

Effect of Iliopsoas and Diaphragm Myofascial Release on Post-Herniorrhaphy Chronic Groin Pain and Functional Performance; a Randomized Controlled Trial

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ABSTRACT

Chronic postoperative inguinal pain (CPIP), defined as persistent pain lasting at least three months that is at least moderate in intensity and impacts daily activities, represents a significant complication following groin hernia repair. With an incidence rate of 10-12%, CPIP affects a substantial patient population, translating to an estimated two million individuals worldwide suffering from sustained pain annually, thereby posing a considerable global health burden. While groin hernia repair (herniorrhaphy) is a common surgical procedure, a subset of patients, particularly young adult males, are at a higher risk of developing this debilitating chronic pain. The etiology of CPIP is multi factorial and complex, often classified as neuropathic or non-neuropathic in origin. Neuropathic pain typically arises from intra-operative damage to the inguinal nerves and usually develops in the sensory distribution of the injured nerve. Non-neuropathic pain, conversely, is frequently associated with mesh-related complications or postoperative fibrosis, leading to an entrapment of neural structures within scar tissue.

Keywords: Diaphragm Myofascial, Chronic Groin Pain, Post-Herniorrhaphy, Effect of Iliopsoas, Neuropathic Pain

INTRODUCTION

Chronic postoperative inguinal pain (CPIP), defined as persistent pain lasting at least three months that is at least moderate in intensity and impacts daily activities, represents a significant complication following groin hernia repair [1]. With an incidence rate of 10-12%, CPIP affects a substantial patient population, translating to an estimated two million individuals worldwide suffering from sustained pain annually, thereby posing a considerable global health burden [2, 3]. While groin hernia repair (herniorrhaphy) is a common surgical procedure [4], a subset of patients, particularly young adult males, are at a higher risk of developing this debilitating chronic pain [5]. The etiology of CPIP is multi factorial and complex, often classified as neuropathic or non-neuropathic in origin [6]. Neuropathic pain typically arises from intra-operative damage to the inguinal nerves and usually develops in the sensory distribution of the injured nerve. Non-neuropathic pain, conversely, is frequently associated with mesh-related complications or postoperative fibrosis, leading to an entrapment of neural structures within scar tissue [7].

The nerves implicated are the Ilioinguinal nerve (IIN), the Iliohypogastric nerve (IHN), the genital branch of the Genitofemoral nerve (GFN), and, infrequently, the Lateral Femoral Cutaneous nerve (LFC). Nerve damage may occur due to partial or total transection, stretching, bruising, crushing, electrical injury, or entrapment in sutures utilized in open repair or tacks employed in laparoscopic repair. Secondary nerve injury may arise from neighboring inflammatory processes, such as granuloma, or from an excessive fibrotic response or mesh encasement [7]. Myofascial release (MFR) is

an increasingly popular manual therapy technique designed to alleviate pain by restoring the functionality of soft tissues. The theoretical foundation of the therapeutic benefits of myofascial release is predicated on the significant involvement of connective tissue layers, known as "fascia," as a primary determinant of musculoskeletal system functionality. According to that hypothesis, the fascial system, extending from head to toe, may serve as an organ with many roles and skills, significantly contributing to the body's dynamic features [8]. The anatomical and functional relationship between the iliopsoas and diaphragm muscles provides a compelling rationale for a novel therapeutic approach. These muscles share a common fascial attachment and a close anatomical relationship proximal to the T12 vertebra [9, 10]. Consequently, fascial dysfunction in one structure can adversely influence the biomechanics of the other, potentially contributing to core instability and dysfunctional load transfer through the anterior hip and inguinal region [10]. MFR techniques, which involve applying gentle, sustained pressure to the myofascial complex to restore optimal function and reduce pain [8], could theoretically address these alterations. Despite the theoretical basis, there is a pronounced lack of high-quality evidence investigating the efficacy of MFR targeting this specific muscular-fascial unit for CPIP. Therefore, the primary aim of this randomized controlled trial was to determine the effect of a combined iliopsoas and diaphragm myofascial release protocol on pain intensity in patients with CPIP after Herniorrhaphy. Secondary aims were to evaluate its effects on hip range of motion (ROM) and muscle strength.

Methods

Study Design

A prospective, double-blind, randomized controlled trial (RCT) with a parallel-group design was executed. Assessments were performed at baseline (pre-intervention) and immediately after the conclusion of the 4-week intervention period (post-intervention).

Participants

Thirty male patients, aged from 15 to 30 years, with chronic postoperative inguinal pain (CPIP) (longer than 3 months) after inguinal hernia repair, participated in this study. They were recruited from the outpatient clinics of the Department of General Surgery at El Kasr El Aini Teaching Hospital, Cairo University, and the Faculty of Physiotherapy at the Modern University for Technology and Information (MTI) between October 2024 and May 2025. The inclusion criteria were as follows: Males, Diagnosis of unilateral inguinal hernia repaired with herniorrhaphy (open or laparoscopic) confirmed by a surgeon, Presence of chronic groin pain for a minimum duration of 3 months post-surgery, with an average intensity of ≥ 3 on the Numeric Pain Rating Scale (NPRS), and Self-reported limitation in the activities of daily living due to groin pain. While the exclusion criteria were: History of previous lumbar spine surgery, lumbar radiculopathy, or severe hip pathology (e.g., hip arthrosis, avascular necrosis), Cognitive impairments or inability to comprehend study instructions and outcome measures, having received physical therapy or invasive procedures (e.g., steroid injections) for groin pain in the 3 months prior to the study, recurrent hernia or surgical complications requiring re-intervention, and known advanced osteoporosis or other systemic conditions contraindicating manual therapy.

Study Setting and Timeline

The study was conducted in the outpatient clinic of the Faculty of Physiotherapy at MTI University, Egypt. Recruitment and data collection took place from October 2024 and May 2025. The intervention period for each participant was four consecutive weeks, with three sessions provided per week, resulting in a total of 12 treatment sessions per participant.

Ethical Considerations

The Ethics Committee of the Faculty of Physiotherapy authorized this study, MTI University, Egypt [REC/2111/MTI.PT/2401042]. It was done following the guidelines of the Declaration of Helsinki. Before joining the study, all potential participants were told about the study's

purpose, risks, and benefits. They signed consent forms before any data was collected. Participants were informed they could leave the study anytime without facing any consequences. To protect privacy, all data was given a unique code before being stored.

Sample Size Calculation

A priori sample size calculation was conducted utilizing G*Power software (version 3.1, Heinrich Heine University, Düsseldorf, Germany). The calculation was based on detecting a large effect size ($d = 0.8$) for the primary outcome (pain intensity on the NPRS) using a one-tailed t-test, with an alpha (α) level of 0.05 and a power ($1-\beta$) of 80%. This calculation yielded a required total sample size of 30 participants (15 per group).

Randomization

Eligible participants were randomly allocated to one of two groups using a simple randomization technique with a rolling die (even number: Group A; odd number: Group B). The allocation sequence was concealed from the researcher enrolling participants until the intervention was assigned.

Blinding

Due to the hands-on nature of the intervention, the treating physical therapists could not be blinded to group assignment. However, participants were blinded to the study hypothesis. They were informed that the research aimed to compare two different physical therapy regimens for post-surgical groin pain. Crucially, all outcome assessments were conducted by a blinded assessor—a research assistant who was not involved in the treatment sessions and was unaware of group assignments. This assessor was instructed not to discuss treatment with participants to maintain blinding.

Allocation

Group A (Experimental Group): Participants in this group received a combination of iliopsoas and diaphragmatic myofascial release techniques in addition to a conventional physical therapy exercise program. The session structure was as follows; Myofascial Release (20 minutes) in the form of Psoas Fascial Induction, Diaphragm Stretching Technique and Phrenic Center Inhibition. Followed by Conventional Exercise Program (20 minutes), they performed a standardized program of stretching and strengthening exercises for the hip joint muscles. These sessions took place three times a week for four weeks. Group B (Control Group): Participants in this group received only the conventional physical therapy exercise program for 20 minutes, three times per week for four weeks.

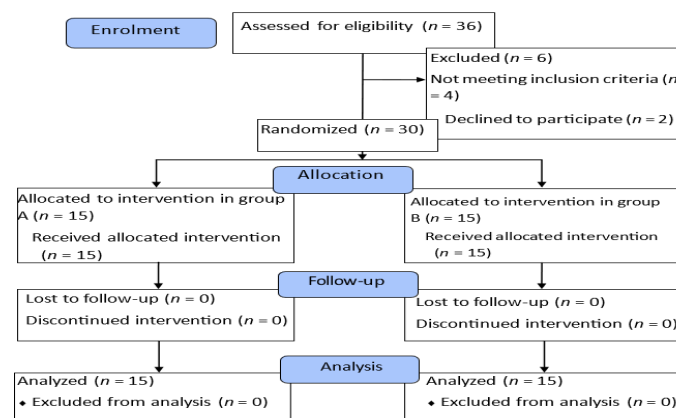


FIGURE 1: The Study Flow Chart

Outcome Measures

All outcome measures were assessed at baseline (pre-intervention) and immediately after the four weeks intervention period (post-intervention) by a blinded assessor.

Primary Outcome Measure

Pain Intensity: The intensity of groin pain was measured using the Numeric Pain Rating Scale (NPRS) [11]. Patients were asked to rate their average pain over the preceding 24 hours on an 11-point scale ranging from 0 (no pain) to 10 (the worst imaginable pain). The NPRS is a valid and reliable tool (reliability coefficient $r = 0.74$) for assessing pain in musculoskeletal conditions [11].

Secondary Outcome Measures

Disease-Specific Pain: The Inguinal Pain Questionnaire (IPQ) was used to evaluate pain specific to CPIP. This validated questionnaire in populations with chronic groin pain assesses pain intensity and its impact on function across various situations, including at rest, during daily activities, and during sports. Higher scores indicate greater pain and functional limitation [12].

Hip Range of Motion (ROM): Active range of motion for hip flexion, extension, and adduction was measured using a digital inclinometer (Lafayette digital inclinometer, Model: Acumar ACU 360). Measurements were taken at the point of first onset of pain in the inguinal region to determine pain-limited ROM [13]. The specific patient positions and inclinometer placement were as follows:

- **Hip Flexion:** With the patient in a supine position, the leg was actively flexed at the hip. The inclinometer was placed over the greater trochanter.
- **Hip Extension:** With the patient in a prone position, the leg was actively extended at the hip. The inclinometer was placed over the greater trochanter.
- **Hip Adduction:** With the patient in a supine position, the leg was actively adducted cross the midline of the body. The inclinometer was placed proximal to the pubic symphysis.

Hip Muscle Strength: Isometric muscle strength for hip flexion, abduction, and adduction was measured using a handheld dynamometer (Lafayette Electronic Handheld Dynamometer, Model: 01165A). A "break" test was performed, where resistance was applied by the assessor until the participant's muscle effort was overcome or until the onset of pain. The mean value of three trials for each movement was recorded in newton (N) [14]. Testing was conducted as follows:

- **Hip Flexion:** Supine position. The dynamometer was placed proximal to the patella on the anterior thigh. Resistance was applied in a caudal direction.
- **Hip Abduction:** Supine position. The dynamometer was placed on the lateral aspect of the thigh, proximal to the knee joint. Resistance was applied towards the midline.
- **Hip Adduction:** Supine position. The dynamometer was placed on the medial aspect of the thigh, proximal to the knee joint. Resistance was applied away from the midline.

Functional Status: The functional impact of pain was assessed using the Copenhagen Hip and Groin Outcome Score (HAGOS). HAGOS is a validated, patient-reported questionnaire that evaluates

symptoms, pain, physical function, and participation in sports and recreational activities in patients with hip and groin pain. A score of 100 represents no symptoms or limitations, and 0 represents extreme symptoms/limitations [15].

Physical Performance: The Timed Up and Go (TUG) test was used to assess functional mobility. Participants were instructed to stand from a standard chair, walk 3 meters, turn around, walk back, and sit down, as quickly and safely as possible. The time was recorded in seconds, for adults, a time of ≤ 10 seconds is generally considered normal for basic functional mobility. Times ≥ 14 seconds may indicate mobility impairment. Lower times are better [16].

Intervention Protocol

Both groups attended three supervised sessions per week for four weeks. Each session lasted approximately 40 minutes.

Group A (Experimental Group): Received myofascial release techniques followed by the standardized exercise program.

Group B (Control Group): Received only the standardized exercise program.

Myofascial Release Techniques (for Group A only)

The following techniques were performed by a certified physical therapist, with each step lasting approximately 20 minutes.

- **Psoas fascial induction:** The patient was positioned supine. The therapist placed their knee under the patient's treated-side knee to facilitate hip flexion. To confirm psoas placement, the patient performed a sub-maximal isometric hip flexion against resistance. The therapist then placed both hands side-by-side with fingertips in contact with the iliopsoas muscle belly. Three sets of 15 transverse gliding motions were performed [17].
- **Diaphragmatic Myofascial Release:** The patient was supine with knees flexed and a pillow supporting the head; a) **Costal Expansion:** The therapist placed both hands over the patient's lower ribs. The patient was instructed to take four deep breaths, during which the therapist gently exaggerated the rib cage's lateral expansion [18]. b) **Respiratory Stretch:** The therapist placed their hands under the lower ribs. During inhalation, the therapist accompanied the inspiratory movement while providing gentle resistance to prevent caudal descent. During exhalation, a sustained stretch was applied in a lateral and cranial direction [18]. **Phrenic center inhibition:** The therapist placed one hand over the sternum and the other on the upper abdomen. During exhalation, the abdominal hand applied a cranial glide towards the xiphoid process while the sternal hand applied a caudal pressure. All forces were released during inhalation. This was repeated for 12 respiratory cycles [19].

Standardized Exercise Program (for both Groups A and B)

All participants performed a 20-minute supervised exercise program, three times per week, and were instructed to repeat it independently on non-clinic days. The program consisted of:

- **Stretching Exercises:** Static stretches for the iliopsoas and hip adductors were held for 30 seconds and repeated 3 times.
- **Strengthening Exercises:** Exercises targeting the hip flexors, abductors, adductors, and extensors were performed for 3 sets

of 10 repetitions. Resistance was progressively increased using elastic bands or ankle weights based on patient tolerance [20].

Statistical Analysis

All statistical analyses were performed utilizing SPSS software, version 15.0 (SPSS Inc., Chicago, IL, USA). The Shapiro-Wilk test was employed to assess the normality of the data distribution. Descriptive statistics are presented as the mean $\pm$ standard deviation (SD). Baseline characteristics and outcome measures between groups were compared using independent samples t-tests. Within-group comparisons (pre- vs. post-intervention) were analyzed using paired samples t-tests. Between-group comparisons of the mean change scores (post-pre) were analyzed using independent samples t-tests.

Effect sizes were calculated using Cohen's d_z for within-group comparisons and Hedges' g for between-group comparisons to account for small sample sizes. The significance level was set at p value $< .05$ [21].

Results

Thirty male participants aged 15–30 years (mean age = 22.1 ± 4.6 years) were enrolled and randomized equally into two groups (Group A = 15, Group B = 15). As presented in (Table 1), baseline comparisons revealed no significant differences between groups for the majority of outcome measures (p values $> .05$), confirming successful randomization. A significant difference was noted only in hip adduction ROM at baseline (p value = $.020$); however, given that the primary analysis focuses on change scores.

Table 1: Baseline Demographic and Clinical Characteristics of the Study Participants (N=30).

Characteristic	Group A (N=15)	Group B (N=15)	P-Value
Age (Years)	22.6 ± 4.8	20.6 ± 3.9	0.228
Gender			
Male, n (%)	15 (100%)	15 (100%)	1.000
Pain Intensity (NPRS, 0-10)	7.6 ± 0.9	6.9 ± 0.95	0.040
Inguinal Pain Questionnaire (IPQ)	49.7 ± 5.5	48.4 ± 3.3	0.428
Hip & Groin Outcome (HAGOS, 0-100)	54.0 ± 6.7	55.0 ± 7.6	0.728
Timed Up & Go (TUG, seconds)	15.3 ± 1.1	15.0 ± 1.0	0.467
Hip Extension ROM ($^{\circ}$)	9.8 ± 2.1	9.5 ± 2.3	0.742
Hip Adduction ROM ($^{\circ}$)	11.5 ± 1.9	13.0 ± 1.6	*0.020
Hip Flexion ROM ($^{\circ}$)	92.0 ± 4.8	88.0 ± 8.9	0.137
Hip Flexion Strength (N)	108.7 ± 7.9	111.0 ± 8.3	0.430
Hip Abduction Strength (N)	93.9 ± 7.5	92.0 ± 11.7	0.622
Hip Adduction Strength (N)	87.9 ± 10.9	89.0 ± 7.9	0.758

Note: Data presented as Mean $\pm$ SD. NPRS = Numeric Pain Rating Scale; HAGOS = Copenhagen Hip and Groin Outcome Score; TUG = Timed Up and Go test; ROM = Range of Motion. Independent Samples t-test used for Continuous Variables; Fisher's Exact Test for Gender.

Within-Group Comparisons

Paired-samples t-test revealed that both groups showed improvements following the intervention as shown in (Table 2).

- In Group A (Experimental Group) showed highly statistically significant improvements from pre- to post-intervention across all outcome measures, including pain intensity (NPRS), pain quality (IPQ), hip and groin function (HAGOS), functional mobility (TUG), hip range of motion (ROM) (extension, flexion, adduction), and muscle strength (flexion, abduction, adduction) (all p values < 0.001). The improvements were large, as indicated by Cohen's d_z effect

sizes ranging from 3.45 (hip flexion ROM) to 8.61 (hip adduction ROM).

- In Group B (Control Group), also showed significant improvements in pain intensity (NPRS, $p < .001$), function (HAGOS, $p < .001$), mobility (TUG, $p = .006$), hip extension ROM ($p < .001$), hip flexion ROM ($p = .001$), and strength (flexion, $p = .003$; abduction, $p = .002$). However, no significant within-group changes were observed for the Inguinal Pain Questionnaire (IPQ, $p = .494$), hip adduction ROM ($p = .127$), or hip adduction strength ($p = .052$). The effect sizes for Group B were small to moderate, indicating limited change in pain perception and adduction mobility.

Table 2: Showing within-Group Comparisons of Outcome Measures from Baseline to Post-Intervention.

Outcome Measure	Group A (Experimental)				Group B (Control)			
	Pre	Post	Mean Change (95% CI)	Effect Size Cohens Dz	Pre	Post	Mean Change (95%CI)	Effect Size Cohens dz
NPRS (0-10)	7.6 ± 0.9	3.2 ± 1.2	-4.35 (-4.83 to -3.87) ***	-4.88	6.9 ± 1.0	5.0 ± 1.1	-1.82 (-2.29 to -1.35) ***	-2.56
IPQ	49.7 ± 5.5	23.2 ± 6.9	-26.49 (-28.43 to -24.55) ***	-7.65	48.4 ± 3.3	47.3 ± 7.3	-1.09 (-4.31 to 2.13)	-0.18
HAGOS (0-100)	54.0 ± 6.7	81.8 ± 8.5	27.81 (24.71 to 30.91) ***	5.05	54.9 ± 7.6	62.7 ± 9.9	7.77 (4.21 to 11.33) **	1.27
TUG (s)	15.3 ± 1.1	10.4 ± 1.2	-4.90 (-5.44 to -4.36) ***	-4.97	15.0 ± 1.0	14.0 ± 1.5	-1.02 (-1.72 to -0.32) **	-0.83
Hip Ext. ROM ($^{\circ}$)	9.8 ± 2.0	20.3 ± 2.8	10.48 (9.35 to 11.61) ***	5.10	9.5 ± 2.3	12.6 ± 2.5	3.05 (2.08 to 4.02) ***	1.63
Hip Add. ROM ($^{\circ}$)	11.5 ± 1.9	23.3 ± 2.7	11.85 (11.08 to 12.62) ***	8.61	13.0 ± 1.6	14.0 ± 3.2	0.96 (-0.30 to 2.22)	0.42
Hip Flex. ROM ($^{\circ}$)	92.0 ± 4.8	112.7 ± 6.3	20.68 (17.30 to 24.06) ***	3.45	88.0 ± 8.9	92.7 ± 10.2	4.71 (2.18 to 7.24) **	1.10
Hip Flex. Str. (N)	108.7 ± 7.9	157.8 ± 8.7	49.19 (44.25 to 54.13) ***	5.08	111.0 ± 8.3	121.1 ± 11.7	10.12 (4.21 to 16.03) **	0.95
Hip Abd. Str. (N)	93.9 ± 7.5	139.6 ± 12.3	45.73 (39.91 to 51.55) ***	4.32	92.1 ± 11.7	102.1 ± 17.8	10.01 (4.21 to 15.81) **	0.96
Hip Add. Str. (N)	87.9 ± 10.9	136.0 ± 15.1	48.13 (44.17 to 52.09) ***	6.12	89.0 ± 7.9	94.6 ± 10.8	5.69 (-0.12 to 11.50)	0.55

Note: Data Presented as Mean $\pm$ SD. Mean Change = Post-Intervention score - Baseline Score. CI = Confidence Interval. *** $p < .001$, ** $p < .01$

Between-Group Comparisons

Independent-samples t-tests on the change scores demonstrated that Group A achieved significantly greater improvements than Group B across all outcome measures ($p < .001$ for all comparisons) (Table 3) and (Figures 2-5). The between-group effect sizes (Hedges' g) were

very large, ranging from 2.98 (hip flexion ROM) to 5.61 (hip adduction ROM), unequivocally supporting the superior efficacy of the combined iliopsoas and diaphragm myofascial release protocol in reducing chronic post-herniorrhaphy groin pain and enhancing function.

Table 3: Showing between-Group Comparisons of Mean Change Scores for all Outcome Measures.

Outcome Measure	Mean Change $\pm$ SD Group A	Mean Change $\pm$ SD Group B	Difference in Mean Change (95% CI)	P Value	Hedges' g Effect Size
NPRS	-4.35 $\pm$ 0.89	-1.82 $\pm$ 0.71	-2.53 (-3.15 to -1.91)	< .001	-3.05
IPQ	-26.49 $\pm$ 3.46	-1.09 $\pm$ 5.99	-25.41 (-29.10 to -21.72)	< .001	-5.05
HAGOS	27.81 $\pm$ 5.50	7.77 $\pm$ 6.11	20.04 (15.71 to 24.37)	< .001	3.35
TUG (s)	-4.90 $\pm$ 0.99	-1.02 $\pm$ 1.23	-3.88 (-4.75 to -3.01)	< .001	-3.38
Hip Extension ROM ($^{\circ}$)	10.48 $\pm$ 2.05	3.05 $\pm$ 1.87	7.43 (5.87 to 8.99)	< .001	3.68
Hip Adduction ROM ($^{\circ}$)	11.85 $\pm$ 1.38	0.96 $\pm$ 2.29	10.89 (9.43 to 12.35)	< .001	5.61
Hip Flexion ROM ($^{\circ}$)	20.68 $\pm$ 6.00	4.71 $\pm$ 4.30	15.97 (11.81 to 20.13)	< .001	2.98
Hip Flexion Strength (N)	49.19 $\pm$ 9.67	10.12 $\pm$ 10.64	39.07 (30.94 to 47.20)	< .001	3.74
Hip Abduction Strength (N)	45.73 $\pm$ 10.59	10.01 $\pm$ 10.41	35.73 (27.57 to 43.89)	< .001	3.31
Hip Adduction Strength (N)	48.13 $\pm$ 7.86	5.69 $\pm$ 10.37	42.45 (35.30 to 49.60)	< .001	4.49

*Note: A Negative Mean Change for NPRS and TUG Indicates Improvement. Positive Mean Change for all Other Measures Indicates Improvement. CI = Confidence Interval. All Between-Group Differences were Significant at $p < .001$. *

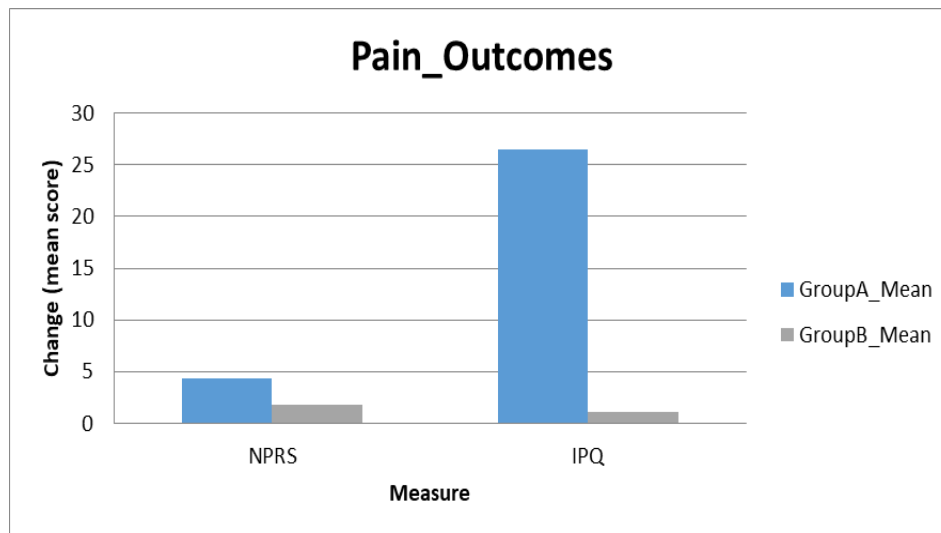


Figure 2: Mean Change in Pain Outcomes for Both Groups. Group A (Iliopsoas and Diaphragm Myofascial Release) Demonstrated Significantly Greater Improvements in Pain Intensity (NPRS) and Pain Perception (IPQ) Compared with Group B ($p < 0.001$).

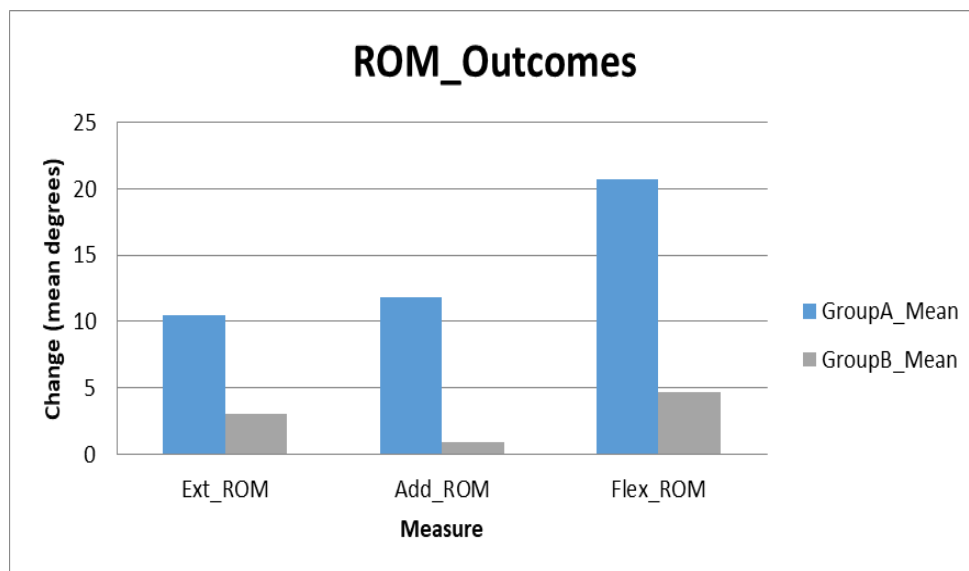


Figure 3: Mean Change in Hip Joint Range of Motion Outcomes. Group A Showed Significantly Larger Gains in Hip Extension, Flexion, and Adduction ROM Compared with Group B ($p < 0.001$).

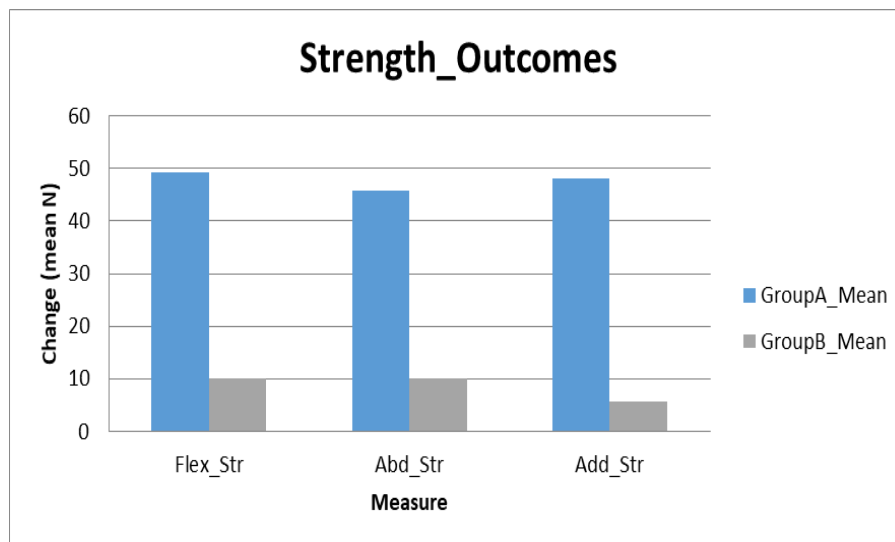


FIGURE 4: Mean Change in Hip Muscle Strength Outcomes. Flexion, Abduction, and Adduction Strength all Improved more in Group A than in Group B ($p < 0.001$).

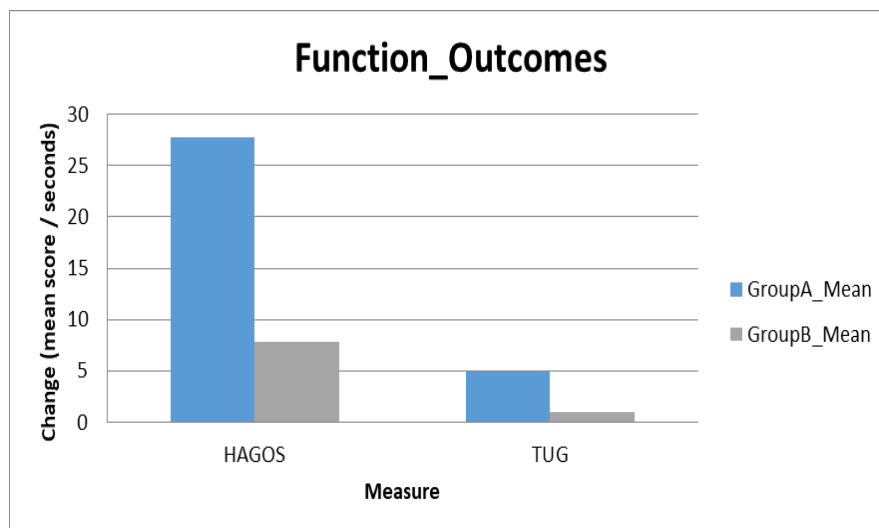


FIGURE 5: Mean Change in Functional Outcomes. Group A Demonstrated Significantly Greater Improvement in Hip and Groin Function (HAGOS) and Mobility Performance (TUG) Compared with Group B ($P < 0.001$).

Discussion

This randomized controlled trial investigated the effects of iliopsoas and diaphragm myofascial release (MFR) in young male patients with chronic postoperative inguinal pain (CPIP) following hernia repair. The results demonstrated that the addition of targeted MFR to conventional physiotherapy yielded significantly greater improvements in pain intensity, pain perception, hip range of motion, muscle strength, and functional outcomes compared to exercise therapy alone. Although both groups improved, effect sizes were consistently larger in the experimental group, indicating a clinically meaningful advantage of addressing fascial dysfunction in CPIP management. The rationale for these findings was based on the anatomical and functional continuity between the diaphragm, iliopsoas, and thoracolumbar fascia [22]. Fascial restrictions and altered muscle tone in this chain may perpetuate abnormal lumbopelvic biomechanics, increase inguinal region tension, and sensitize peripheral nerves. Releasing these restrictions likely reduces mechanical load, restores neuromuscular efficiency, and improves core stability, thereby reducing pain and enhancing function. Our

results align with the concept of fascial plasticity and its role in musculoskeletal pain syndromes [23].

Supporting Evidence

The findings of this RCT are consistent with recent trials in related populations. Siğlan and Çolak [22] demonstrated that combined iliopsoas and diaphragmatic release significantly reduced pain and improved lumbar mobility and function in patients with chronic low back pain. Similarly, a systematic review of diaphragm manual therapy by López-de-Uralde-Villanueva et al. [23] found immediate improvements in diaphragmatic mobility, thoraco-abdominal expansion, and in some cases pain in adjacent regions, supporting the broad musculoskeletal effects of diaphragmatic interventions. Beyond musculoskeletal pain, Kroon et al. [24] identified non-surgical contributors to CPIP such as altered biomechanics and soft-tissue tension, reinforcing the plausibility that fascial restriction is a relevant target for conservative treatment.

Contrasting Evidence

On the other hand, several studies emphasize the predominant role of neuropathic mechanisms in CPIP, which may limit the efficacy

of purely fascial interventions. Ndresen et al. [25] reported minimal influence of soft-tissue therapy on CPIP compared to neural factors, and Schwartz et al. [26] (2016) suggested neuropathic injury as the primary driver of persistent pain, Surgical approaches further highlight this: Gemici and Özeren [27] showed that prophylactic iliohypogastric neurectomy significantly reduced CPIP incidence, while a meta-analysis of neurectomy techniques confirmed superior pain reduction in surgically managed neuropathic CPIP [28]. These findings suggest that while MFR may be highly effective in patients with a mechanical or fascial pain component, outcomes may be less pronounced when neuropathic injury dominates.

Clinical Implications

Taken together, the results and the literature highlight that CPIP is a multifactorial condition in which both neuropathic and mechanical contributors may coexist. Myofascial release offers a non-invasive, low-risk adjunct to conventional physiotherapy that may reduce reliance on pharmacological or surgical interventions, especially in patients with biomechanical dysfunction. The consistently large effect sizes in our study suggest that this subgroup responds particularly well to fascial release, and patient stratification may be valuable in future clinical practice.

RECOMMENDATIONS FOR FUTURE RESEARCH

1. Include larger, more diverse populations (including women and older adults) to improve generalizability.
2. Incorporate long-term follow-up to determine the durability of MFR effects.
3. Use objective mechanistic outcomes (e.g., imaging of fascial thickness, electromyography, ultrasound diaphragm mobility) to explore pathways of improvement.

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4. Compare different manual therapy techniques and dosing schedules to clarify specificity of effects.

5. Investigate combinations of fascial release and neural desensitization techniques in patients with mixed mechanical-neuropathic CPIP.

LIMITATIONS

This study has limitations. The small sample size (n=30) restricts generalizability, and the short-term follow-up precludes conclusions about long-term efficacy. Only young male participants were included, reducing external validity to other demographic groups. Therapist blinding was not possible, potentially introducing bias. Finally, we did not stratify patients based on neuropathic versus mechanical pain dominance, which could influence responsiveness to fascial interventions.

Conclusion

This study conclusively demonstrates that the combination of iliopsoas and diaphragm myofascial release with conventional physiotherapy results in significantly enhanced pain relief, mobility, strength, and functionality in young boys with CPIP. These findings highlight the clinical value of targeting fascial dysfunction in post-herniorrhaphy pain rehabilitation. MFR techniques targeting the iliopsoas and diaphragm may serve as a valuable adjunct to conventional rehabilitation, potentially reducing reliance on pharmacological management or surgical re-intervention. While further research is warranted, myofascial release represents a promising, non-invasive therapeutic strategy for the management of CPIP, complementing existing medical and surgical options.

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