Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/89fgzd37

COMPARISON OF CORE STABILIZATION EXERCISES AND PROPRIOCEPTIVE NEUROMUSCULAR FACILITATION TRAINING ON PAIN RELATED NEUROMUSCULAR RESPONSE OUTCOMES FOR LOW BACK PAIN

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ABSTRACT

Introduction: Low back pain (LBP) is a highly prevalent musculoskeletal condition with a significant socioeconomic burden. Despite various treatment strategies, the most effective rehabilitation approach remains uncertain. Core stabilization exercises (CSE) and proprioceptive neuromuscular facilitation (PNF) training are commonly used physiotherapeutic interventions for managing LBP, yet direct comparisons of their effectiveness on pain-related neuromuscular outcomes are limited.

Objectives: This study aimed to compare the effects of CSE and PNF training on pain related outcomes among low back pain patients.

Methodology: An experimental study was conducted on 30 LBP patients (aged 18–50 years), divided into two groups receiving either a two-week CSE or PNF intervention. Pain intensity was measured

using the Numeric Pain Rating Scale (NPRS), while functional disability was assessed with the Roland-Morris Disability Questionnaire (RMDQ). Pre- and post-intervention comparisons were made using paired t-tests. Data was analyzed by SPSS version 26.
Result: Both groups showed significant improvements in all pain-related outcomes post-intervention ($p < 0.05$). However, the CSE group exhibited a greater reduction in pain intensity (72% vs. 65.2%) and a more significant improvement in functional disability scores compared to the PNF group. These findings suggest that CSE is superior in enhancing core stability and reducing pain.
Conclusion: Two-week intervention showed that core stabilization exercises (CSE) is more effective in alleviating low back pain symptoms and improving neuromuscular function as compared to proprioceptive neuromuscular facilitation (PNF). Future research should explore long-term effects and optimal exercise protocols for sustained benefits.

Keywords: Low back pain, core stabilization exercises, proprioceptive neuromuscular facilitation, functional disability, pain management.

Introduction

Low back pain (LBP) is a common medical problem. There is a 50–70% chance of a person having LBP pain during his or her lifetime (1). Low back pain (LBP), one of the most common musculoskeletal problems, carries a high individual, community and globalsocioeconomic burden (2). Low back pain (LBP) is a common, challenging medical and socioeconomic problem in working-age adults (3). LBP is the significant cause of years lived with disability, work absenteeism and high compensation in modern societies (3). Although the majority of LBP patients recover within six weeks without medical treatment,almost 20% of these cases become chronic (3).The vast majority of low back pain (LBP)patients (up to 90%) are labelled as having non-specific LBP, which is defined as symptoms without a clear specific cause, that is, LBP of unknown origin (4). In 2015, lowback pain (LBP) and neck pain were the fourth leading cause of disability-adjusted life years (DALYs) globally, with a worldwide prevalence of 540 million and 358 million, respectively (5). These two spinal conditions have a major impact on individuals and theirpersonal as well as professional lives (6). As leading causes of work absenteeism and diminished productivity (7, 8). LBP possesses a massive socioeconomic problem and a major public health burden (6, 9). The huge majority of low back pain (LBP) patients (up to 90%) are known as having non-specific LBP, which is well-defined as symptoms without a clear specific cause, that is, LBP of unknown etiology (10,11).

DEFINITIONS

Low Back Pain:

Low back pain is defined as pain and discomfort, localized below the costal margin and above the inferior gluteal folds, with or without leg pain.

Core Stabilization Exercises:

Core stabilization exercise (CSE) is a popular option in restoring functions of trunk muscles to achieve optimal lumbar stability during daily activities. CSE includes training aimed are-educating deep trunk muscle function, and coordination of deep and superficialtrunk muscles in static, dynamic, and functional tasks.

Proprioceptive Neuromuscular Facilitation:

Proprioceptive Neuromuscular Facilitation (PNF) is a more advanced form of flexibility training. PNF involves both stretching and contracting (activation) of the muscle group being targeted in order to achieve maximum static flexibility.

Signs and Symptoms:

Low back pain can result from many injuries, conditions or diseases most often an injuryto muscles

or tendons in the back. Pain can range from mild to severe. In some cases, pain can make it difficult or impossible to walk, sleep, work or do everyday activities. Usually, lower back pain gets better with rest, pain relievers and physical therapy. Cortisone injections and hands on treatment (like osteopathic or chiropractic manipulation) can relieve pain and help the healing process. Some back injuries and conditions required surgical repair. Symptoms of lower back pain can come on suddenly or appear gradually. Sometimes pain occurs after a specific event, such as bending to pick something up .Pain may be sharp or dull and achy, and it may radiate to your bottom or down the back of your legs (sciatica).if you strain your back during an activity you may hear a pop sound when it happened. Pain is often worse in certain positions (bending over) and gets better when you lie down. Other symptoms stiffness, posture problem, muscle spasm. Many injuries,conditions and diseases cause lower back pain. They include: Strains and sprains, fractures, disc problems, structural problems (spinal stenosis), Arthritis, Disease (spine tumors), Spondylolisthesis.

Treatment

Muscle relaxants relieve pain more than placebo, strong evidence also shows, but side effects such as drowsiness may occur. Conversely, strong evidence shows that bed restand specific back exercises (strengthening, flexibility, and stretching, flexion, and extension exercises) are not effective. Moderate evidence shows that spinal manipulation,behavioral treatment, and multidisciplinary treatment (for sub-acute low back pain) for pain relief. That exercise and intensive multidisciplinary pain treatment programs are effective for chronic low back pain is supported by strong evidence.

Treating LBP with PNF

Keeping in mind such observations, some investigations have been conducted on the effectiveness of proprioception neuromuscular facilitation technique that specifically target the imbalance between proprioceptive apparatus to alleviate the pain and facilitatestrong communication between different components of apparatus. Compared 42 patients of CLBP with the control group, and found out that after undergoing a 4-week PNF training intervention, participants showed a significant long-term reduction in pain intensity and functional capacity, and enhanced patients' contentment (12). Another contrast study, comparing the effects of CSE and PNF training on pain-related outcomesand trunk muscle activity in between the Forty-five CLBP patients, ranging from 18 to 50 years of age, concluded that Four-week CSE and PNF training provided short-term and long-term effects on pain-related consequences, along with increased deep trunk muscleactivity in CLBP patients (8).

Treating LBP with CSE

In response to such observations the exercise approach that is most common is for CLBP is strengthening trunk muscles (13). Also, core stability exercise (CSE) has been considered as a treatment for LBP in recent years. The biological reasoning for CSE is essentially based on the idea that the stability and control of the spine are altered in people with LBP (14). CSE had greater temporary effects on pain alleviation and overall functional ability in CLBP patients (15). Such findings that abdominal drawing-in maneuver training of CSE can increase stimulation and activation of deep abdominal muscles in CLBP patients withclinical lumbar instability (15, 16). The code of CSE is to reestablish the neuromuscular system's ability to control the inter segmental mobility, thereby preventing injury and providing stability during functional tasks or sports (16,17,18) Our study chose ADIM for training as it can improve TrA and LM muscle function and their capacities, such as strength to control inter segmental movements of the lumbar spine (15,16)

Methods and materials

Design

This experimental study was conducted over six months after the approval of the research synopsis. The study aimed to compare the effects of core stabilization exercises (CSE) and proprioceptive neuromuscular facilitation (PNF) training on pain-related outcomes in low back pain (LBP) patients.

The research took place at South City Hospital and Jinnah Postgraduate Medical Center, Karachi, Pakistan. A probability simple random sampling technique was used to ensure unbiased participant selection.

Participants

A total of 30 participants diagnosed with LBP for 5 to 6 weeks were recruited for this study. The inclusion criteria encompassed both male and female patients aged between 18 to 50 years. Participants were excluded if they had specific spinal pathologies such as sacroiliac dysfunction, malignancy, a history of lumbo-pelvic surgery, or pregnancy. Informed consent was obtained from all participants before enrollment.

Procedure

Participants were randomly allocated into two groups:

- **Group A:** Core Stabilization Exercise (CSE)
- **Group B:** Proprioceptive Neuromuscular Facilitation (PNF)

Each group underwent a two-week intervention program tailored to their respective exercise regimen. Before initiating the intervention, participants were given a comprehensive briefing on the study's objectives, procedures, and expected outcomes. The Numeric Pain Rating Scale (NPRS) was used to assess pain intensity, while functional disability was evaluated using the Roland-Morris Disability Questionnaire (RMDQ).

Participants provided demographic information, including age, gender, and duration of LBP. Following baseline assessment, they engaged in their assigned exercise regimen under the supervision of physiotherapists. After completing the two-week intervention, post-treatment data were collected using the same outcome measures.

Outcome Measures

Pain intensity was assessed using the **11-point Numeric Pain Rating Scale (NPRS)**, where 0 represented "no pain" and 10 indicated "extreme pain." Functional disability was measured using the **24-item Thai version of the Roland-Morris Disability Questionnaire (RMDQ)**, which scores from 0 (no disability) to 24 (maximum disability). Patient satisfaction and neuromuscular response of trunk muscles were also evaluated.

Ethics Approval

Ethical approval was obtained from the administration of **South City Hospital Karachi** and **Jinnah Postgraduate Medical Center** before the commencement of data collection. Written informed consent was obtained from all participants.

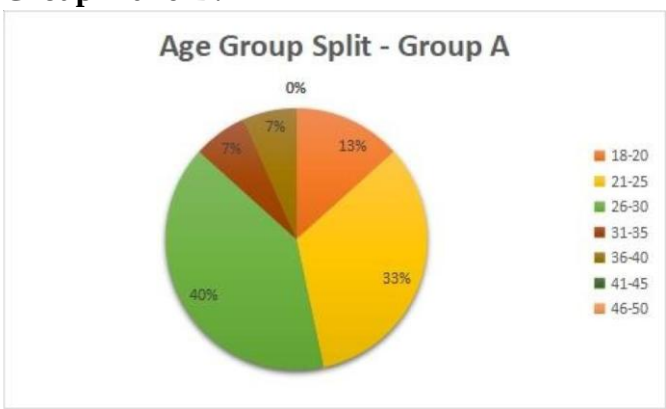
Data Analysis

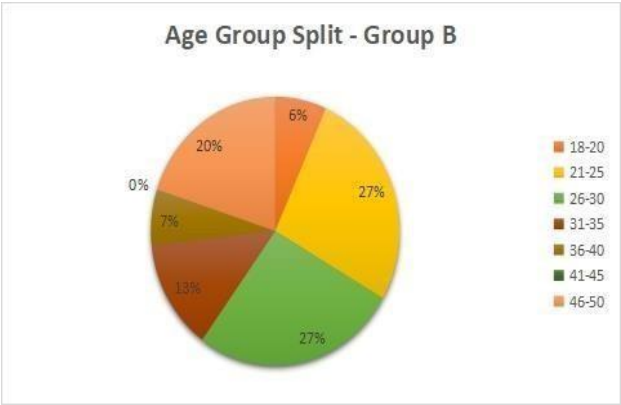
The collected data were analyzed using **IBM SPSS Statistics version 26**. Pre- and post-intervention comparisons were conducted using the **paired sample t-test** to determine significant differences between groups. Descriptive statistics were used to summarize the participants' demographic data, and results were presented in mean and standard deviation. A p-value of **<0.05** was considered statistically significant.

Results

The age split of acquired sample groups can be determined from below mentionedgraphs:

Group A and B:





Statistical Analysis

1. **Pre-Post Treatment Analysis for Pain Score via Paired Sample T-Test – Group A Vs. Group B**

Table 1 **Paired Samples Statistics**

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pain Pre A	6.60	15	1.957	.505
	Pain Post A	1.80	15	1.207	.312
	Pain Pre B	6.13	15	1.995	.515
	Pain Post B	2.13	15	1.125	.291
Pair 2					

Table 2 **Paired Samples Correlations**

		N	Correlation	Sig.
Pair 1	Pain Pre A & Pain Post A	15	.659	.008
Pair 2	Pain Pre B & Pain Post B	15	.691	.004

Table 3 **Paired Samples Test**

		Paired Differences					t	Df	Sig. (2tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Pain Pre A -Pain Post A	4.8	1.474	0.38	3.984	5.616	12.616	14	0
Pair 2	Pain Pre B -Pain Post B	4	1.464	0.378	3.189	4.811	10.583	14	0

From Table 1-3 indicates comparative analysis of Pain Scores of patients in Group A vs patients in Group B by comparing the scores via used test tools before treatment and after treatment.
Table 1 indicates that the mean value of Pain score has dropped from 6.6 before treatmentto 1.8 after treatment in case of Group A and in case of group B has dropped from 6.13 before treatment to 2.13 after treatment. Hence, mean value drop in case of Group A is significantly higher i.e., 72% than that of Group B i.e., 65.2%.

Table 2 indicates that Pain Score data acquired before treatment and after treatment arehighly and

positively correlated i.e. approximately 66% correlation in case of group A while69% correlated in case of group B.

Table 3 shows t and Sig value of performed T-test on the given data. Considering confidence interval at 95%, the p-value (Sig-value) for both groups is less than 0.05 whichinfers that there is significant difference in average Pain Score from before treatment to after treatment for both groups. While the average difference of Group A is higher than Group B i.e. 4.8 > 4.

2. **Pre-Post Treatment Analysis for RMS Score via Paired Sample T-Test - Group Avs. Group B**

Table 4 **Paired Samples Statistics**

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	RMS Pre A	10.87	15	3.681	.951
	RMS Post A	2.87	15	.990	.256
Pair 2	RMS Pre B	10.87	15	2.326	.601
	RMS Post B	4.60	15	1.056	.273

Table 5 **Paired Samples Correlations**

		N	Correlation	Sig.
Pair 1	RMS Pre A & RMS Post A	15	.955	.000
Pair 2	RMS Pre B & RMS Post B	15	.966	.000

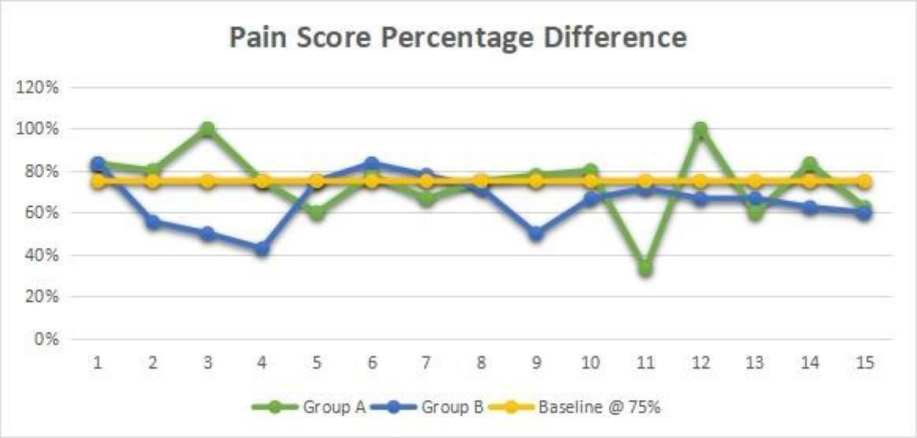
Table 6 **Paired Samples Test**

		Paired Differences					T	df	Sig. (2tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	RMS Pre A - RMS Post A								
Pair 2	RMS Pre B - RMS Post B	8	2.752	0.71	6.476		9.524	11.26	14 0

From Table 1-3 indicates comparative analysis of RMS Scores of patients in Group A vs.patients in Group B by comparing the scores via used test tools before treatment and after treatment.
Table 1 indicates that the mean value of RMS score has dropped from 10.87 before treatment to 2.87 after treatment in case of Group A and in case of group B has droppedfrom 10.87 before treatment to 4.6 after treatment. Hence, mean value drop in case of Group A is significantly higher i.e., 73.6% than that of Group B i.e., 57.7%
Table 2 indicates that RMS Score data acquired before treatment and after treatment arehighly and positively co related i.e. approximately 95.5% correlation in case of group A while 96.6% co related in case of group B

Table 3 shows t and Sig value of performed T-test on the given data. Considering confidence interval at 95%, the p-value (Sig-value) for both groups is less than 0.05 whichinfers that there is significant difference in average RMS Score from before treatment to after treatment for both groups. While the average difference of Group A is higher than Group B i.e. 8 > 6.267

Descriptive Analysis



From Figure 1 it can be observed that percentage difference from pre-treatment vs post treatment score of most of the samples in Group A is higher than samples from Group B.Considering a baseline score difference of 75% almost 9 out of 15 patients in group A have a score difference higher than baseline, while in case of Group B only 3 patients have a score difference higher than baseline.

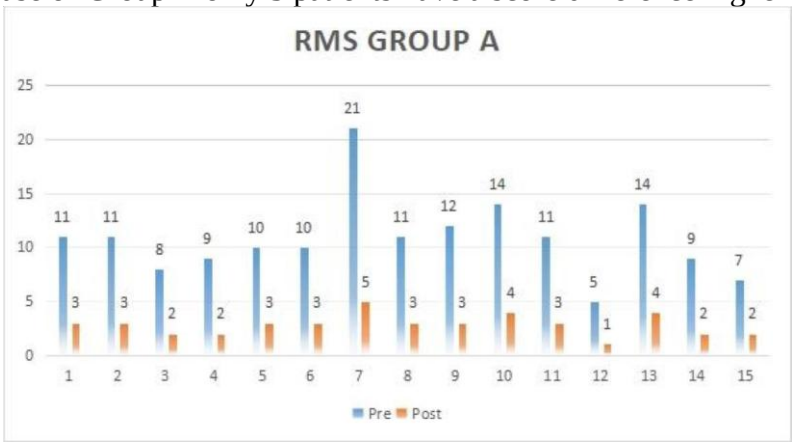


Figure 2

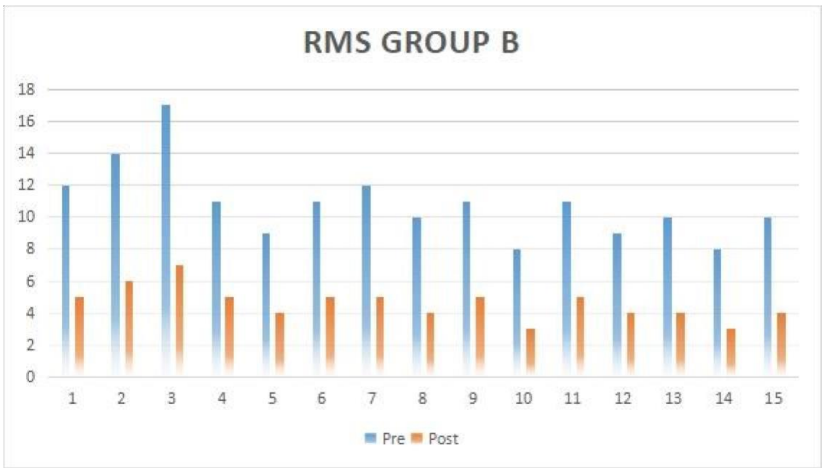


Figure 3

A graphical comparison of Figure 2 vs. Figure 3 comparing pre and post RMS scores of group A and

B, respectively, indicates that there is a significant drop in RMS scores of patients in Group A after given treatment as compared to patients in group B where RMSscores dropped only to a minor extent.

Discussion

This study aimed to compare the effects of CSE and PNF training on pain relatedoutcomes in low back pain patients. Overall, compared to other studies, our findings showed that after a two-week interventions, core stabilization exercises are more effectiveas compared to other proprioceptive neuromuscular facilitation technique. Previousresearch showed that after a four-week intervention, both CSE and PNF techniques improved pain intensity and functional disability, at a three-month follow up, it was observed that achieved pain related persisted. Greater improvement in those outcomes from baseline to follow-up period were also observed in both CSE and PNF training groups. Patients in the core stabilization exercises group had significantly improvement inall pain related outcomes in this study, as concurring with the previous study's findings showed that patients in the proprioceptive neuromuscular facilitation training group had significantly improved regarding pain intensity, functional disability and patient's satisfaction in 4 and 12 week follow-ups.

Conclusion

The statistical data acquired in this research for Group A vs. Group B appeared similar, however, conducting comparative analysis with the help of test performed and descriptiveanalysis of acquired data conclude that Pain Score and Roland Morris Disability Index Score of patients in Group A treated with Core Stabilization Exercises (CSE) significantlyimproved i.e., lowered after given treatment in comparison to that of patients in Group B treated with proprioceptive neuromuscular facilitation(PNF) techniques. Thus, concluding that Group a method is more effective for Low Back Pain patients as compared to Group b Method.

Limitations

This study had limitations, including a **small sample size** and **short intervention duration**, which restricted the assessment of long-term effects. The findings apply mainly to **working-age individuals**, limiting generalizability to other age groups. Additionally, **PNF was less effective than CSE**, suggesting CSE as the preferred intervention for low back pain.

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