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Comparative Effects of Muscle Energy Technique and Proprioceptive Neuromuscular Facilitation Stretching in the Management of Lower Cross Syndrome

Atif Ali Attar[1], **Ifra Maryam**[2], **Mariam Mehmood**[3], **Rabel Chang**[2], **Rida Fatima**[4], **Azka Laraib**[5], **Nida Naz**[6], **Fiza Rehman**[7], **Intsam Aslam**[8]

Correspondence
Intsam Aslam.
Intsamaslam6@gmail.com

Affiliations
1 Bhitai Institute of Physiotherapy and Rehabilitation Sciences, Mirpurkhas, Pakistan
2 University of Modern Sciences (Indus Medical College Hospital), Hyderabad, Pakistan
3 Allied Hospital, Faisalabad, Pakistan
4 Department of Rehabilitation Medicine, The Second Affiliated Hospital of Chongqing Medical University, Chongqing, China
5 Department of Neurology, The Second Affiliated Hospital of Chongqing Medical University, Chongqing, China
6 MARS Institute of Health Sciences for Women, Lahore, Pakistan
7 Johar Medicare, Lahore, Pakistan
8 PSRD College of Rehabilitation Sciences, Lahore, Pakistan

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ABSTRACT

Background: Lower Cross Syndrome (LCS) results from muscle imbalance due to poor posture, causing tightness in lumbar and hip flexor muscles alongside weakness in abdominal and gluteal muscles. It leads to lumbar hyperlordosis, chronic low back pain, and functional disability.

Objective: This study aimed to compare the effectiveness of Muscle Energy Techniques (METs) and Proprioceptive Neuromuscular Facilitation (PNF) stretching in the management of LCS.

Methods: A randomized clinical trial was conducted with 60 participants, aged 18-45, diagnosed with LCS. Participants were divided into two groups: METs (n=30) and PNF stretching (n=30). Interventions were performed thrice a week for four weeks. Outcome measures included pain (NPRS), disability (Oswestry Low Back Pain Disability Questionnaire), hip extension range (goniometer), and anterior pelvic tilt. Statistical analysis was done using SPSS version 25, with non-parametric tests due to non-normal data distribution ($p<0.05$).

Results: The METs group showed greater improvement in post-treatment Oswestry scores (mean rank 19.30, $p<0.001$) and NPRS (mean rank 16.53, $p<0.001$), compared to the PNF group. Hip extension range and anterior pelvic tilt also improved significantly in the METs group ($p<0.001$).

Conclusion: METs were more effective than PNF stretching in managing LCS, significantly reducing pain and disability while improving range of motion.

INTRODUCTION

Lower Cross Syndrome (LCS) is a postural condition caused by the imbalance between tight and weak muscle groups, primarily due to prolonged poor posture. This condition is characterized by tightness of the lumbar muscles and hip flexors, coupled with weakness in the abdominal and gluteal muscles, resulting in an anterior pelvic tilt and hyperlordosis in the lumbar region. LCS can impair daily functioning by inducing significant biomechanical changes in the lumbar and pelvic regions, leading to a persistent cycle of discomfort and muscular dysfunction (1). The condition is often seen in individuals with sedentary lifestyles, including office workers and athletes, as it develops from repetitive or sustained poor postural habits, such as prolonged sitting, inadequate ergonomic practices, or activities that involve continuous lumbar flexion (2).

Muscle imbalances associated with LCS cause compensatory patterns in movement, leading to an increase in lumbar curvature and a reduction in flexibility, mobility, and muscular strength. As a result, individuals often experience chronic low back pain, reduced range of motion, and significant postural instability (3). This condition affects the body's soft tissues, classified into tonic and phasic muscles, which are responsible for maintaining upright posture and engaging in movement patterns. Tonic muscles, being more prone to tightness, can exacerbate the imbalance when subjected to prolonged physical stress, altering natural movement and contributing to the persistence of musculoskeletal dysfunction (4).

Lower Cross Syndrome, often considered a precursor to more severe musculoskeletal disorders, presents not only as a mechanical issue but also as a condition that significantly impacts quality of life by restricting mobility and increasing the risk of injury. Patients with LCS typically exhibit symptoms such as lumbar hyperlordosis, anterior pelvic tilt, and compromised gait, all of which contribute to chronic discomfort and long-term disability if left untreated (5). The impact of LCS on postural muscles is particularly significant in those who spend prolonged hours in seated positions, which has been linked to musculoskeletal disorders (MSD) commonly observed in office workers. Such individuals often report pain in the lower back, neck, shoulders, and upper limbs due to muscle imbalances and improper posture (6).

Several therapeutic approaches have been explored for managing LCS, including muscle energy techniques (METs) and proprioceptive neuromuscular facilitation (PNF) stretching, both of which have been widely used in clinical settings to improve muscle flexibility, reduce pain, and restore normal movement patterns. METs involve isometric contractions followed by passive stretching, designed to

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reduce muscle tension and improve joint mobility. The post-isometric relaxation (PIR) technique, a specific form of MET, has shown significant effectiveness in alleviating pain and disability in musculoskeletal conditions such as LCS (7). PNF stretching, on the other hand, aims to enhance both active and passive ranges of motion by engaging the stretch-reflex mechanism to relax targeted muscles and improve flexibility (8).

The present study aims to compare the effectiveness of METs, specifically the PIR technique, with PNF stretching in managing LCS. Both interventions are expected to have positive effects on pain reduction, disability scores, and range of motion in the lumbar and hip regions. By conducting a randomized clinical trial with individuals suffering from LCS, this study seeks to identify the superior therapeutic approach in terms of improving functional outcomes and restoring biomechanical balance in patients with this condition (9). The findings will contribute to the growing body of knowledge on non-invasive treatments for musculoskeletal disorders, offering insights into the most effective therapeutic strategies for managing postural syndromes and improving patient outcomes in both clinical and rehabilitation settings.

MATERIAL AND METHODS

The study was designed as a randomized clinical trial involving participants diagnosed with Lower Cross Syndrome (LCS). A total of 60 participants were recruited, comprising both male and female individuals between the ages of 18 and 45 who exhibited moderate back pain (rated 4-7 on the Numeric Pain Rating Scale) and a positive prone extension test. Participants with a history of idiopathic scoliosis, lumbar instability, any systemic diseases, history of trauma, or recent surgeries involving the lumbar spine or hip were excluded from the study (1). The participants were randomly assigned to one of two treatment groups: Group A, which received Muscle Energy Techniques (METs) with post-isometric relaxation, and Group B, which received Proprioceptive Neuromuscular Facilitation (PNF) stretching. Both groups also received baseline treatment consisting of a moist heating pad applied to the lower back while lying prone for 10 minutes, followed by strengthening exercises targeting the abdominal and gluteal muscles.

Data collection was conducted using a range of validated tools. Pain intensity was measured using the Numeric Pain Rating Scale (NPRS), which is a single-dimension scale ranging from 0 (no pain) to 10 (worst pain imaginable). Disability was assessed using the Oswestry Low Back Pain Disability Questionnaire, a widely used outcome measure for patients with low back pain, which requires approximately five minutes to complete and is rated based on the level of functional impairment, ranging from minor disability to complete bed rest (2). Hip extension range of motion was measured using a goniometer, while anterior pelvic tilt was evaluated using standard clinical assessment techniques.

Ethical approval for the study was obtained from the relevant institutional review board, ensuring compliance with the ethical principles outlined in the Declaration of Helsinki. All participants were informed about the nature and purpose of the study, and written consent was obtained before enrollment. Confidentiality was maintained throughout the study, and participants were informed of their right to withdraw at any point without consequence (3).

The intervention lasted for a total of four weeks, during which participants in both groups received three treatment sessions per week. Group A underwent post-isometric relaxation METs, targeting the iliopsoas and erector spinae muscles, while Group B underwent PNF stretching using the hold-relax technique on the same muscle groups. Both interventions were designed to alleviate muscle tightness and improve range of motion, with METs focusing on reducing muscle tension through isometric contraction followed by passive stretching, and PNF aiming to enhance flexibility and motor control through a combination of passive and active stretching.

Statistical analysis was performed using SPSS version 25. The Shapiro-Wilk test was applied to assess data normality, and as the data were found to be non-normally distributed, non-parametric tests were used for subsequent analyses. The Mann-Whitney U test was employed to compare the outcomes between the two groups, while the Wilcoxon signed-rank test was used for within-group analyses. Statistical significance was set at a p-value of less than 0.05 for all tests (4).

The primary outcomes measured were changes in pain intensity, functional disability, hip extension range of motion, and anterior pelvic tilt before and after the intervention. The results were analyzed to determine whether one technique was more effective than the other in managing the symptoms of LCS. All findings were interpreted with respect to their clinical relevance in the management of patients with postural syndromes such as Lower Cross Syndrome.

RESULTS

A total of 60 participants were enrolled in the study, with 30 assigned to the Muscle Energy Techniques (METs) group and 30 to the Proprioceptive Neuromuscular Facilitation (PNF) stretching group. The demographic characteristics of the participants, including age and gender distribution, are shown in Table 1. The mean age of participants in the METs group was 27.2 ± 4.72 years, while the mean age in the PNF stretching group was 26.9 ± 4.46 years. In terms of gender distribution, 20 participants (33.3%) were male and 40 participants (66.7%) were female, with a higher prevalence of LCS in females.

Table 1: Age and Gender Distribution of Participants

Group	Mean Age ± SD	Male (%)	Female (%)
METs	27.2 ± 4.72	33.3	66.7
PNF	26.9 ± 4.46	33.3	66.7

The marital status of the participants showed that 29 (48.3%) were unmarried, while 31 (51.7%) were married.

Data normality was assessed using the Shapiro-Wilk test, which indicated that the data were not normally distributed ($p < 0.05$ for all variables). As a result, non-parametric tests were used for between-group and within-group comparisons. The Mann-Whitney U test was employed to analyze the differences between the two groups.

Table 2 shows the results of the between-group analysis using the Mann-Whitney U test. Before treatment, there were no significant differences between the groups in terms of the Oswestry Low Back Pain Disability Questionnaire score, NPRS, hip extension range, and anterior pelvic tilt. However, after treatment, significant differences were observed between the METs and PNF groups, with the METs group showing greater improvement in all outcomes.

Table 2: Between-Group Analysis (Mann-Whitney U Test)

Variable	Group	Median (IQR)	Mean Rank	Sum of Ranks	Z-Value	p-Value
Pre-Oswestry Low Back Pain Disability Score	MET	2.00	31.30	939.00	-0.443	0.658
	PNF	2.00	29.70	891.00		
Post-Oswestry Low Back Pain Disability Score	MET	0.00	19.30	579.00	-5.414	0.000
	PNF	1.00	41.70	1251.00		
Pre-Numeric Pain Rating Scale	MET	6.00	28.32	849.50	-1.045	0.296
	PNF	7.00	32.68	980.50		
Post-Numeric Pain Rating Scale	MET	2.00	16.53	496.00	-6.280	0.000
	PNF	6.00	44.47	1334.00		
Pre-Hip Extension Range	MET	0.00	30.50	915.00	0.000	1.000
	PNF	0.00	30.50	915.00		
Post-Hip Extension Range	MET	1.00	39.00	1170.00	-4.375	0.000
	PNF	0.00	22.00	660.00		
Pre-Anterior Pelvic Tilt	MET	1.00	30.50	915.00	0.000	1.000
	PNF	1.00	30.50	915.00		
Post-Anterior Pelvic Tilt	MET	0.00	22.00	660.00	-4.476	0.000
	PNF	1.00	39.00	1170.00		

The Wilcoxon signed-rank test was used for within-group analysis to evaluate the changes in outcomes from pre- to post-treatment in both groups. The METs group demonstrated significant improvements in all parameters, including pain intensity, disability score, hip extension range, and anterior pelvic tilt ($p < 0.05$). Similarly, the PNF group also showed significant improvements, although the magnitude of change was less pronounced compared to the METs group. The METs group showed significantly greater improvement compared

Table 3: Within-Group Analysis (Wilcoxon Test)

Variable	Group	Median (IQR)	Mean Rank	Sum of Ranks	Z-Value	p-Value
Oswestry Low Back Pain Disability Score	MET	0.00	19.30	579.00	-4.765	0.000
	PNF	1.00	41.70	1251.00	-3.207	0.001
Numeric Pain Rating Scale	MET	2.00	16.53	496.00	-4.813	0.000
	PNF	6.00	44.47	1334.00	-3.368	0.007
Hip Extension Range	MET	1.00	39.00	1170.00	-4.690	0.000
	PNF	0.00	22.00	660.00	-2.236	0.025
Anterior Pelvic Tilt	MET	0.00	22.00	660.00	-4.472	0.000
	PNF	1.00	39.00	1170.00	-2.449	0.083

to the PNF group in terms of reductions in the Oswestry Low Back Pain Disability Questionnaire score and Numeric Pain Rating Scale, as well as increases in hip extension range and reductions in anterior pelvic tilt ($p < 0.05$). While both treatment groups exhibited positive changes from pre- to post-treatment, the METs group demonstrated superior results, indicating that Muscle Energy Techniques were more effective in managing symptoms of Lower Cross Syndrome.

DISCUSSION

The present study aimed to evaluate the comparative effectiveness of Muscle Energy Techniques (METs) and Proprioceptive Neuromuscular Facilitation (PNF) stretching in the management of Lower Cross Syndrome (LCS). The results demonstrated that METs provided greater improvements in reducing pain, increasing range of motion, and improving disability compared to PNF stretching. These findings align with prior studies that have highlighted the efficacy of METs in musculoskeletal rehabilitation, particularly in conditions involving muscle imbalances and postural dysfunction (1).

METs, through post-isometric relaxation, were found to effectively reduce muscle tension and improve joint mobility, which may explain the superior outcomes observed in this group.

Previous studies have suggested that both METs and PNF stretching are valuable in restoring functional movement patterns in conditions involving chronic low back pain and muscle tightness. However, the present study adds to the growing body of evidence indicating that METs may offer a more targeted approach to addressing the underlying muscle imbalances seen in LCS, particularly by reducing tension in overactive muscles like the iliopsoas and erector spinae (2). The significant improvements in the Oswestry Low Back Pain Disability Questionnaire score and Numeric Pain Rating Scale in the METs group support this assertion. Moreover, the increase in hip extension range and reduction in anterior pelvic tilt further show that METs were more effective in restoring normal biomechanics compared to PNF stretching.

Despite these positive findings, it is important to acknowledge the limitations of the study. The sample size was relatively small, and the study was conducted in a single geographic region, which may limit the generalizability of the results to a broader population. Additionally, the study only included short-term follow-up data, and the long-term effects of both interventions remain unclear. Future research should consider larger, multicenter trials with extended follow-up periods to assess the sustainability of the improvements observed in this study (3). Furthermore, while METs showed superior outcomes in this trial, it is possible that combining METs with other therapeutic interventions, such as spinal mobilization or stabilization exercises, could yield even better results. Future studies could explore the potential synergistic effects of combining different treatment modalities.

The strength of this study lies in its randomized design and the use of validated outcome measures, which provide robust evidence for the effectiveness of METs and PNF in treating LCS. However, the use of subjective measures such as pain intensity may introduce bias, as patient-reported outcomes can be influenced by various external factors, including psychological state and environmental conditions. To minimize such bias, future studies should incorporate objective measures such as electromyography (EMG) or gait analysis to more accurately assess muscle function and movement patterns.

CONCLUSION

In conclusion, this study found that METs were more effective than PNF stretching in managing the symptoms of Lower Cross Syndrome. These findings have important implications for clinical practice, as they suggest that METs should be considered as a first-line treatment for patients with LCS, particularly those presenting with chronic low back pain and reduced hip mobility. While both interventions proved positive effects, METs showed greater potential for improving functional outcomes, which could lead to enhanced quality of life for patients suffering from this common postural condition. Future research should focus on the long-term effectiveness of these interventions and explore the benefits of integrating METs with other therapeutic approaches to optimize patient outcomes in the management of LCS.

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