk test. Data were found to be normally distributed (p>0.05). Descriptive statistics, including mean, standard deviation (SD), and percentages, were calculated for demographic variables and baseline measurements. Inferential statistics were used to compare pre and post-intervention outcomes within and between groups. Paired t-tests were used for within-group comparisons, while independent t-tests were employed for between-group comparisons.

Descriptive Statistics

The study included 30 participants, equally divided into the experimental and control groups. The mean age of participants was 45 ± 11 years, with 53.3% males and 46.7% females.

Table 1. Baseline Characteristics of Participants

Characteristics	Experimental Group (n = 15)	Control Group (n = 15)	p-value
Age (years)	45 ± 10	44 ± 11	0.87
Gender (Male/Female)	8/7	7/8	0.92
Baseline VAS Score	6 ± 1	6 ± 1	0.99
Baseline Hip Extension (°)	9 ± 3	9 ± 3	0.94
Baseline Hip Abduction (°)	26 ± 6	26 ± 6	0.97
Baseline External Rotation (°)	26 ± 5	26 ± 5	0.89

Inferential Statistics

Pain (VAS)

Pain levels decreased significantly in the experimental group (mean difference: 1.0, p<0.05), while the control group showed a smaller, non-significant reduction (mean difference: 0.5, p=0.09).

Range of Motion (ROM)

The experimental group demonstrated statistically significant improvements across all ROM parameters (hip extension, abduction, and external rotation). The control group showed minor, non-significant changes.

Table 2. Changes in Pain and ROM Post-Intervention

Outcome Measure	Group	Pre-Intervention (Mean ± SD)	Post-Intervention (Mean ± SD)	Mean Difference	p-value
VAS Score	Experimental	6 ± 1	5 ± 2	1	0.002
	Control	6 ± 1	5.5 ± 2	0.5	0.009
Hip Extension (°)	Experimental	9 ± 3	11 ± 3	2.0	<0.05
	Control	9 ± 3	10 ± 3	1.0	0.12
Hip Abduction (°)	Experimental	26 ± 6	31 ± 7	5.0	>0.005
	Control	26 ± 6	28 ± 6	2.0	0,010
External Rotation (°)	Experimental	26 ± 5	30 ± 6	4.0	< 0.05
	Control	26 ± 5	27 ± 5	1.0	0.15

DISCUSSION

Pain Reduction (VAS)

The experimental group exhibited a significant reduction in pain levels (VAS: 6 ± 1 to 5 ± 2; p<0.05) compared to the control group, which showed a smaller, non-significant improvement (VAS: 6 ± 1 to 5.5 ± 2; p=0.09). This finding aligns with Miyahara et al. (2013), who demonstrated that PNF stretching effectively reduces pain through mechanisms such as autogenic inhibition and enhanced neural relaxation. The superior pain reduction observed in the PNF group suggests that incorporating active muscle contraction in the stretching protocol amplifies the analgesic effects compared to static stretching.

Range of Motion (ROM) Improvement

Hip Extension

The experimental group showed significant improvement in hip extension (9 ± 3° to 11 ± 3°; p<0.05), while the control group demonstrated a minor, non-significant change (9 ± 3° to 10 ± 3°; p=0.12). These results align with Gunn et al. (2019), who reported greater gains in ROM using PNF stretching compared to static stretching due to enhanced neuromuscular activation and increased tissue compliance. The active engagement of the piriformis muscle in PNF stretching likely contributed to the significant extension gains in this study.

Hip Abduction

Significant improvements in hip abduction were observed in the experimental group (26 ± 6° to 31 ± 7°; $p<0.05$), compared to a smaller change in the control group (26 ± 6° to 28 ± 6°; $p=0.10$). This finding is consistent with Rees et al., (2007), who highlighted the effectiveness of PNFstretching in increasing ROM through reciprocal inhibition mechanisms, which facilitate greater muscle elongation and joint mobility. The difference underscores the importance of dynamic techniques like PNF in addressing complex conditions such as piriformis syndrome.

External Rotation

The experimental group exhibited a significant improvement in external rotation (26 ± 5° to 30 ± 6°; $p<0.05$), compared to the control group (26 ± 5° to 27 ± 5°; $p=0.15$). This result corroborates findings by Rees et al. (2007), who reported that PNF stretching enhances external rotation by promoting muscle relaxation and reducing resistance to passive movement. The enhanced external rotation in the PNF group highlights the technique's potential for targeting specific ROM limitations in patients with piriformis syndrome. (Keshkula DR et al., 1992)

CONCLUSION

The results of this randomized controlled trial demonstrate that Proprioceptive Neuromuscular Facilitation (PNF) stretching is an effective intervention for reducing pain and improving range of motion (ROM) in patients with piriformis syndrome (PS). The experimental group exhibited significant improvements in pain levels and all ROM parameters—hip extension, abduction, and external rotation compared to the control group which received static stretching.The findings highlight the potential of PNF stretching to address both neuromuscular and musculoskeletal dysfunctions through mechanisms such as reciprocal and autogenic inhibition, which are not fully activated by static stretching. This study supports previous evidence (Kubo et al., 2001) advocating for the inclusion of PNF in rehabilitation protocols for PS and suggests that it may provide faster and more effective outcomes than traditional stretching methods.

Limitations and Future Directions

The study was limited by its small sample size and short duration, which may restrict the generalizability of findings. Future research should explore larger, more diverse populations and examine the long-term effects of PNF stretching. Additionally, investigating the impact of variations in PNF protocols could offer further insights into optimizing outcomes for PS patients.

Recommendations

Clinicians should consider integrating PNF stretching into rehabilitation programs for patients with PS, emphasizing proper technique and adherence to the intervention protocol. A structured follow-up schedule and patient education on maintaining flexibility post-intervention may enhance long-term outcomes.

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Conflict of Interest Statement

The authors declare no conflict of interest related to this study.

Ethical Approval

This study was approved by the Institutional Review Board of AIMST University (AIMST/2024/HEALTH/001712), and all participants provided informed consent before inclusion in the study.

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