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Effect of neurodynamic mobilization techniques in patients with diabetic neuropathy

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ABSTRACT
Purpose. Neurodynamic mobilization is a set of passive or active movements aimed at restoring the neural system's ability to bear the normal compressive, friction, and tensile stresses encountered in daily life. This study aimed to investigate the effect of neurodynamic mobilization on sensory and motor nerve conduction studies, pain, and functional activity in patients with type 2 diabetic neuropathy (DN).
Methods. A total of 42 patients were randomly assigned to the neurodynamic mobilization group (NMG) or selected therapy program group (STPG). Electrophysiological measurements for median sensory and tibial motor nerve conduction velocity, and functional activity were conducted using the Katz Index of Independence, while pain was evaluated using the visual analogue scale.
Results. Improvement was noted in the post-treatment median sensory ($p = 0.002$) and tibial motor ($p < 0.001$) nerve conduction velocity, functional activity ($p < 0.001$), and pain ($p < 0.001$), and a statistically significant difference was demonstrated for the NMG, but not for the STPG.
Conclusions. Neurodynamic mobilization improved the sensory and motor nerve conduction velocity, functional activity, and pain in patients with type 2 DN.
Key words: neurodynamic technique, sensory nerve conduction study, motor nerve conduction study, functional outcome, diabetic polyneuropathy

Introduction

More than a quarter of people with type 2 diabetes mellitus (T2DM) in 14 countries may develop diabetic neuropathy (DN) according to recent research. Diabetes duration disrupted glycaemic control, history of cardiovascular disease, depressive symptoms, and hypertension were the most significant risk factors for T2DM-related DN [1]. In people with T2DM, even strict glycaemic control cannot adequately prevent neuropathy [2].

Diabetes symptoms may appear quickly or gradually over time (in overweight adults over the age of 40 years). The typical signs and symptoms include fatigue and sickness, frequent urination, thirst, hunger, and weight loss. Other signs of high blood sugar include irritation, disorientation, headache, shaky hands, tingling in the fingers or tongue, buzzing in the ears, elevated pulse, unusual hunger, and clumsiness. Additionally, men manifest erectile dysfunction, as well as blurred vision, visual spots, double vision, visual hallucinations, lack of coordination, weakness, and abrupt awakenings from sleep. There is also rapid and shallow breathing, anxiety, faintness, cold clammy skin, restlessness, insomnia, pallor, nausea, and tremors [3].

The nervous system's ability to endure the typical compressive, friction, and tensile pressures associated with daily activities is restored by neural tissue mobilisation procedures, often known as 'neurodynamic techniques'. These neurodynamic approaches may im-

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prove the intraneural circulation, axoplasmic flow, and neural connective tissue viscoelasticity and reduce the sensitivity of aberrant impulse-producing sites in the dorsal root ganglion, according to researchers [4].

Two types of neurodynamic treatments include tensioner and slider procedures. Tensioner procedures preserve the neural tissue's physical abilities to allow movements that lengthen the nerve bed. Slider approaches allow non-provocative sliding movement between the neural regions and nearby non-neural tissues [5].

Neural mobilisation is crucial to restore the nervous system's flexibility and mobility and to support the resumption of normal functioning [6–7]. The treatment involves moving or tensing the nervous system, which lowers the inherent pressure of the neural tissue, which can restore neural biomechanics such as elasticity and axoplasmic flow, allowing the brain to endure normal compressive, tensile, and friction forces and pain from daily activities [8–9].

Thus, the present study is designed to investigate the efficacy of neurodynamic mobilization for sensory and motor nerve conduction velocity studies, pain, and functional activity in patients with type 2 DN. The hypothesis of the current study suggested that there was no statistically significant effect of neurodynamic mobilization on sensorimotor nerve conduction studies, pain, and functional activity in patients with type 2 DN.

Material and methods

Setting, study population, and sampling

Forty-two DN patients were selected by a neurologist from various hospitals in Cairo, Giza, on October 6th. The participants' characteristics and criteria are presented in the results. Participants (males and females) diagnosed with T2DM for ≥10 years determined by electrophysiological measurements were enrolled [10]. The participants regularly took their diabetes medications during the assessment and treatment period. Moreover, the use of any sedatives or anticonvulsants was contraindicated for all participants. The exclusion criteria were as follows: uncontrolled T2DM or diagnosed with T2DM for < 10 years [11]; neural, muscular, or skeletal system deformities; radiculopathy; and psychiatric disorders. G-power 3.1 was used for the prior analysis of this study using the multivariate analysis of variance (MANOVA) option. The recommended sample size is 21 patients for each group, with a total of 42 patients [12].

Study flow chart

As presented in Figure 1.

Design of the study

This study is a double-blind, randomised controlled trial (RCT) (participants were evaluated by the same investigator pre- and post-treatment). Neither the participants nor the investigators were instructed regarding the allocation of the groups. Participants were randomly allocated through a secure system of opaque, closed envelopes and divided into the neurodynamic mobilization group (NMG) or selected therapy program group (STPG).

Procedure and instrumentations

Assessment

A physician performed the neurophysiological measurements for both the median sensory and tibial motor nerve conduction velocity studies. A device model was applied for the study (Nihon Kohen, Japan, MEB-9200/9300). Tibial motor nerve conduction velocity studies were performed by placing an active electrode on the abductor hallucis brevis muscle. Stimulating electrodes were placed in two locations (ankle and popliteal fossa), with an earth electrode placed between the stimulator cathode and the active pickup electrode, and a reference electrode was placed over the big toe's metatarsal-phalangeal joint. The median sensory nerve conduction study was accomplished by placing a stimulator at the level of the wrist, an active electrode on the second finger, and an earth electrode placed between the stimulator and active electrodes [13]. Pain was assessed via the visual analogue scale (a score of '0' indicates no pain and a score of '10' indicates extreme pain [14]), which has good validity and test-retest reliability between 0.95 and 0.97 [15]. Katz Index of Independence was used to examine functional activity (a score of 6 indicates full function, 4 indicates moderate impairment, and 2 or less indicates many functional impairments [16]); reliability was established with 12 subjects interviewed by one interviewer with a second-rater present, but not participating in the interview process. Inter-rater reliability was established at 0.85. The validity was tested by determining the correlation of the Katz Index of Independence with four scales that measured domains of functional status, physical classification, the Mental Status Questionnaire, and the Behavior and Adjustment rating scales [16].

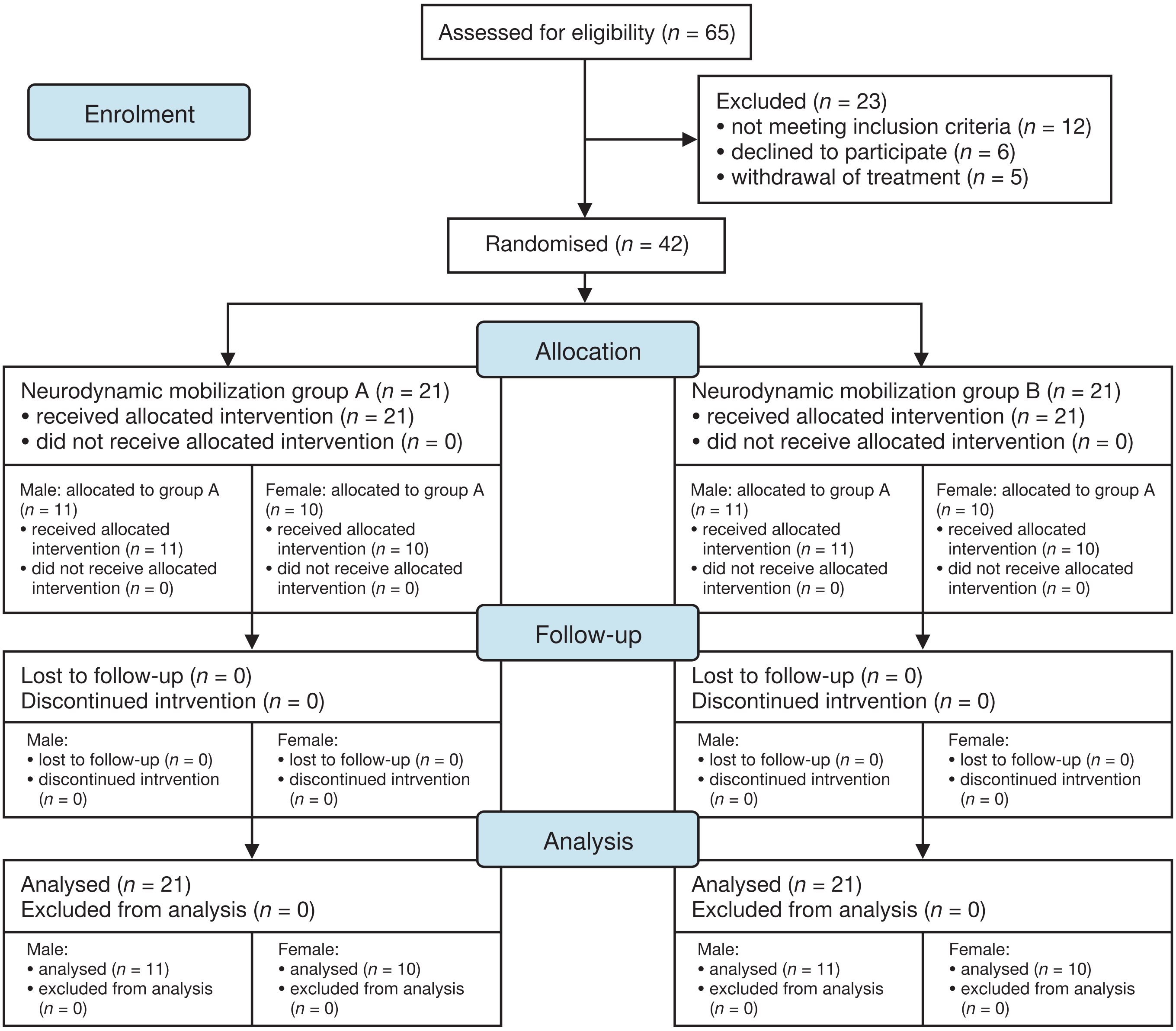

Figure 1. Participant flow chart

Intervention

NMG

The NMG received three sessions per week for 4 weeks, with each session lasting for 30 min. The slider neurodynamic technique for the median nerve is conducted as follows: in a sitting or standing position, with the patient's back supported, ask the patient to actively move, starting from the neck side bending to the opposite side, followed by shoulder abduction and external rotation and elbow and wrist extension to the same position, except for the neck side bending to the same side reciprocally with a wrist flexion position. The tensioner neurodynamic technique for the median nerve is conducted as follows: in a sitting or standing position, with the patient's back supported, ask the patient to actively move the neck in a neutral position followed by shoulder abduction and external rotation and elbow and wrist extension to the same position, except for the neck side bending to the opposite side. The slider neurodynamic technique for the tibial nerve is conducted as follows: in a slump position with the patient's back supported, ask the patient to actively move, starting from the neck followed by trunk flexion, knee flexion, and ankle plantar flexion to a position of neck and trunk extension, knee extension, and ankle dorsiflexion. The tensioner neurodynamic technique for the tibial nerve is conducted as follows: in a slump position with the patient's back supported, ask the patient to actively move, starting from the neck followed by trunk extension, knee flexion, and ankle plantar flexion to a position of neck and trunk extension, knee flexion, and ankle dorsiflexion. In the selected therapy program, the following were included: graduated active range of motion exercises for both UL and LL joints and graduated gait training, which were also added in the NMG.

STPG

The participants only received a selected therapy program similar to the NMG with no change in duration.

Outcome measures

The outcome measures include demonstrating the efficacy of neurodynamic mobilization for sensory and motor nerve conduction studies, pain, and functional activity in T2DM patients with DN.

Data analysis and collection

SPSS version 25 was used for the data analysis, using mean and median values, and then the Kolmogorov–Smirnov and Shapiro–Wilk tests. The primary data were analysed using descriptive statistics and the t-test. MANOVA was used to analyse the sensory and motor conduction velocity, pain, and functional activity, with statistical significance set at $p < 0.05$. Bonferroni's post hoc test was used for the pairwise comparisons among the study groups.

Ethical approval

The research related to human use has complied with all the relevant national regulations and institutional policies, has followed the tenets of the Declaration of Helsinki, and has been approved by the Physical Therapy Research Ethical Committee in Cairo University (approval No.: P.T.REC/012/003496 on 5/12/2021). Clinical Trial Registration: NCT05628168.

Informed consent

Informed consent has been obtained from all individuals included in this study.

Results

A total of 65 patients were screened for the study; 23 patients were excluded because they failed to meet the criteria. Forty-two participants were randomly assigned to either the NMG (n = 21) or STPG (n = 21). The results show that there was no significant difference in the general characteristics between both groups, as shown in Table 1.

Sensory and motor nerve conduction velocity parameters

Before the treatment plan, no statistically significant difference was observed for the NMG compared with the STPG ($p = 0.64$) for the median sensory ($p = 0.18$) or for the tibial motor nerves, as shown in Table 2.

The NMG presented a significant enhancement for median sensory and tibial motor nerve conduction velocity in comparison with the STPG. Moreover, significant differences were found for both groups post-treatment for median sensory ($p = 0.002$) and tibial motor nerve ($p < 0.001$) conduction, as presented in Table 2.

Visual analogue scale (pain)

Regarding pain severity, an improvement (decrease) in pain severity was demonstrated in the NMG over the STPG with a statistically significant difference ($p < 0.001$), as shown in Table 2.

Table 1. Patients' general characteristics

General characteristics	NMG (n = 21)	STPG (n = 21)	*MD*	*p*-value
	Mean ± *SD*	Mean ± *SD*		
Age (years)	52.72 ± 4	51.14 ± 4.92	1.58	0.26
Weight (kg)	67.95 ± 2.77	67.67 ± 2.74	0.28	0.703
Height (cm)	1.71 ± 0.02	1.71 ± 0.02	0	1
BMI (kg/m²)	23.2 ± 1.04	23.14 ± 1.08	0.06	0.86
General characteristics (sex)	NMG (n = 21)	STPG (n = 21)	χ^2 value	*p*-value
Female	10 (48%)	10 (48%)	0	1
Male	11 (52%)	11 (52%)	0	1

NMG – neurodynamic mobilization group, STPG – selected therapy program group, BMI – body mass index, *MD* – mean difference, *p*-value – probability value ($p < 0.05$) to be a significant result

Table 2. Comparison of VAS, sensory and motor conduction velocity, and Katz index between groups

Variables	NMG (n = 21) Mean ± *SD*	NMG (n = 21) *MD*	% change	STPG (n = 21) Mean ± *SD*	STPG (n = 21) *MD*	% change	p-value
VAS		5	71.43		0	0	
Pre-	7 ± 1.14			7 ± 1.14			1
Post-	2 ± 1.14			7 ± 1.14			< 0.001
MSN-NCV (m/s)		–6.64	16.97		–0.25	0.63	
Pre-	39.12 ± 5.61			39.95 ± 5.89			0.64
Post-	45.76 ± 5.08			40.2 ± 5.79			0.002
TMN-NCV (m/s)		–4.19	11.2		–0.2	0.52	
Pre-	37.42 ± 2.49			38.48 ± 2.54			0.18
Post-	41.61 ± 1.51			38.68 ± 2.59			< 0.001
Katz index		–2.1	72.41		–0.1	3	
Pre-	3 ± 1.14			3 ± 1.14			1
Post-	5 ± 1.14			3.1 ± 1			< 0.001

NMG – neurodynamic mobilization group, STPG – selected therapy program group, VAS – Visual Analogue Scale, MSN-NCV – median sensory nerve NCV, TMN-NCV – tibial motor nerve NCV, NCV – nerve conduction velocity, *MD* – mean difference, p-value – probability value ($p < 0.05$) to be a significant result

Katz index (functional activity)

The final data results presented a significant enhancement in functional activity in the NMG compared to the second group ($p < 0.001$), as presented in Table 2.

Discussion

This study aimed to investigate the effect of neurodynamic mobilization on sensorimotor nerve conduction studies, pain, and functional activity in patients with type 2 DN.

This study found that treating DN patients with NM for 4 weeks improves the sensorimotor nerve conduction study parameters, pain, and functional activity, all of which focus on improving nerve function. The underlying mechanisms of the improvement in sensorimotor nerve conduction study parameters, pain, and functional activity, as well as a possible explanation for this, were a refinement of the mechanical movement of neural tissues and non-neural structures surrounding the nervous system. This mobilisation causes a variety of mechanical and physiological responses in nervous tissues, as well as pain relief [17].

Tensioner and slider neurodynamic mobilization techniques were deemed to be more efficacious than selected therapy program treatment for improving nerve ability, relieving pain, and increasing functional activity.

Pressure on the nerve causes edema and hypoxia after nerve root compression, which compromises the microcirculation. Neurodynamic mobilization consists of short, sustained movements that are effective in dispersing edema and reducing hypoxia to reduce the associated symptoms and dysfunctions [5].

The current findings corroborate previous studies reviewed by [18] and [19], who showed that neural mobilisation techniques can reduce the radiating symptoms better than traditional physical therapy treatment.

The findings of the study were approved by [20], who reported that the efficacy of neurodynamic techniques showed improvement in the sensory and motor conduction studies of the median nerve, including reduced pain severity and improved functional status.

This study is a double-blind RCT on the efficacy of neurodynamic mobilization on the sensorimotor nerve conduction velocity, pain, and functional activity in DN patients, which is the strength of the present study. Therefore, neurodynamic mobilization is shown to be a useful, effective, and non-invasive approach in the treatment of DN patients.

Limitations

The present study was limited by some patients' fear of falling, refusal to be transported to different locations during assessment and treatment, differences in the patients' lifestyles and educational levels, and differences in motivation between all patients.

Conclusions

Neurodynamic mobilization can be regarded as a non-invasive method of improving sensory and motor parameters, pain, and functional activity in diabetic patients with polyneuropathy. The current study's team hopes that in the future, all physical therapy programs for DN patients will include neurodynamic mobilization due to its efficacy in DN.

Clinical implication

The research will shed light on the visibility of improved nerve functions in patients with type 2 DN.

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Disclosure statement

No author has any financial interest or received any financial benefit from this research.

Conflict of interest

The authors state no conflict of interest.

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