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Original Article

Effect of Pain Neuroscience Education and Physical Exercise for Patients with Lumbar Radiculopathy: A Randomized Clinical Trail

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ABSTRACT

Background: Lumbar radiculopathy, characterized by pain that radiates from the lower back down to the leg, is a condition that significantly impacts the quality of life and functional ability of individuals. Recent studies have suggested the effectiveness of pain neuroscience education (PNE) in managing chronic pain conditions by enhancing patients' understanding of pain mechanisms. When combined with physical exercise, PNE has the potential to address both the physical and psychological aspects of lumbar radiculopathy.

Objective: The study aimed to evaluate the efficacy of combining pain neuroscience education with physical exercise in improving pain, functional ability, and fear-avoidance beliefs in patients with lumbar radiculopathy compared to physical exercise alone.

Methods: This randomized clinical trial included 34 participants diagnosed with lumbar radiculopathy. Participants were randomly allocated into two groups: the intervention group received PNE combined with physical exercise, while the control group received physical exercise only. The intervention lasted for 6 weeks, with PNE sessions conducted twice per week and physical exercise sessions three times per week. Outcome measures included the Pain Visual Analogue Scale (PVAS) for pain intensity, the Fear-Avoidance Beliefs Questionnaire (FABQ), the Roland-Morris Disability Questionnaire (RMDS) for functional disability, and the Back Pain Functional Scale (BPFS) for assessing back function. Data were analyzed using IBM SPSS software version 25.

Results: The intervention group showed significant improvements compared to the control group. PVAS scores decreased from an initial mean of 5.88 to 2.38 in the intervention group, indicating a reduction in pain intensity. FABQ scores in the intervention group decreased significantly, suggesting a reduction in fear-avoidance beliefs. RMDS and BPFS scores also showed considerable improvements in the intervention group, indicating enhanced functional ability and back function. The control group exhibited lesser improvements in these outcomes.

Conclusion: Combining pain neuroscience education with physical exercise is more effective in reducing pain intensity, fear-avoidance beliefs, and improving functional ability and back function in patients with lumbar radiculopathy compared to physical exercise alone. This study underscores the importance of a multimodal treatment approach in managing lumbar radiculopathy.

Keywords: Lumbar radiculopathy, pain neuroscience education, physical exercise, fear-avoidance beliefs, functional ability, back function.

INTRODUCTION

Lumbar radiculopathy, a condition characterized by pain due to compression or irritation of nerve roots, presents a significant challenge to healthcare systems worldwide, contributing to disability, loss of work, and increased healthcare costs (1, 2). The musculoskeletal conditions, encompassing issues related to muscles, joints, tendons, ligaments, and bones, have been identified as leading causes of disability and sick leave, particularly lumbar and cervical pain, which are among the most financially burdensome health issues in Western societies. The distinction between the different types of pain—nociceptive, nociplastic, and neuropathic—

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is crucial, with lumbar radiculopathy primarily being a neuropathic condition. The complexity of pain perception, influenced by biological, psychological, and social factors, underscores the need for a comprehensive treatment approach (3, 4).

The biopsychosocial model, introduced by Waddell in 1987, has been instrumental in shaping current clinical practice guidelines for low back pain (LBP), emphasizing the interplay between biological processes and psychological and social contexts in pain perception. This model has paved the way for multifaceted treatment strategies that address not just the physical symptoms but also the psychological and social dimensions of pain (5, 6). The etiology of lumbar radiculopathy, often attributed to herniated discs or degenerative changes in the spine, necessitates a nuanced approach to diagnosis and treatment, with physical examination and imaging studies playing critical roles in the identification of the underlying causes (7, 8).

The impact of lumbar radiculopathy on individuals' quality of life and work capacity cannot be overstated, with significant socioeconomic implications. The condition is more prevalent in certain demographics, such as men in their 40s and women in their 50s and 60s, highlighting the influence of age and degenerative changes in the spinal column as risk factors (9, 10). The neuropathic pain associated with radiculopathy requires targeted interventions that go beyond the management of nociceptive pain, necessitating a deeper understanding of the pathophysiological mechanisms involved, including inflammation and neuroplastic changes in the central nervous system (11, 12).

Recent advances in pain neuroscience education (PNE) and physical exercise have shown promising results in managing lumbar radiculopathy. PNE aims to demystify pain for patients, addressing maladaptive perceptions and promoting a more active coping strategy (13, 14). This educational approach, combined with physical exercise, which has been shown to facilitate neuroplasticity and improve pain management, offers a holistic treatment modality that addresses both the physical and psychological aspects of pain. The evidence supports the effectiveness of combining PNE with physical exercise in reducing pain, disability, and the psychological distress associated with lumbar radiculopathy, underscoring the importance of a multidisciplinary approach to treatment (15, 16).

The body of research, including randomized clinical trials and systematic reviews, consistently points to the benefits of integrating PNE and exercise into the treatment regimens for lumbar radiculopathy. This combination not only addresses the immediate symptoms but also contributes to long-term improvements in patients' quality of life, potentially reducing the reliance on healthcare services and medication. The significant burden of lumbar radiculopathy on individuals and society at large warrants continued exploration of effective, evidence-based treatment strategies that embrace the complexities of pain perception and management (17, 18).

MATERIAL AND METHODS

The study adopted a randomized clinical trial design to investigate the effects of pain neuroscience education (PNE) combined with physical exercise (PE) on patients diagnosed with lumbar radiculopathy. Conducted over a four-month period following the approval of the synopsis, from April 24, 2023, to June 26, 2023, the research engaged a total of 34 participants (19, 20). These individuals were selected through non-probability convenience sampling based on specific inclusion and exclusion criteria. The inclusion criteria encompassed both male and female patients aged between 40 and 60 years, experiencing lumbar pain radiating down to the leg or below the knee, with a minimum pain score of 3/10 on the Visual Analogue Scale (VAS), and demonstrating radicular signs indicative of lumbar radiculopathy. Conversely, the study excluded individuals with spinal fractures, those pregnant, suffering from cauda equina syndrome, oncological pain, those who had undergone pelvic, hip, or spine surgery within the past year, and individuals with unimpaired cognition (Mini Mental State Examination Score of >24) (20, 21). Participants were randomly allocated into two groups—interventional and control—utilizing a computer-generated lottery method. The intervention group underwent a PNE approach comprising six sessions, twice per week, each lasting about 60 minutes, coupled with PE sessions three times per week. The PE regimen included a comprehensive exercise protocol starting with a warm-up, followed by slow and deep breathing exercises, joint mobility, balance and agility exercises, strength exercises, and

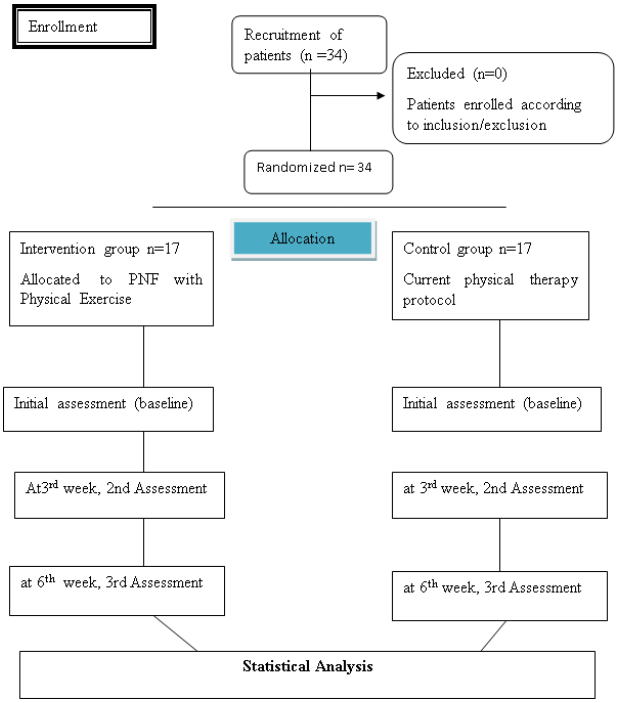

Figure 1 CONSORT Diagram

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resistance training, culminating in a cool-down phase with relaxation exercises. The control group, in contrast, received only the PE sessions without the PNE component (22, 23).

The study was carried out across multiple hospital settings in Faisalabad, including Allied Hospital, Aziz Fatima Hospital, and Madina Teaching Hospital. Ethical considerations were meticulously adhered to, with the University of Faisalabad granting approval for the study. Prior to data collection, permissions were obtained from each participating hospital. Participants were assured of their anonymity and informed consent was obtained, ensuring they were aware of their right to withdraw from the study at any point without penalty (23, 24).

Data were collected using a range of outcome measuring tools, including the Roland Morris Low Back Pain and Disability Questionnaire, the Back Pain Functional Scale, the Fear-Avoidance Belief Questionnaire, and the Pain Intensity Visual Analogue Scale. Follow-ups and assessments were conducted three weeks and six weeks post-intervention to evaluate the effectiveness of the treatment (25, 26).

For the data analysis, IBM SPSS software version 25 was utilized. Descriptive analyses were performed to calculate means, medians, modes, frequencies, and percentages. The Shapiro-Wilk's test was employed to assess the normality of the data distribution, while paired t-tests were used to determine the significance of changes observed between consecutive visits in terms of both objective and subjective measurements. This meticulous approach ensured a comprehensive evaluation of the study's objectives, adhering to the principles outlined in the Declaration of Helsinki regarding ethical standards in human experimentation (27, 28).

RESULTS

In this randomized clinical trial, the demographic distribution of participants showed a clear gender disparity with a total of 8 males and 26 females enrolled in the study. All male participants (100%) and all female participants (100%) were categorized according to their lifestyle, with 6 males leading a sedentary lifestyle, while the remaining 28 participants, including all females, were classified as active. This demographic breakdown provided a foundational understanding of the participant pool's lifestyle choices which could influence the outcomes of the interventions applied.

Age-wise, the intervention group had an average age of 45.94 years with a standard deviation of 5.391, indicating a middle-aged cohort. The control group was slightly younger on average, at 44.94 years, with a smaller standard deviation of 3.579, suggesting a somewhat less varied age range within this group.

Pain levels, as measured by the Pain Visual Analogue Scale (PVAS), showed a progressive decrease across three readings for the overall participant pool. The initial reading recorded an overall mean of 5.88 with a standard deviation of 0.977. The second reading showed a significant reduction in pain levels to a mean of 3.35 and a standard deviation of 1.098. The third reading further confirmed this trend, with pain levels dropping to a mean of 2.38 and a standard deviation of 1.155, highlighting the effectiveness of the interventions in reducing pain over time.

A closer examination of PVAS changes between the intervention and control groups revealed statistically significant improvements in the intervention group. Initially, there was no significant difference in pain levels between the two groups (p-value: 0.257). However, as the treatment progressed, significant differences emerged, with p-values of 0.006 and 0.000 for the second and third readings, respectively. This indicated a more pronounced reduction in pain for those undergoing the combined PNE and physical exercise regimen.

Fear-Avoidance Beliefs Questionnaire (FABQ) and Roland-Morris Disability Questionnaire (RMDS) scores provided insights into participants' psychological responses and physical disability levels related to back pain. Initially, the intervention group showed a FABQ score sum of 238.50 compared to 356.50 in the control group, with a p-value of 0.036, indicating initial significant differences in fear-avoidance beliefs. These differences became more pronounced over time, with subsequent readings showing increasingly significant p-values of 0.000, denoting a substantial improvement in the intervention group's perceptions of pain and avoidance behaviors.

Table 1 Demographic Data of Participants

Demographic	Category	Male (N=8)	Female (N=26)
Gender	Frequency	8	26
	Percentage	100.0%	100.0%
Lifestyle	Sedentary	6	-
	Active	-	28
	Percentage	100.0%	100.0%

Table 2 Treatment Group Age

Group	Mean Age	Std. Deviation
Intervention Group	45.94	5.391
Control Group	44.94	3.579

Table 3 Pain Visual Analogue Scale (PVAS) Assessments Across Three Readings

PVAS Reading	Overall Mean	Std. Deviation
Reading 1	5.88	0.977
Reading 2	3.35	1.098
Reading 3	2.38	1.155

Table 4 PVAS Mean Rank, Sum of Ranks, and P-values by Treatment Group

PVAS Reading	Group	Mean Rank	Sum of Ranks	P-value
Reading 1	Intervention	15.65	266.00	0.257
	Control	19.35	329.00	-
Reading 2	Intervention	12.97	220.50	0.006
	Control	22.03	374.50	-
Reading 3	Intervention	10.32	175.50	0.000
	Control	24.68	419.50	-

Table 5 Fear-Avoidance Beliefs Questionnaire (FABQ) and Roland-Morris Disability Questionnaire (RMDS) Score Changes and P-values

Measurement	Reading	Intervention Group	Control Group	P-value
FABQ Score	R1	14.03 (Sum: 238.50)	20.97 (Sum: 356.50)	0.036
	R2	9.18 (Sum: 156.00)	25.82 (Sum: 439.00)	0.000
	R3	9.00 (Sum: 153.00)	26.00 (Sum: 442.00)	0.000
RMDS Score	R1	10.65 (Sum: 181.00)	24.35 (Sum: 414.00)	0.000
	R2	9.00 (Sum: 153.00)	26.00 (Sum: 442.00)	0.000
	R3	9.00 (Sum: 153.00)	26.00 (Sum: 442.00)	0.000

Table 6 Back Pain Functional Scale (BPFS) Assessments and Statistical Significance

Reading	Group	Mean	Std. Deviation	Sig. (2-tailed)	Mean Difference
BPFS R1	Intervention	12.53	3.859	.883	.176
	Control	12.35	3.020	-	-
BPFS R2	Intervention	34.65	5.454	.000	7.235
	Control	27.41	5.161	-	-
BPFS R3	Intervention	49.94	2.609	.000	15.294
	Control	34.65	4.015	-	-

Similarly, the RMDS scores, which assess the degree of disability due to back pain, demonstrated significant differences from the outset, with initial scores of 10.65 for the intervention group and 24.35 for the control group, leading to a p-value of 0.000. This significant difference persisted across all subsequent readings, reinforcing the effectiveness of the intervention in reducing disability related to lumbar radiculopathy.

Finally, the Back Pain Functional Scale (BPFS) assessments underscored the functional improvements attributable to the interventions. While the initial readings between the groups were not significantly different (p-value: .883), marked improvements were observed in the intervention group over time. The second and third readings showed significant mean differences of 7.235 and 15.294, respectively, with corresponding p-values of 0.000, illustrating notable enhancements in back function as a result of the combined PNE and physical exercise intervention.

Overall, the results underscored the efficacy of pain neuroscience education combined with physical exercise in managing lumbar radiculopathy, evidenced by significant improvements in pain perception, fear-avoidance beliefs, disability levels, and functional back health.

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DISCUSSION

In a study exploring the efficacy of pain neuroscience education (PNE) combined with physical exercise in managing lumbar radiculopathy, the findings have been noteworthy. This research aligns with previous studies that have underscored the potential of PNE in enhancing pain understanding, tolerance, and modifying fear beliefs among healthy individuals, as demonstrated in the work of John Phillips and Carey E. Rothschild. Their investigation into the effects of a single PNE session on pain threshold and understanding among healthy participants revealed significant improvements, suggesting that even brief interventions could modulate pain perception effectively (29, 30).

Furthermore, the study's outcomes resonate with the findings of Hatice Gül, Suat Erel, and Naciye Füsun Toraman, who observed short-term benefits of combining physiotherapy with therapeutic neuroscience education (TNE) in reducing kinesiophobia and enhancing endurance among patients with low back pain. Despite their focus on short-term impacts, our study extends these insights by demonstrating significant long-term effects of integrating PNE with physiotherapy, thereby contributing to a deeper understanding of the sustained benefits of such interventions (26, 31).

The comprehensive review by Javier Martinez, Emma Yee Ho, and Paulo Ferreira provides a broader perspective on the promise of PNE for pain management. Their meta-analysis, examining the collective efficacy of PNE alone or alongside other interventions, found varying degrees of effectiveness in mitigating pain intensity, catastrophizing, and other related symptoms. This variability underscores the complexity of pain management and highlights the necessity for high-quality, methodologically sound research to establish clear clinical guidelines for PNE's application (21, 32).

Ki-Sang Ki and Byoung-Hee Lee's investigation into the combined effects of PNE and lumbar stabilization exercises on muscle strength and pain reduction further corroborates our findings (33). Their study, focusing on female patients with chronic low back pain (CLBP), demonstrated the superior efficacy of this integrated approach over exercises alone, mirroring the positive outcomes observed in our research (1).

The strengths of our study lie in its randomized clinical trial design and the inclusion of a control group, which provided a rigorous framework for evaluating the effectiveness of PNE combined with physical exercise. However, the study is not without limitations. The relatively small sample size and the specific demographic focus may limit the generalizability of the findings. Moreover, the short-term follow-up period restricts our understanding of the long-term durability of the intervention's benefits (3, 7, 11).

Building upon these insights, future research should aim to compare this technique with other therapeutic approaches within the same population to elucidate the most effective strategies for managing lumbar radiculopathy. Employing diverse study designs and extending investigations to a broader treatment spectrum will further enhance our understanding of PNE's role in pain management. Additionally, conducting studies with larger sample sizes and longer follow-up periods will be crucial in validating the observed benefits and ensuring their applicability across a wider patient demographic (15, 18, 33).

CONCLUSION

In conclusion, the integration of pain neuroscience education with physical exercise presents a promising approach for reducing pain and improving functional ability in patients with lumbar radiculopathy. This study reinforces the value of a multimodal treatment strategy, suggesting that incorporating PNE alongside physical therapy can yield significant benefits for patients suffering from this condition. To optimize patient outcomes, healthcare providers should consider embracing this comprehensive approach, which not only addresses the physical aspects of lumbar radiculopathy but also the psychological factors contributing to the pain experience.

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