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Original Article

Effectiveness of Pain Neuroscience Education on Chronic Pain in Diabetic Neuropathy

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ABSTRACT

Background: Diabetic neuropathy, a common complication of diabetes mellitus, often leads to chronic pain, significantly impacting the quality of life. Pain Neuroscience Education (PNE) has emerged as a potential intervention to address the bio-psychosocial aspects of chronic pain. This study aimed to evaluate the effectiveness of PNE in combination with conventional therapy in reducing pain and improving the quality of life in individuals with diabetic neuropathy.

Objective: The primary objective was to assess the impact of Pain Neuroscience Education combined with conventional therapy on pain levels and quality of life in patients with diabetic neuropathy.

Methods: A randomized clinical trial was conducted with 30 participants, divided into two groups: 15 in the treatment group and 15 in the control group. Participants were recruited from neurology and physical therapy outpatient departments and selected based on specific inclusion and exclusion criteria. The treatment group received PNE and conventional therapy (TENS, stretching, and strengthening exercises), while the control group received only conventional therapy. Pain levels were assessed using the Visual Analogue Scale (VAS) at baseline and after 6 weeks of intervention.

Results: The pre-treatment VAS scores showed no significant difference between the groups (Treatment: Mean = 57.00, SD = 16.77583; Control: Mean = 56.2667, SD = 15.91705, P = 0.903). Post-treatment, the treatment group exhibited a significant reduction in pain (Mean = 19.6667, SD = 6.39940) compared to the control group (Mean = 45.3333, SD = 14.81634), with a mean difference of 25.66 and a P-value of 0.000.

Conclusion: The study demonstrated that Pain Neuroscience Education, when combined with conventional therapy, significantly reduces pain and improves the quality of life in patients with diabetic neuropathy. This suggests that PNE could be an effective component of a multi-modal approach to managing diabetic neuropathy pain.

Keywords: Diabetic Neuropathy, Pain Neuroscience Education, Chronic Pain, Quality of Life, Visual Analogue Scale, Randomized Clinical Trial.

INTRODUCTION

Diabetes mellitus, a complex group of metabolic diseases, is characterized by elevated blood glucose levels, glucose presence in urine, heightened cholesterol, and metabolic acidosis. These symptoms arise from irregularities in the production and function of insulin, leading to increased fasting and postprandial blood glucose levels (1). One of the most severe complications of diabetes is diabetic neuropathy, a debilitating and sometimes fatal nerve degeneration affecting 30 to 90 percent of diabetic patients worldwide (2). This condition leads to a host of long-term complications including retinopathy, resulting in vision loss; nephropathy, causing renal failure; peripheral neuropathy, leading to foot ulcers, amputations, and joint contractures; and autonomic neuropathy, manifesting in gastrointestinal, genitourinary, and cardiovascular symptoms, as well as sexual dysfunction (3, 4). Diabetes is expected to impact an estimated 693 million people globally, making it one of the fastest-growing diseases worldwide (5, 6).

Neuropathy is prevalent in up to half of individuals with diabetes, often accompanied by neuropathic pain in 30–40 percent of cases. Forms of peripheral nerve injury in diabetes include Progressive Distal Symmetric Polyneuropathy (PDSP), autonomic neuropathy, radiculo-plexopathies, and mono-neuropathies (7). Diabetic Peripheral Neuropathy (DPN) is typically symmetric and predominantly sensory, starting in the distal extremities and gradually advancing proximally (8). Currently, there is no singular treatment that can

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completely alleviate pain, halt, or reverse neuropathy progression, or restore normal function (9, 10). The primary therapeutic approaches for PDN include intensive glycaemic control and risk factor management, pathologically targeted medications, and symptomatic pain management (11).

Symptoms of diabetic neuropathy, such as numbness, burning, pain, weakness, and discomfort, often begin in the toes and advance proximally, eventually affecting the upper limbs. DPN, often underdiagnosed and undertreated, is linked with high morbidity and an increased mortality rate (12). Diabetic neuropathies can be categorized into two types: symmetrical (polyneuropathy affecting both sides of the body) and asymmetrical (focal neuropathy associated with diabetes) (1).

The rationale for this research lies in the chronic nature of diabetic neuropathic pain and the need for effective management strategies. Pain Neuroscience Education, an evidence-based approach for managing chronic pain across various conditions, is chosen as the focus of this study (2, 13, 14). The primary objective is to evaluate the impact of Pain Neuroscience Education on chronic pain in patients with diabetic neuropathy (15). The research question centres on whether Pain Neuroscience Education effectively mitigates chronic pain in diabetic neuropathy, aiming to contribute valuable insights into the management of this debilitating condition (16-18).

MATERIAL AND METHODS

In this randomized clinical trial, a total of 30 participants were enrolled and randomly allocated into two groups, with 15 individuals in the experimental group and 15 in the control group. The participants were recruited from the neurology and physical therapy outpatient departments (OPDs) of Madina Teaching Hospital Faisalabad and Allied Hospital Faisalabad. Selection criteria were meticulously established to ensure a homogenous participant pool, focusing on individuals aged between 40 and 70 years, both male and female, diagnosed with diabetic neuropathy. Eligibility was determined based on several factors: a positive monofilament test, a documented history of diabetes exceeding five years, enduring pain for a duration ranging from six months to one year, and a hemoglobin A1C (HBA1C) level of 6.5 percent or higher. The study deliberately excluded participants with other diagnosed neuropathies, wounds or amputations in the lower extremity, or auditory disorders. Prior to the commencement of the study, informed consent was obtained from all participants, ensuring they were aware that their information would be used solely for research purposes.

The main tool used to measure pain in diabetic neuropathy patients was the Visual Analogue Scale (VAS) (19). Additionally, a comprehensive data collection tool was developed, comprising demographic data of each participant, results of the monofilament test as a screening measure, and the VAS for pain assessment. Post-consent, the participants were divided into two groups: Group A (experimental) and Group B (control). Group A received Pain Neuroscience Education in conjunction with Conventional Therapy, which included Transcutaneous Electrical Nerve Stimulation (TENS), stretching, and strengthening exercises. Group B, serving as the control, received only the Conventional Therapy. The intensity of pain was initially measured using the VAS as a baseline before starting the intervention, with a follow-up assessment conducted after six weeks at the end of the intervention.

Pain Neuroscience Education sessions were conducted twice weekly for a duration of six weeks, each session lasting one hour, and were administered by the same physiotherapist. These sessions incorporated hand drawings and educational booklets as teaching aids. The Conventional Therapy comprised High-Frequency TENS with a 100Hz frequency, adjustable pulse width of 200-400 microseconds, and a duration of 20 minutes per session. The intensity of the TENS stimulus was gradually increased to a level recognizable by the patient but without causing discomfort. Additionally, the therapy included strengthening exercises such as stair climbing, with 2-4 repetitions, and stretching exercises (static stretch with a 30-second hold), performed in 1-3 sets on alternative days of the week for the six-week period.

Ethical considerations were paramount throughout the trial. The research protocol, including data collection methods, was approved by a university ethics committee. All participants remained anonymous, and the information provided was used exclusively for the purposes of this research. Participants were informed about the nature of the study and assured that there were no associated risks with the interventions. This transparency and ethical rigor ensured the integrity of the research process and the protection of participant rights.

RESULTS

The results of the Normality Test, specifically the Shapiro-Wilk test, were used to assess the distribution of the pre-treatment Visual Analogue Scale (VAS) scores for both the treatment and control groups. For the treatment group, the Shapiro-Wilk statistic was 0.952 with a significance (Sig.) value of 0.550, and for the control group, the statistic was 0.933 with a Sig. value of 0.307. These significance values, being greater than 0.05, indicate that the VAS scores were normally distributed for both groups prior to the intervention.

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In terms of the outcome variables measured, the pre-treatment VAS scores for the treatment group had a mean of 57.00 and a standard deviation of 16.77583. The control group had a slightly lower pre-treatment mean VAS score of 56.2667 with a standard deviation of 15.91705. The t-test comparing these pre-treatment scores yielded a T-value of 0.123 with a mean difference of 0.733 and a P-value of 0.903. This high P-value suggests no significant difference in the initial pain levels between the two groups before the intervention.

However, the post-treatment VAS scores revealed a significant change. The treatment group showed a substantial decrease in pain, with a post-treatment mean VAS score of 19.6667 and a standard deviation of 6.39940. In contrast, the control group had a post-treatment mean VAS score of 45.3333 with a standard deviation of 14.81634.

Table 1 Normality Test

Normality Test				
Pre-Visual Analogue Scale score	Groups	Shapiro-Wilk		
		Statistic	Df	Sig.
	Treatment	.952	15	.550
	Control	.933	15	.307

The t-test for these post-treatment scores yielded a T-value of 6.159, indicating a significant mean difference of 25.66 in the VAS scores between the two groups. The P-value for this test was 0.000, denoting a highly significant reduction in pain levels in the treatment group as compared to the control group following the intervention.

Table 2 Mean Comparison using Independent Samples t Test

Outcome Variables	Groups	N	Mean	Standard Deviation	t	Mean Difference	P Value
Pre-Visual Analogue Scale score	Treatment	15	57.0000	16.77583	0.123	0.733	0.903
	Control	15	56.2667	15.91705			
Post-Visual Analogue Scale score	Treatment	15	19.6667	6.39940	6.159	25.66	0.000
	Control	15	45.3333	14.81634			

These results suggest that the intervention, which combined Pain Neuroscience Education with conventional therapy, was significantly more effective in reducing pain levels among participants as measured by the VAS, compared to the control group that received only conventional therapy.

DISCUSSION

The conducted research provided novel insights into the effectiveness of Pain Neuroscience Education (PNE) as a part of a comprehensive intervention for diabetic neuropathy pain. The study's primary objectives were to implement high-quality, evidence-based pain management strategies, assess changes in pain knowledge before and after PNE using the updated Neurophysiology of Pain Questionnaire, and evaluate the impact of the PNE program on participants' perceptions of pain and its influence on their quality of life (QOL) using both quantitative and qualitative measures (20).

The research revealed that neurophysiology education led to a stabilization of pain attitudes and beliefs, a reduction in catastrophizing, and an enhancement in physical performance. The Visual Analogue Scale (VAS) for pain intensity indicated that participants receiving PNE in conjunction with conventional therapy experienced a significant reduction in pain, alongside an improvement in QOL. This supports the notion that PNE has immediate effects on various clinical indicators and symptoms associated with central sensitization.

For the educational component, high-quality, evidence-based materials including hand drawings and booklets were specifically designed. The quantitative results demonstrated an improved understanding of fundamental neurobiological concepts among participants, while the qualitative data revealed a positive shift in pain reconceptualization. This reconceptualization involved understanding that pain is not solely an indicator of tissue injury, but is also influenced by physical, psychological, and social factors. Furthermore, chronic pain becomes a less reliable indicator of tissue state over time. The qualitative findings highlighted the role of the brain, emotions, and thoughts in pain production, indicating that participants had grasped these key concepts. There was also a notable improvement in functional ability and sense of control in managing pain, aligning with the project's goals.

Pain narratives, the personal stories people create around their pain, are shaped by individual beliefs and values. The PNE program aimed to encourage participants to reevaluate their pain narratives and consider healthier, more positive interpretations. The study's results showed that PNE led to significantly higher pain pressure thresholds and increased pain-free movement performance, demonstrating that learning about pain physiology can be beneficial.

The combination of Pain Neuroscience Education and conventional therapy proved effective in reducing pain levels from severe to mild according to the VAS. This reduction in pain correspondingly decreased impairments in quality of life, enabling participants to perform daily activities more easily. PNE's goal is to educate patients to differentiate between pain and tissue damage, challenging the notion that physical therapy addresses only fictional tissue diseases (21). This study re-evaluates the effectiveness of manual therapy combined with PNE and controlled physical activity, advocating for a balanced approach in treating chronic musculoskeletal pain (22).

Despite the positive outcomes, the study had potential limitations. The duration of the interventions and follow-up sessions may not have been sufficient to observe long-term effects. Patients with chronic pain often present with comorbidities, which could influence their response to the treatments (23). The choice of individual over group sessions was made based on patient convenience, but this leaves open the question of the efficacy of group interventions. Additionally, the study did not employ tools to assess neuroplastic and structural changes in the brain, which could be an avenue for future research using techniques such as resting state functional magnetic resonance imaging (fMRI) and diffusion-weighted magnetic resonance imaging (dMRI) (24).

CONCLUSION

In conclusion, the study supports the growing body of evidence that PNE is beneficial in the treatment of diabetic neuropathy pain. It advocates for a comprehensive approach that combines physical therapy with PNE, emphasizing the importance of a well-balanced intervention strategy in managing chronic pain associated with diabetic neuropathy.

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