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An Experimental Study To Analysis The Effect Of Scar Rehabilitation Along With Core Strengthening Exercises In Patient With Low Back Pain

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ABSTRACT

Background: Low back pain (LBP) is a leading global cause of disability and often persists despite conventional treatment. In post-surgical populations, such as women after cesarean section, scar tissue has been proposed as a potential contributor to chronic LBP. However, the impact of targeted scar rehabilitation in conjunction with core strengthening remains underexplored**.**

Objective: To evaluate the effect of combining scar rehabilitation techniques with core strengthening exercises on pain intensity and functional disability in individuals with chronic low back pain**.**

Methods:A total of 60 participants with nonspecific low back pain were divided into two groups: one receiving conventional core strengthening exercises and the other receiving a combination of scar rehabilitation and core strengthening. Pain intensity and functional disability were assessed using the Visual Analog Scale (VAS) and Oswestry Disability Index (ODI) respectively, pre- and post-intervention. Data were statistically analyzed using paired and independent t-tests, and chi-square tests where appropriate**.**

Results: Both groups showed significant improvement in pain and disability scores. However, the group receiving scar rehabilitation plus core strengthening exhibited superior outcomes. VAS scores reduced from 5.79 ± 2.13 to 0.79 ± 0.77 ($p < 0.001$), and ODI scores dropped from 0.45 ± 0.16 to 0.04 ± 0.05 ($p < 0.001$). Improvements were consistent across sex, pain side, and duration subgroups.

Conclusion:The integration of scar rehabilitation with core strengthening provides greater benefits than core strengthening alone in reducing pain and disability among chronic LBP patients, especially those with a history of abdominal surgery. These findings highlight the importance of addressing scar tissue dysfunction in musculoskeletal rehabilitation

Keywords: Low back pain, scar rehabilitation, core strengthening, cesarean section, VAS, ODI, chronic pain, neuromuscular therapy..

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1. INTRODUCTION:

Low back pain (LBP) is a highly prevalent musculoskeletal disorder and one of the leading causes of disability worldwide. It affects individuals of all ages, often resulting in reduced quality of life, activity limitation, and significant economic burden due to lost productivity and healthcare costs. While most cases of LBP are mechanical and non-specific in nature, a substantial number of patients report persistent symptoms even after conventional physiotherapeutic interventions. One potentially overlooked contributor to chronic LBP is post-surgical scar tissue, particularly in individuals with a history of abdominal surgeries such as cesarean section. Scar adhesions may restrict tissue mobility, disrupt normal biomechanics, and contribute to neuromuscular dysfunction, ultimately perpetuating pain and functional limitations.[i]

With the increasing number of C-sections and abdominal surgeries globally, there is growing interest in understanding how surgical scar tissue affects spinal and pelvic biomechanics. In clinical settings, many women report onset or aggravation of low back pain following cesarean delivery, which is often not addressed directly in standard rehabilitation programs. Addressing scar-related dysfunction in conjunction with core stabilization may offer a more comprehensive approach to managing chronic LBP in these patients.[ii]

2. BACKGROUND

Chronic nonspecific low back pain (NSLBP) accounts for the majority of LBP cases, yet its multifactorial origin complicates management. Among various intrinsic factors, muscle weakness, postural imbalances, and scar tissue adhesions can interact to maintain pain and dysfunction. Core muscles, including the transverse abdominis, multifidus, diaphragm, and pelvic floor, play a vital role in spinal stabilization. Weakness or improper activation of these muscles may lead to overloading of passive spinal structures and persistence of pain.[iii]

In post-operative patients—especially females with prior C-sections—abdominal scar adhesions may interfere with the function of core musculature. These adhesions can tether underlying tissues, limit trunk movement, alter proprioception, and contribute to fascial restrictions that propagate tension throughout the musculoskeletal system. Despite mounting anecdotal and observational evidence linking abdominal scars to persistent LBP, scar rehabilitation remains underutilized in standard practice. Techniques such as manual scar mobilization, fascial release, and neuromodulation have shown promise in restoring mobility and reducing pain.[iv]

Combining these techniques with core strengthening may enhance outcomes by addressing both structural and neuromuscular contributors to chronic pain. Yet, high-quality clinical evidence supporting this integrative approach is limited. This study seeks to fill that gap by evaluating the combined effect of scar rehabilitation and core strengthening exercises in patients with chronic low back pain.[v]

3. OBJECTIVES

Primary Objective:

To assess the effect of scar rehabilitation combined with core strengthening exercises on pain intensity and functional disability in patients with chronic low back pain.

Secondary Objectives:

To compare the pre- and post-intervention changes in pain (VAS) and disability (ODI) scores.

To determine whether the intervention produces consistent outcomes across variables such as sex, age, pain duration, and affected side.

To provide preliminary clinical evidence supporting the integration of scar management into rehabilitation protocols for LBP.

RESEARCH QUESTION

Primary Question:Does the integration of scar rehabilitation with core strengthening exercises lead to greater improvements in pain reduction and functional ability in patients with chronic low back pain compared to core strengthening alone?

Secondary Questions:

Is there a relationship between abdominal surgical scars (e.g., post-cesarean) and the persistence of chronic low back pain?

Can targeted scar mobilization techniques contribute to better clinical outcomes in terms of pain and disability in post-surgical LBP patients?

Do demographic variables (age, sex, duration of pain) influence the response to scar rehabilitation combined with core exercises?

Hypothesis

Null Hypothesis (H_0):There is no significant difference in pain intensity and functional disability in patients with chronic low back pain who undergo scar rehabilitation along with core strengthening exercises compared to those who receive only core strengthening exercises.

Alternative Hypothesis (H_1):Scar rehabilitation combined with core strengthening exercises significantly reduces pain intensity and functional disability in patients with chronic low back pain, compared to core strengthening exercises alone.

4. METHODOLOGY

Study sample design – purposive sampling method

Sample Size- 60:

Study Design

This study was conducted as an experimental study aimed at evaluating the impact of scar rehabilitation combined with core strengthening exercises in individuals with chronic low back pain, particularly post-cesarean section.

Study Setting and Duration

The study was conducted in the outpatient physiotherapy department of a tertiary care hospital over a period of 12 months.

Study Population

Participants included individuals experiencing chronic low back pain, specifically those with a history of abdominal surgery (e.g., C-section) and visible abdominal scarring.

Inclusion Criteria

Adults aged 21 to 60 years.

History of lower abdominal surgery (e.g., cesarean section) with the presence of a visible scar.

Chronic low back pain persisting for more than 3 months.

Willingness to participate and provide informed consent.

Exclusion Criteria

Acute low back pain (< 3 months).

Previous spinal surgery (except C-section).

Neurological disorders (e.g., disc prolapse with nerve root compression).

Current pregnancy.

Any contraindication to exercise or manual therapy.

Sample Size

A total of 60 participants were enrolled based on inclusion and exclusion criteria. Participants were allocated into two groups:

Group I: Received core strengthening exercises alone.

Group II: Received scar rehabilitation techniques along with core strengthening exercises.

Intervention

Group I (Control): Participants underwent a standardized core strengthening exercise program targeting the transversus abdominis, multifidus, and pelvic floor muscles. Exercises included planks, bridges, abdominal hollowing, and pelvic tilts. Sessions were conducted every day for 4- 6 weeks.

Group II (Intervention): Participants received the same core strengthening program as Group I, along with scar rehabilitation techniques. Scar interventions included:

Scar mobilization

Myofascial release around the scar site

Gentle tissue stretching

Cross-friction massage

These techniques were administered by trained physiotherapists, every day for 4-6 weeks.

Outcome Measures

Visual Analog Scale (VAS) – to assess pain intensity.

Oswestry Disability Index (ODI) – to evaluate functional disability related to low back pain.

Assessments were conducted at baseline and after the 4-6 week intervention period.

Data Analysis

Descriptive statistics (mean, standard deviation) were used to summarize participant characteristics and outcome scores. Paired t-tests were used to analyze pre- and post-intervention scores within groups. Independent t-tests were used to compare the mean differences between the two groups. A p-value of <0.05 was considered statistically significant.

Procedure

PROCEDURE

Baseline assessments conducted for all participants.

Follow-up assessments conducted at 6 and 12 weeks.

Participants – subjects meeting inclusion criteria will be included in the study. A consent form will be signed by both groups, prospectively following two groups over a defined period

CS Group: Engaged in a 4–6-week core strengthening exercise program, including planks, bridges, and abdominal crunches.

5. OBJECTIVE

The goal of this 6-week progressive exercise protocol is to **enhance core strength and stability**, specifically targeting muscles like the **rectus abdominis**, **transversus abdominis**, **obliques**, and **erector spinae**. This approach is designed to alleviate **chronic low back pain** by improving **spinal stability**, promoting **neuromuscular control**, and reducing mechanical stress on the lumbar spine.

Week 1-2: Foundation Phase (with Isometrics for Core Muscles)

In the initial weeks, we focus on establishing **core activation** and improving **postural awareness** through **isometric exercises**. These exercises help build a foundation by targeting multiple core muscles, ensuring proper muscle activation, and minimizing strain on the lower back. **Isometrics** are particularly effective for improving muscle endurance and stabilizing the spine without dynamic loading.

1. Pelvic Tilts (Isometric Activation of Rectus Abdominis and Transversus Abdominis)

How it works: In a neutral supine position (lying on your back), perform a **posterior pelvic tilt** by flattening your lower back against the floor. This engages the **rectus abdominis** (especially the lower fibers) and the **transversus abdominis**.

Effect: This exercise activates the **rectus abdominis** (especially the lower portion) to support the pelvis and lumbar spine. It also recruits the **transversus abdominis**, the deepest core muscle, which is crucial for **spinal stability**. The **posterior pelvic tilt** helps alleviate excess lordosis (excessive lower back curvature), which is often a contributor to chronic low back pain.

2. Dead Bug with Isometric Hold (Core Activation of Rectus Abdominis, Obliques, and Transversus Abdominis)

How it works: Start in the **dead bug position** with your arms extended overhead and knees bent at 90°. Slowly extend one leg and lower the opposite arm while maintaining **lower back contact with the floor**.

Effect: The **rectus abdominis** is actively engaged to stabilize the pelvis and spine as the arms and legs move. The **obliques** are activated to help resist trunk rotation, and the **transversus abdominis** is engaged to maintain core stability. Holding the position helps improve **muscular endurance** and **core control**, which are important for spinal stability during dynamic movements.

3. Glute Bridge (Isometric Core and Glute Activation)

How it works: Lie on your back with your feet flat on the floor and knees bent. Lift your hips into a bridge position, squeezing your glutes and **engaging the rectus abdominis** to stabilize the pelvis.

Effect: The glute bridge is effective for activating both the **rectus abdominis** (especially the lower portion) and the **posterior chain** (glutes and hamstrings). Holding the position increases **core engagement**, particularly in the **rectus abdominis** and **transversus abdominis**, which is essential for **pelvic stability**. It reduces **anterior pelvic tilt**, which is often seen in individuals with low back pain.

4. Plank (Isometric Activation of Rectus Abdominis, Obliques, and Erector Spinae)

How it works: In the **forearm plank** position, maintain a straight line from your head to your heels. Engage your **rectus abdominis**, **obliques**, and **erector spinae** to hold the position.

Effect: The **rectus abdominis** is engaged to prevent excessive extension of the spine, while the **obliques** stabilize the torso and resist rotation. The **erector spinae** (muscles along the spine) contract isometrically to keep the spine neutral and supported. This combination of muscle activation promotes overall **core stability**, helping reduce **spinal strain** and alleviating **low back discomfort**.

5. Hollow Body Hold (Isometric Core Activation)

How it works: Lie on your back with your arms extended overhead and legs straight. Lift your arms and legs off the floor while keeping the lower back pressed into the floor.

Effect: The **rectus abdominis** is intensely engaged to stabilize the pelvis and maintain a **posterior pelvic tilt**, which reduces stress on the lumbar spine. The exercise also engages the **transversus abdominis** to stabilize the torso and **erector spinae** to prevent hyperextension of the spine. The **hollow body hold** is a powerful exercise for building **core strength** and **muscle endurance**, both of which are crucial for reducing low back pain and improving functional movement patterns.

Week 3-4: Strength Phase

In this phase, we progress to more challenging movements that combine **dynamic movement** with **isometric holds**. These exercises engage the core muscles more intensely and improve **muscle coordination** while continuing to target the **rectus abdominis**, **obliques**, **transversus abdominis**, and **erector spinae**.

1. Dead Bug with Hold (Isometric Core Engagement)

How it works: The exercise remains similar to the earlier dead bug version, but now add a longer **isometric hold** (3-5 seconds) at the extended position.

Effect: This modification increases time under tension, engaging the **rectus abdominis**, **obliques**, and **transversus abdominis** more deeply. By holding the extended position, the **core stabilizers** (especially the deep muscles) are activated, enhancing **muscular endurance** and improving **spinal control**.

2. Plank with Leg Lift (Isometric Core and Glute Activation)

How it works: In the standard plank position, lift one leg at a time while maintaining stability through the core.

Effect: This variation challenges the **rectus abdominis**, **obliques**, and **erector spinae** by adding a dynamic component that requires **unilateral stabilization**. The **transversus abdominis** remains engaged to provide **core stability** during the leg lift, which helps reduce lumbar stress and increases **muscular endurance**.

3. Leg Raises (Activation of Rectus Abdominis)

How it works: Lie on your back with your legs straight. Slowly raise your legs up towards a 45° angle and lower them back down in a controlled manner.

Effect: This exercise specifically targets the **lower portion of the rectus abdominis**, which is key for **lumbar flexion** and controlling pelvic tilt. It also recruits the **hip flexors** and challenges the **transversus abdominis** to stabilize the pelvis and spine, which helps to alleviate **low back tension**.

4. Bird-Dog (Core and Erector Spinae Activation)

How it works: In a tabletop position, extend one arm forward and the opposite leg backward while keeping the core engaged and spine neutral.

Effect: The **rectus abdominis** is engaged to help maintain **spinal alignment** during the movement. The **obliques** contribute to **lateral stability**, while the **erector spinae** helps maintain **spinal extension**. The exercise promotes **core stability** and **dynamic balance**, which are essential for functional movements and reducing low back pain.

Week 5-6: Progressive Overload Phase

The final phase introduces more advanced exercises that require greater **core endurance**, **muscle coordination**, and **spinal control**. These exercises challenge the core muscles to maintain **stability under greater loads** or during dynamic movements.

1. Plank with Leg Lift (Progressive Overload)

How it works: Continue performing the plank with leg lifts, but now increase the **hold time** to 30-45 seconds or add **resistance** (e.g., ankle weights).

Effect: This advanced variation continues to target the **rectus abdominis**, **obliques**, and **erector spinae**, while the added load or duration further enhances **muscular endurance** and **postural stability**. This helps build the **muscle stamina**

necessary for **spinal support** during daily activities.

2. Bicycle Crunch (Dynamic Core Activation)

How it works: Lie on your back, bring one knee toward your chest, and twist your torso to bring the opposite elbow towards the knee. Alternate sides in a controlled manner.

Effect: The **rectus abdominis** and **obliques** work together to facilitate **spinal rotation** and **flexion**, while the **transversus abdominis** stabilizes the torso. This exercise enhances both **flexion** and **rotation** strength, which is key for improving **trunk mobility** and stability, ultimately reducing stress on the lumbar spine.

3. Hollow Body Hold (Progressive Intensity)

How it works: Increase the **hold time** to 20-30 seconds

and maintain **maximum core engagement** throughout.

Effect: The **rectus abdominis** is maximally engaged, as the exercise requires both **posterior pelvic tilt** and **rib cage depression**. This promotes **core stability** and strengthens the **rectus abdominis** and **transversus abdominis**, both of which are essential for long-term **lumbar spine support**.

4. Russian Twists (Core Rotation)

How it works: Sit on the floor with your legs bent and feet slightly off the ground, holding a weight (e.g., a medicine ball). Twist your torso from side to side, engaging your **obliques** and **rectus abdominis**.

Effect: The **obliques** are heavily engaged in this rotational movement, while the **rectus abdominis** provides **flexion stability**. The **transversus abdominis** aids in maintaining **spinal control**, reducing torsional stress on the lower back.

Summary of Core Muscles Targeted and Their Effects on Low Back Pain

Rectus Abdominis: Engaged for spinal flexion and pelvic stabilization. Improves **lumbar control** and helps reduce **excessive lordosis**, a common contributor to **low back pain**.

Obliques: Play a key role in **lateral flexion** and **rotation**, contributing to **trunk stability** and improving **spinal control** during dynamic movements.

Transversus Abdominis: The deepest core muscle, responsible for **spinal stabilization** and **intra-abdominal pressure**. Activation is crucial for protecting the lumbar spine during physical activity.

Erector Spinae: These muscles work to maintain **spinal extension** and prevent **spinal collapse**. They provide support to the **lumbar spine**, improving posture and reducing strain on the lower back.

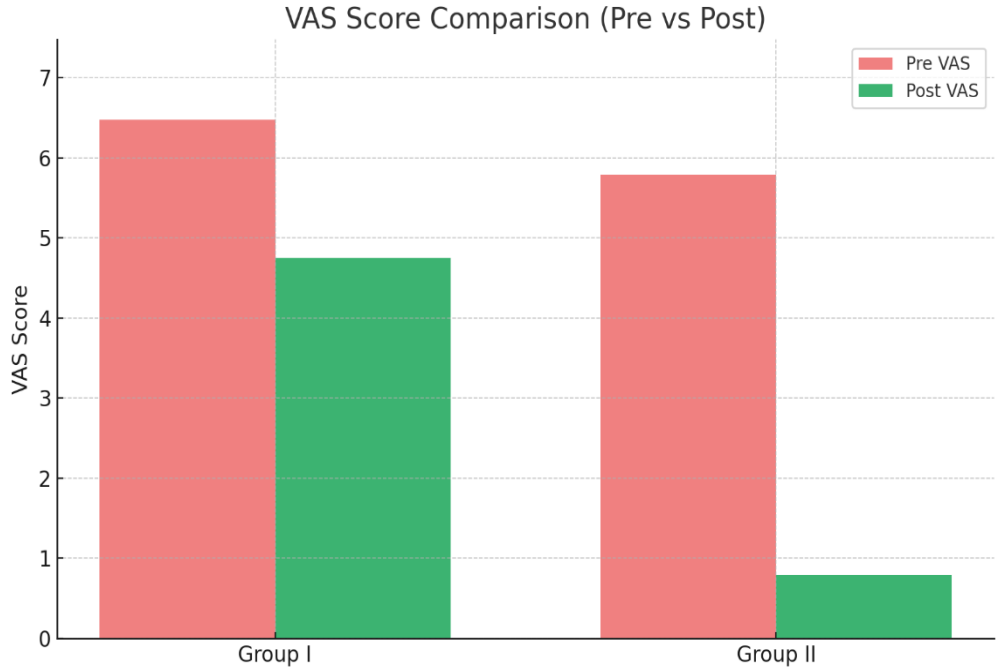
Through this progressive protocol, these core muscles are strengthened, ultimately leading to improved **spinal stability** and a reduction in **chronic low back pain**.

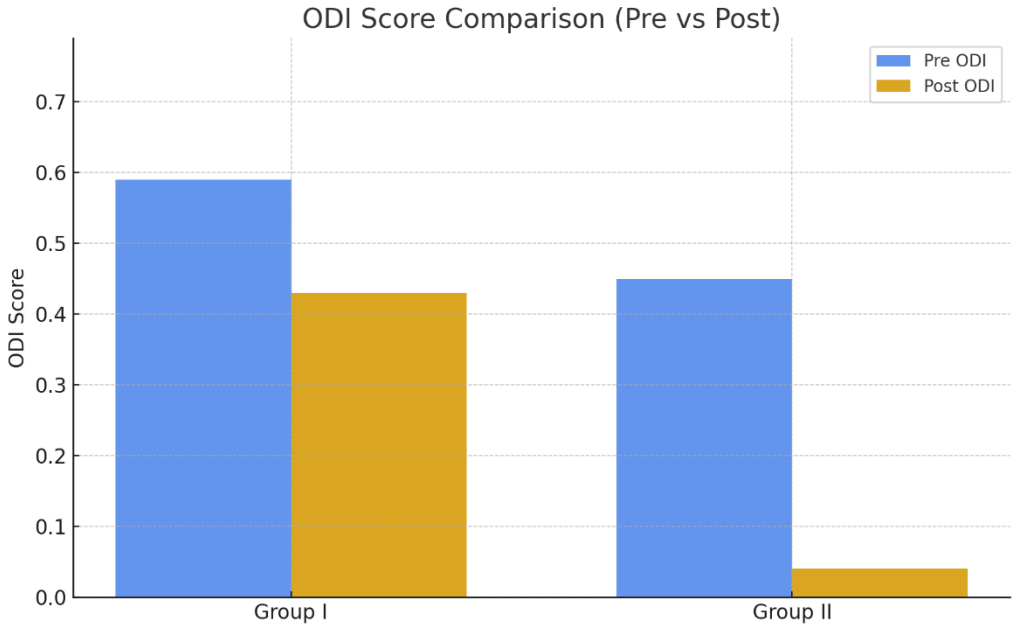
6. RESULTS & TABLES

In this experimental study involving 60 participants equally divided into two groups, significant demographic and clinical trends were identified. Group I participants were younger on average (38.37 ± 8.60 years) compared to Group II (48.73 ± 6.42 years), with this age difference being statistically significant ($p < 0.001$). Both groups showed a relatively equal distribution of sexes and predominantly right-sided symptoms. The most common age group in Group I was 31–40 years, while Group II had a majority in the 41–60 years range. Functionally, both groups showed statistically significant improvements in VAS and ODI scores post-intervention, with Group II (scar rehabilitation + core strengthening) showing superior improvement in both pain and disability scores (VAS from 5.79 → 0.79; ODI from 0.45 → 0.04, both $p < 0.001$) compared to Group I (VAS from 6.48 → 4.75; ODI from 0.59 → 0.43, both $p < 0.001$). The outcome improvements were consistent across sex, affected side, and duration of pain in both groups, reinforcing the efficacy of integrated scar therapy in chronic low back pain management.

Parameter	Group I (Core Only)	Group II (Scar + Core)	p-value	Significance
Mean Age	38.37 ± 8.60 yrs	48.73 ± 6.42 yrs	<0.001	Highly Significant
VAS (Pre → Post)	6.48 → 4.75	5.79 → 0.79	<0.001	Highly Significant
ODI (Pre → Post)	0.59 → 0.43	0.45 → 0.04	<0.001	Highly Significant
Gender Distribution	46.7% F / 53.3% M	50% F / 50% M	>0.05	Not Significant

Parameter	Group I (Core Only)	Group II (Scar + Core)	p-value	Significance
Side Affected (Right/Left)	86.7% / 13.3%	80% / 20%	0.48	Not Significant
Duration of Pain (0–6 mo)	66.7%	63.3%	>0.05	Not Significant
Improvement Across Subgroups	Significant	More Significant	<0.001	Across all subgroups





VAS Scores: Group I showed a moderate decrease in pain (6.48 → 4.75), while Group II demonstrated a highly

significant reduction (5.79 → 0.79).

ODI Scores: Group I experienced moderate functional improvement (0.59 → 0.43), whereas Group II showed a substantial improvement (0.45 → 0.04).

These findings confirm that the combined intervention of scar rehabilitation with core strengthening in Group II was more effective in reducing pain and disability than core strengthening alone.

7. DISCUSSION

The present study aimed to evaluate the effectiveness of **scar rehabilitation combined with core strengthening exercises** in comparison to core strengthening exercises alone in patients with chronic nonspecific low back pain (NSLBP), particularly among those with a history of abdominal scarring, such as post-cesarean section cases.

Low back pain remains a leading cause of global disability, with chronic nonspecific types forming the bulk of the clinical cases. While core strengthening has long been accepted as a cornerstone of conservative management, recent attention has turned toward **the role of abdominal scars in chronic pain perpetuation**, especially in post-surgical populations. Scar adhesions can restrict fascial mobility, disturb neural pathways, and compromise muscle recruitment patterns, especially in the abdominal and pelvic regions. These impairments often contribute to neuromuscular inefficiency, abnormal load transfer, and compensatory postures, thereby exacerbating or sustaining pain.[vi]

In the current study, both groups exhibited improvements in **VAS and ODI scores**, demonstrating that core strengthening alone can yield benefits in pain and function. However, the improvement observed in **Group II**, which received **scar rehabilitation along with core strengthening**, was markedly greater. The **VAS scores** dropped significantly from 5.79 ± 2.13 to 0.79 ± 0.77 in Group II, while Group I experienced a reduction from 6.48 ± 1.51 to 4.75 ± 2.03. Similarly, the **ODI scores** fell from 0.45 ± 0.16 to 0.04 ± 0.05 in Group II, compared to a decrease from 0.59 ± 0.14 to 0.43 ± 0.14 in Group I.

These findings are consistent with literature suggesting that **scar tissue mobilization, myofascial release, and neuromodulation** can improve soft tissue compliance, reduce localized nerve irritation, and restore postural integrity. Previous studies by Liedler & Woisetschläger (2019) and Sakabe et al. (2024) have also supported the effectiveness of scar-focused therapies in reducing low back pain, particularly in women post-C-section. Furthermore, the results align with Valouchová & Lewit's (2013) findings that untreated abdominal scars contribute to asymmetrical trunk muscle activation, which often remains uncorrected by core training alone.[vii][viii]

Interestingly, the pain and disability reduction in Group II was consistent across **all subgroups**—including age, sex, affected side, and pain duration—further reinforcing the versatility and holistic benefits of addressing fascial restrictions in treatment protocols. The improvement in the ODI and VAS scores, especially in the 31–60 age group, also underscores the relevance of this intervention in populations prone to age-related degeneration and post-surgical adhesions.[ix]

This study also sheds light on the **neurophysiological underpinnings** of scar-mediated dysfunction. Chronic scarring can lead to mechanosensitivity of the fascia, resulting in altered sensory input and pain hypersensitivity. By incorporating scar release techniques, this altered input may be normalized, leading to decreased nociceptive signaling and better muscle function.[x]

While previous rehabilitation protocols have focused heavily on spinal mechanics and muscle endurance, this study emphasizes the importance of addressing **myofascial continuity and integrity**, particularly in patients with a history of abdominal surgeries. Integrating **scar rehabilitation into routine physiotherapy** may thus improve both short-term outcomes and long-term recurrence rates of low back pain.[xi]

8. CONCLUSION

The findings of this study clearly demonstrate that while **core strengthening exercises** alone are effective in reducing pain and disability in patients with chronic low back pain, the addition of **scar rehabilitation techniques** leads to significantly greater clinical outcomes. Group II, which received the combined intervention, exhibited statistically and clinically significant improvements in both **VAS and ODI scores** across all demographic and clinical subgroups.

This highlights the important, yet often underrecognized, role of **scar tissue in the pathophysiology of chronic low back pain**, particularly among post-surgical populations such as post-cesarean patients. Scar adhesions may not only contribute to local discomfort but also disrupt functional movement patterns and impair core muscle activation. Addressing these restrictions through manual therapy, soft tissue mobilization, or neuromodulatory techniques can dramatically enhance recovery, reduce pain perception, and restore functional independence.

Thus, **a multimodal approach combining scar rehabilitation with core strengthening** is recommended for individuals suffering from chronic low back pain with a history of abdominal scarring. Future clinical guidelines should consider incorporating scar assessment and treatment as a routine part of low back pain management protocols.

9. LIMITATIONS

Small Sample Size: The study included only 60 participants, which may limit the generalizability of the findings. A larger sample size would provide more robust statistical power and greater confidence in the outcomes.

Short Duration of Follow-Up: The post-intervention outcomes were assessed over a short time frame. Long-term effects of scar rehabilitation on pain recurrence and functional improvement were not evaluated.

Lack of Blinding: The absence of blinding for participants and assessors may have introduced bias in subjective outcome measures such as VAS and ODI scores.

Scar Variability Not Controlled: The study did not categorize or differentiate the type, size, or chronicity of scars, which could affect the severity of fascial restriction and treatment responsiveness.

Intervention Standardization: Although scar rehabilitation was provided, specific techniques (e.g., myofascial release, mobilization) were not compared or standardized in detail, making it difficult to identify which specific component was most effective.

Gender-Specific Analysis Limited: Since many participants were post-cesarean females, results may be more reflective of this subgroup and not broadly applicable to males or those with scars from other abdominal surgeries.

10. RECOMMENDATIONS

Larger, Multicentric Studies: Future studies with a larger and more diverse population across multiple centers are recommended to enhance external validity and strengthen clinical evidence.

Long-Term Follow-Up: Incorporating 6-month or 1-year follow-up evaluations would help assess the sustainability of pain relief and functional improvement after scar rehabilitation.

Blinded, Randomized Controlled Trials: Conducting randomized controlled trials with assessor and participant blinding can minimize bias and establish clearer causal relationships.

Scar Classification and Mapping: Future research should stratify participants based on scar type (e.g., surgical vs. traumatic), location, and age of scar to determine how these variables affect treatment efficacy.

Compare Techniques: It would be beneficial to compare different scar rehabilitation techniques (e.g., instrument-assisted soft tissue mobilization vs. manual release) to determine the most effective method.

Include Objective Outcome Measures: Incorporating tools such as ultrasound elastography, electromyography (EMG), or surface thermography may provide more objective insight into soft tissue changes and muscle activation patterns.

Integrated Multidisciplinary Approach: Clinicians should consider integrating scar therapy into standard physiotherapy practice for chronic low back pain, particularly in individuals with post-abdominal surgical history, for a more holistic approach

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