Effect of Neural Mobilization on Pain Intensity in Patients with Cubital Tunnel Syndrome.

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KEYWORDS

Cubital tunnel syndrome, Unar Neuropathy and Visual Analogue Scale.

ABSTRACT

Background: Ulnar nerve neuropathies are among the most frequently encountered entrapment neuropathies affecting the upper extremities. Cubital tunnel syndrome often presents with symptoms such as numbness, tingling, or discomfort in the ring and small fingers, as well as the dorsoulnar region of the hand. The best approach for managing cubital tunnel syndrome remains a topic of ongoing debate.**Objective**: This study aimed to evaluate the impact of neural mobilization (NM) on pain intensity in individuals with cubital tunnel syndrome. **Methods**: This research utilized a randomized controlled trial design. Sixty participants, aged 30–50 years, with mild to moderate unilateral cubital tunnel syndrome, were randomly assigned to either a study group or a control group. The control group underwent conventional physical therapy alone, while the study group received both conventional physical therapy and neural mobilization. The interventions were carried out three times weekly over a four-week period. Pain intensity was assessed using the Visual Analogue Scale (VAS). **Results**: After four weeks of treatment, a significant difference in pain reduction was observed between the groups, with the neural mobilization group showing greater improvement ($p < 0.001$). The VAS mean ± standard deviation (M ± SD) scores were 75.67 ± 7.55 mm for the control group and 32.27 ± 3.08 mm for the study group ($p < 0.001$).**Conclusions**: Neural mobilization demonstrated superior effectiveness in alleviating pain compared to conventional physical therapy alone in patients with cubital tunnel syndrome. These findings support the inclusion of neural mobilization as a complementary treatment for nerve entrapment disorders. Additional research is recommended to explore its long-term outcomes and broader clinical applications

Introduction

Cubital tunnel syndrome (CuTS), also referred to as ulnar neuropathy at the elbow, is a common and often debilitating condition involving the compression or irritation of the ulnar nerve as it passes through the cubital tunnel at the elbow (Anderson et al., 2022). The incidence of CuTS is estimated to range from 21 to 24 cases per 100,000 individuals annually, affecting approximately 2–6% of the general population (An et al., 2017; Cambon-Binder, 2021). Understanding various treatment approaches for CuTS is essential for healthcare professionals, researchers, and patients (Nee & Butler, 2006; Anderson et al., 2022). The ulnar nerve plays a crucial role in upper limb function by providing sensory and motor innervation to the forearm and hand. When compromised, the nerve's entrapment can lead to symptoms such as numbness, tingling in the ring and small fingers, muscle weakness in the hand, and pain along the medial aspect of the elbow (Chauhan et al., 2023).

Pain is among the most commonly reported symptoms in CuTS, manifesting in various forms. Patients often describe discomfort localized to the inner elbow, radiating pain down the forearm into the hand, or localized tenderness at the site of nerve compression (Staples & Calfee, 2017). Pain intensity can vary, often worsening during activities that place additional strain on the ulnar nerve. CuTS-induced muscle weakness and altered sensation may result in clumsiness, leading to unintentional dropping of objects or difficulties with precise hand movements (Kooner et al., 2019; Sharrak & Das, 2023). Treatment often includes medications such as nonsteroidal anti-inflammatory drugs (NSAIDs) and corticosteroids to manage inflammation and pain. NSAIDs provide short-term symptom relief, while corticosteroid injections can reduce swelling and alleviate discomfort, though their effects are generally transient (Ghlichloo & Gerriets, 2023).

Neural mobilization (NM) has emerged as an effective physical therapy approach to optimize the dynamic balance of entrapped nerves within their surrounding mechanical environments, thus enhancing physiological function (Solanki & Samuel, 2015; Graf et al., 2022). Nerve gliding exercises, integral to NM, are frequently included in rehabilitation programs to promote the mobility and health of affected nerves. These exercises aim to prevent adhesions, enhance nerve functionality, and reduce the risk of compression. By gently mobilizing the ulnar nerve, physical therapists can support healing and recovery (Coppieters & Nee, 2015; Ballestero-Pérez et al., 2017).

Despite increasing interest in neural mobilization for managing musculoskeletal conditions, there remains a paucity of literature focusing specifically on its effectiveness for cubital tunnel syndrome. Existing studies tend to emphasize other neuropathies, with methodological variability and inconsistent findings limiting the ability to draw definitive conclusions about the role of NM in CuTS. Consequently, this study aims to investigate the effect of neural mobilization on pain intensity in patients diagnosed with cubital tunnel syndrome.

Material and methods:

Design of the study

This study was a prospective, pre-post-test randomized controlled trial conducted from February 2022 to August 2022 at the outpatient clinics of the Physical Therapy Department, Police Academy Hospital, Cairo, Egypt. Participants were informed about the study's objectives, potential benefits, and their right to withdraw at any time. Confidentiality of their data was ensured, and informed written consent was obtained before participation. The study adhered to CONSORT guidelines.

Participants:

Patients referred to physical therapy were screened for eligibility based on the following inclusion criteria: diagnosis and referral by an orthopedist, age between 30–50 years, body mass index (BMI) <34.9 kg/m², unilateral mild-to-moderate cubital tunnel syndrome (CuTS) confirmed by recent electromyography (EMG) findings (sensory nerve conduction velocity <40 m/sec and motor distal latency >4.2 msec). Exclusion criteria included cervical brachialgia, metabolic diseases such as diabetes or severe thyroid disorders, anemia, pregnancy, hypertension, previous hand or elbow surgeries (e.g., carpal tunnel release), corticosteroid injections, and proximal median nerve involvement (e.g., thoracic outlet syndrome).

Sample size calculation:

The sample size for this randomized controlled trial was calculated using G*Power version 3.1.9.7**,** based on a two-tailed t-test for two independent groups. The effect size was determined using the minimal clinically important difference (MCID) for pain intensity on the Visual Analogue Scale (VAS), set at 20 mm, with an effect size (Cohen's d) of 0.78. The power (1-β) was set at 0.80 (80%) to reduce the risk of a Type II error, and the significance level (α) was set at 0.05 (5%). An allocation ratio of 1:1 was applied to ensure equal group sizes. Using these parameters, the minimum required sample size was calculated as 54 participants (27 per group). To account for a potential 10% dropout rate, the total sample size was adjusted to 60 participants, with 30 participants in each group.

Randomization

Sixty participants with unilateral, mild and moderate CuTS were randomized into either the study group or the control group using a computer-generated randomization sequence. To balance the allocation and maintain equal group sizes throughout the study, a block randomization method was implemented. Blocks of varying sizes (e.g., 4, 6, and 8) were used to further prevent predictability of allocation. The randomization sequence, including the block sizes and group assignments, was generated by an independent statistician who was not involved in the recruitment, intervention, or outcome assessment. To ensure allocation concealment and minimize selection bias, the group assignments were placed in sequentially numbered, opaque, sealed envelopes.

Intervention:

All group participants received the conventional physical therapy program, three days a week for four weeks. The program included therapeutic ultrasound therapy session, transcutaneous electrical nerve stimulation, and individualized therapeutic exercise protocol (**Oskay et al., 2010).** The therapeutic ultrasound (Chattanooga Ultrasound Therapy unit ‘a FDA approved) was applied with 1 MHz (frequency), 1 W/cm^2 (intensity), for four minutes, three sessions a week for four weeks. Transcutaneous Electrical Nerve Stimulation:(Chattanooga Electrotherapy device ‘a FDA approved’) was applied with 8 Hz (frequency), 60 µs (pulse duration), at level of comfortable tingling sensation for twenty minutes, three sessions a week for four weeks.

The traditional therapeutic exercise program conducted three times a week for four weeks. The program focused on strengthening exercises aimed at improving upper limb function and reducing symptoms associated with cubital tunnel syndrome. Participants were educated about the purpose and procedures of the therapeutic strengthening exercises prior to initiation to ensure comprehension and adherence to the protocol. The exercise regimen included a combination of closed kinetic chain strengthening exercises using dumbbells and a Swiss ball. These exercises were designed to target the muscles supporting the elbow and forearm, enhancing stability and reducing mechanical stress on the ulnar nerve. Dumbbell exercises involved controlled movements that emphasized elbow flexion and extension, as well as forearm pronation and supination, with sustained holds to promote endurance and control. Swiss ball exercises incorporated dynamic stabilization, where participants gently engaged the upper limb while maintaining weight-bearing pressure on the ball to enhance proprioception and neuromuscular coordination(**Oskay et al., 2010)**. Participants were carefully monitored during each session to ensure the exercises were performed correctly and within their pain tolerance. Instructions emphasized avoiding any significant discomfort, worsening of numbness, or pain during or after the exercises. Adjustments were made as necessary to accommodate individual symptoms and functional limitations.

The intervention group received conventional physical therapy modalities first, followed immediately by neural mobilization (NM), performed three times a week for a total of four weeks. Each participant informed in simple terms about the purpose and procedures. The specific technique used in this study was based on the protocol described by **Oskay et al.,** (2010**)** and involves a series of controlled movements aimed at improving the glide and mobility of the ulnar nerve. For each session, participants were positioned in a supine position with the affected arm extended. The fourth author(M. T. M. H) performed the neural mobilization technique first, by doing wrist extension with forearm supinated followed by full-range elbow flexion. Then, the author depressed participant targeted shoulder girdle, then moved it into lateral abduction with lateral rotation. The participants` hand maintained above participants` ear in the final position with fingers pointing backwards to enhance ulnar nerve gliding that aims to restore neural tissue mobility. The therapist then guided the patient's arm into progressive movements that gently stretch and release tension along the nerve pathway, alternating between nerve tension and relaxation phases. Each movement was performed slowly and carefully to avoid any discomfort or injury, with the goal of restoring full mobility without exacerbating symptoms.The neural mobilization was done in a rhythmic and controlled manner, with each cycle lasting about 2 minutes, followed by a 30-second rest. The treating author monitored the patient’s pain level throughout the session using the Visual Analogue Scale to ensure that the technique was performed within the patient's tolerance and did not exacerbate symptoms. The mobilization was continued for 10–15 minutes per session depending on the patient's tolerance.

Outcome Measure

The demographic characteristics of participants such as age, gender, height, weight, body mass index, and affected side were recorded at the baseline. The primary outcome measure used in this study was the Visual Analogue Scale (VAS) to assess pain intensity level. The VAS is a widely recognized and validated tool for measuring subjective pain levels, providing a simple and effective method for participants to rate their pain on a 100-mm horizontal line, with endpoints indicating "no pain" and "worst imaginable pain." The VAS has been extensively studied and demonstrated to have excellent reliability, with intraclass correlation coefficients (ICCs) ranging from 0.97 to 0.99 in various populations, ensuring consistent results across repeated measures. Its validity has been confirmed through strong correlations with other pain assessment tools, such as the McGill Pain Questionnaire, making it a robust choice for clinical and research settings. The scale's sensitivity to detect clinically significant changes in pain levels further supports its use, particularly in studies evaluating interventions aimed at reducing pain (**Koziej et al., 2018)**. In this study, the VAS was administered at baseline and after four weeks of intervention to quantify the effect of neural mobilization and traditional therapeutic exercise on pain reduction.

Statistical Analysis

Data analysis was performed using SPSS version 25(IBM Corp., Armonk, NY, USA). Normality was assessed using the Shapiro-Wilk test. Descriptive statistics (mean ± SD for continuous variables, frequencies for categorical variables) were used. Baseline differences were assessed with independent t-tests for continuous variables and chi-square tests for categorical variables. Post-intervention VAS scores were compared between groups using independent samples t-tests, while within-group changes were analyzed using paired samples t-tests. Missing data were handled using the last observation carried forward (LOCF) method, and an intention-to-treat approach was applied. Statistical significance was set at $p < 0.05$.

For the primary outcome (pain intensity measured by the Visual Analogue Scale), an independent samples t-test was used to compare post-intervention pain levels between the neural mobilization group and the control group. Within-group changes from baseline to post-intervention were analyzed using the paired samples t-test. Statistical significance was set at $p < 0.05$, and all tests were two-tailed. Data were presented with 95% confidence intervals to provide additional context for the results. Missing data were handled using the last observation carried forward (LOCF) method to maintain the integrity of the sample size. The statistical procedures followed the principles of intention-to-treat analysis to ensure robustness of the findings.

Results:

The flowchart of the study was presented in Figure 1. The data in Tables (1) showed no statistically significant difference among three groups in demographic characteristics of participants ($p > 0.5$). The data in Tables (2) showed between and within group differences in pain scores at baseline and after 4 weeks of intervention.

The baseline characteristics of participants were comparable between the study and control groups, as there was no statistically significant difference in pre-treatment pain levels measured by the Visual Analogue Scale (VAS) ($p = 0.63$). The mean VAS scores at baseline were 81.73 ± 2.77 mm for the study group and 81.27 ± 4.45 mm for the control group, with a mean difference (MD) of -0.47 mm (95% CI: -2.38 to 1.45) and a t-value of -0.49.

After four weeks of intervention, the study group, which received neural mobilization in addition to conventional therapy, showed a significant reduction in pain intensity compared to the control group, which received only conventional therapy. The post-treatment mean VAS score was significantly lower in the study group (32.27 ± 3.08 mm) compared to the control group (75.67 ± 7.55 mm), with a between-group MD of 43.4 mm (95% CI: 40.42 to 46.38; $p < 0.001$) and a t-value of 29.14.

Within-group analysis revealed a significant reduction in VAS scores in both groups after the intervention. The study group showed a mean reduction of 49.47 mm (95% CI: 47.89 to 51.04; $t = 64.27$; $p < 0.001$), while the control group demonstrated a smaller mean reduction of 5.6 mm (95% CI: 3.68 to 7.52; $t = 5.97$; $p < 0.001$).

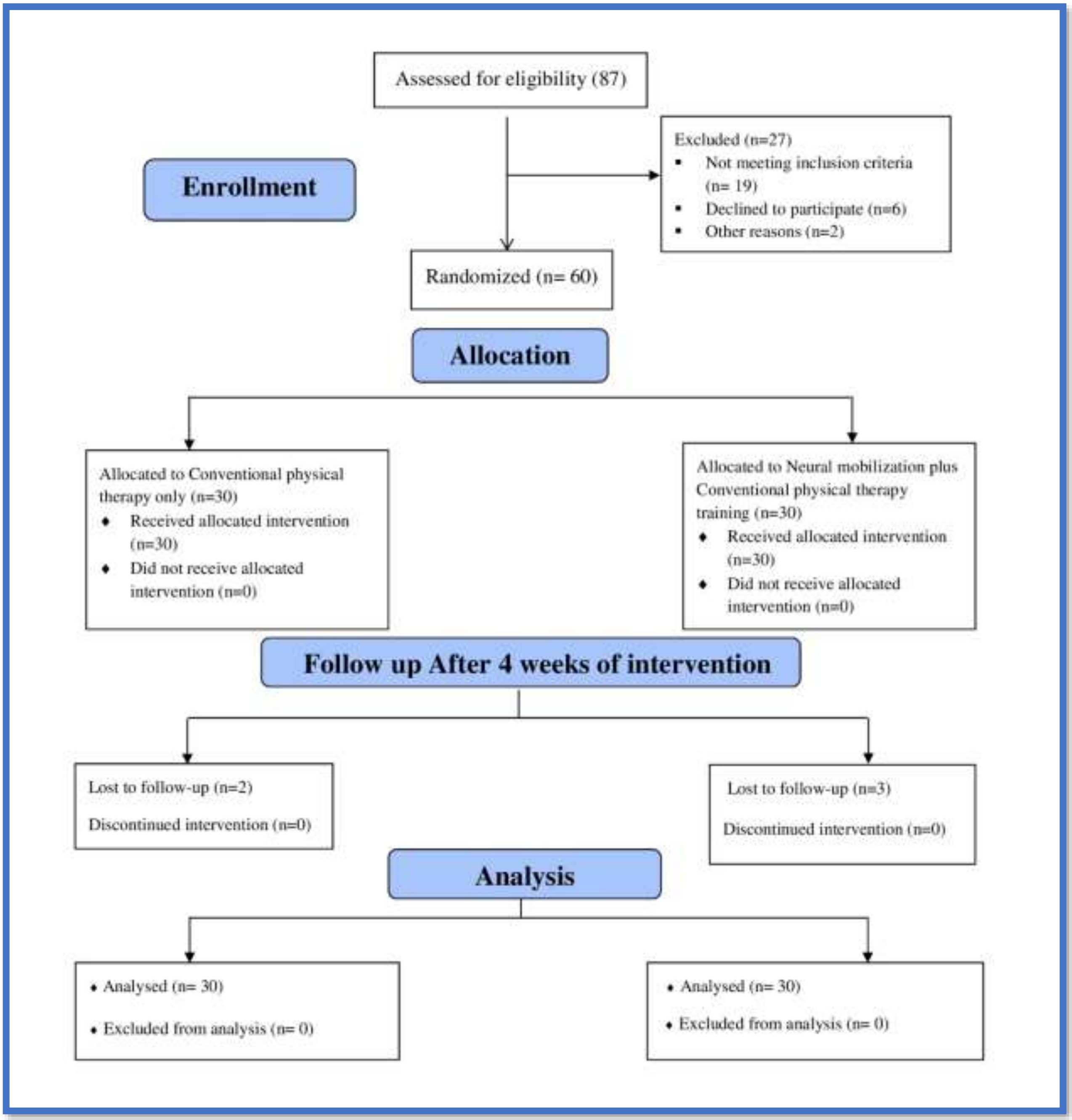

Figure 1: Flow chart of the study

Table 1: Demographic characteristics of subjects (N= 60)*

Characteristics	**Control Group (n=30)**	**Study Group (n=30)**	**P-value**
Age (years)	39.70 ± 5.08	40.37 ± 4.39	0.14
Weight (kg)	74.12 ± 6.65	75.62 ± 4.51	0.54
Height (cm)	165.43 ± 3.48	167.03 ± 3.17	0.18
BMI (kg/m²)	27.08 ± 2.38	27.12 ± 1.65	0.99
Affected Side, n (%)			
Left	21(70%)	20(67%)	0.76
Right	9(30%)	10(33%)	
Sex, n (%)			
Male	14 (47%)	15 (50%)	0.73
Female	16 (53%)	15 (50%)	

BMI, body mass index; * Data are mean± SD for all demographics except non- parametric data for sex and affected side; (%), P-Value < 0.05 indicate statistical significance.

Table 2: Within and between group analysis for Pain at baseline and after 4 weeks of intervention.

Variables	**Control Group (n=30)**	**Study Group (n=30)**	**MD (95% CI)**	**t-value (between-group)**	**P-value (between groups)**
VAS (mm)					
Pre-treatment	81.27 ± 4.45	81.73 ± 2.77	-0.47 (-2.38, 1.45)	-0.49	0.63
Post-treatment	75.67 ± 7.55	32.27 ± 3.08	43.4 (40.42, 46.38)	29.14	0.001
MD (95% CI)	5.6 (3.68, 7.52)	49.47 (47.89,51.04)			
t-value(within-group)	5.97	64.27			
P-value (within-group)	0.001	0.001			

VAS: Visual Analogue Scale; p: probability, MD: mean difference; CI: confidence interval. * Data are mean± SD, P-Value < 0.05 indicate statistical significance

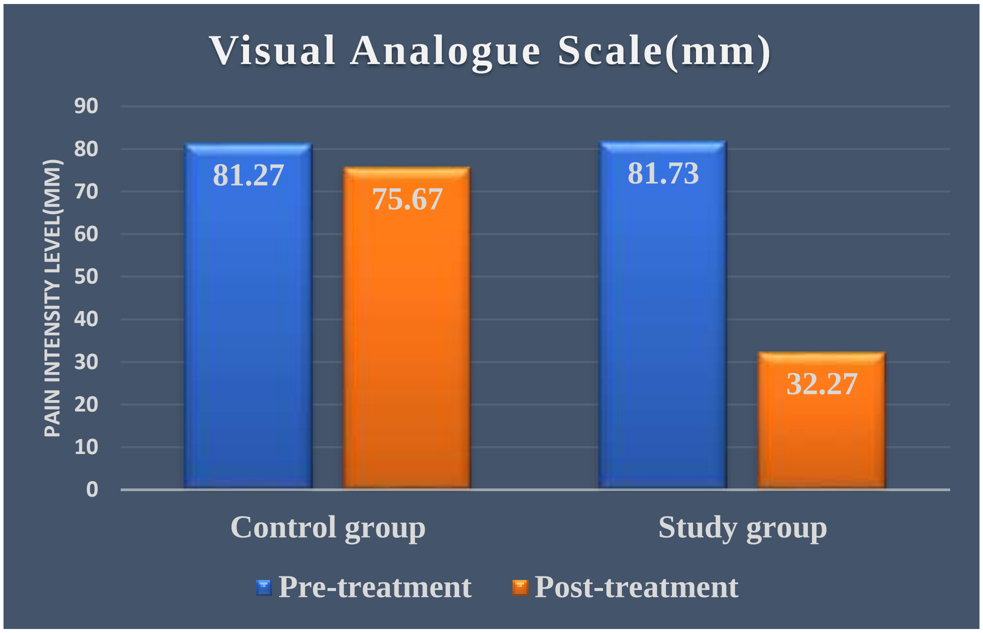

Figure 2. Mean values for both groups at baseline and after 4 weeks of intervention

Discussion

The main finding of this study is that neural mobilization, when combined with conventional physical therapy, significantly reduces pain intensity in patients with mild to moderate cubital tunnel syndrome compared to conventional therapy alone. After four weeks of intervention, the study group demonstrated a substantial reduction in pain levels, as measured by the Visual Analogue Scale (VAS), with a mean decrease of 49.47 mm. In contrast, the control group, which only received conventional therapy, showed a much smaller reduction of 5.6 mm. These results suggest that neural mobilization can be an effective adjunctive treatment for improving pain outcomes in patients with cubital tunnel syndrome, providing further support for its use in clinical practice.

The findings of this study align with previous research indicating the benefits of nerve-gliding techniques in the conservative treatment of cubital tunnel syndrome (CuTS). Coppieters et al. (2004) reported that incorporating nerve-gliding techniques can be advantageous in managing CuTS, suggesting that movement-based interventions may enhance patient outcomes. Similarly, Oskay et al. (2010) found that neurodynamic mobilization, including sliding and tensioning techniques, significantly improved the condition of patients with mild to moderate symptoms of CuTS. These techniques aim to enhance the gliding and mobility of the ulnar nerve, which plays a crucial role in reducing pain and restoring function, with long-term positive results.

The concept of nerve gliding is crucial in formulating effective treatment plans for CuTS. Kleinrensink et al. (1995) discussed that nerve gliding involves applying tension at one point of the nerve while releasing it at another, facilitating movement within the nerve and between the nerve and surrounding tissues. This approach can reduce intraneural edema and improve neural function.

Additionally, Cleland et al. (2006) demonstrated positive outcomes in pain reduction and functional improvement in patients with chronic low back pain through a combination of mobilization and exercise, supporting the efficacy of movement-based therapies in neuropathic conditions. Kavlak and Uygur (2011) also reported favorable results using nerve mobilization techniques in patients with carpal tunnel syndrome, noting improvements in pain, range of motion, and sensory function.

In contrast, a systematic review by Ellis and Hing (2008) found limited evidence supporting the therapeutic efficacy of neural mobilization for upper quadrant conditions, including CuTS. The authors noted that while some studies reported benefits, the overall quality and consistency of the evidence were lacking. Additionally, another systematic review and meta-analysis by Basson et al. (2017) found that two studies reported no added benefit when using neural mobilization in addition to usual care for post-lumbar surgery and cubital tunnel syndrome. This suggests that neural mobilization may not provide additional advantages over standard care in certain conditions. However, the athors reported that due to the limited evidence and varying methodological quality, conclusions may change over time.

Furtheremore, a systematic review of Wolny wt al,(2022) evaluated the effects of physiotherapy in the conservative treatment of CuTS. The review concluded that there is limited evidence to support the effectiveness of physiotherapy interventions, including neural mobilization, in treating CuTS. The authors emphasized the need for high-quality randomized controlled trials to establish the efficacy of these treatments.

Limitations

This study has several limitations. First, the sample size was relatively small, which may limit the generalizability of the findings to a broader population. Second, the study only assessed short-term outcomes, and the long-term effects of neural mobilization on pain and functional recovery were not evaluated. Third, the lack of blinding for participants and therapists could introduce performance and measurement bias, potentially influencing the results. Additionally, the study focused solely on pain intensity as the primary outcome, without examining other important factors such as nerve conduction, grip strength, or functional performance. Future studies with larger sample sizes, longer follow-up periods, and more comprehensive outcome measures are recommended to validate these findings and address these limitations.

Clinical Implications

The findings of this study suggest that neural mobilization is an effective adjunctive treatment for reducing pain intensity in patients cubital tunnel syndrome. Incorporating neural mobilization into standard physical therapy programs could enhance pain relief and improve patient outcomes, making it a valuable option in clinical practice. This technique offers a non-invasive, low-risk intervention that can be easily implemented by trained therapists to address the symptoms of nerve entrapment syndromes. By reducing pain and potentially improving nerve mobility, neural mobilization may contribute to a faster recovery and improved quality of life for patients. These results encourage clinicians to consider neural mobilization as part of a multimodal approach to managing cubital tunnel syndrome.

Conclusion

Neural mobilization combined with conventional physical therapy significantly reduced pain intensity in patients with mild to moderate cubital tunnel syndrome compared to conventional therapy alone. This study highlights the efficacy of neural mobilization as an adjunctive treatment for managing pain associated with nerve entrapment conditions. Further research is needed to investigate its long-term effects and broader clinical applications.

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Declaration of Conflicting Interests

The authors declare that there are no potential conflicts of interest regarding the research, authorship, or publication of this article.

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