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The Effect of Neural Mobilization on Muscle Strength, Reaction Time and Pain Threshold

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ABSTRACT:
Purpose: This study's objective was to assess the effectiveness of neural mobilization on asymptomatic, healthy volunteers' pain, muscle strength, and reaction time.
Material and Methods: Handgrip strength, reaction time, and pain thresholds of 50 participants' were evaluated using a dynamometer, the Nelson Hand Reaction Test, and a digital algometer, respectively. While the dominant extremities of the participants constituted the neural mobilization group, the non-dominant extremities constituted the control group. The same measurements were repeated in both extremities by the blinded assessor after median nerve mobilization was applied to the dominant upper extremities of participants.
Results: When the measurements before and after mobilization were compared in the neural mobilization group, it was seen that the handgrip strength increased ($p<0.01$) and the reaction time decreased ($p<0.001$) after mobilization; The differences in pain threshold score were not statistically significant ($p> 0.05$). There was no statistically significant difference in handgrip strength between the control group before and after neural mobilization ($p> 0.05$); however, a statistically significant decrease was found in reaction time and pain threshold score ($p <0.05$). There was no statistically significant difference between the groups in parameters before and after mobilization ($p> 0.05$).
Conclusion: Neural mobilization may increase grip strength in healthy individuals but has no effect on pain threshold. Its effect on reaction time can be explained by motor learning. New studies are needed in different disease groups.
Keywords: *Neural mobilisation, Muscle strength, Reaction time, Pain threshold*

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INTRODUCTION

The nerve function is altered in entrapment neuropathies as a result of mechanical or dynamic compression. Anatomical restrictions at specific areas lead to nerve entrapment disorders. Anatomical places where the nerve passes through fibro-osseous or fibromuscular tunnels or penetrates a muscle are at risk for nerve entrapment disorders (Meyer et al., 2018). Besides the most common carpal tunnel syndrome, thoracic outlet syndrome, tarsal tunnel syndrome, and cubital tunnel syndrome are also common entrapment neuropathies. Surgical procedures or conservative treatments like resting splints, anti-inflammatory drugs, steroid injection, physiotherapy, manual therapy, and mobilization approaches are recommended in the literature as treatment options (Alam et al., 2018; Ballestero-Perez et al., 2017). Recently, several studies have reported the use of neurodynamic mobilization as a conservative treatment option (Bassoon et al., 2019; Plaza-Manzano et al., 2020). The more comprehensive term “neurodynamics” was suggested by Shacklock in 1995 (Kostopoulos, 2004). The integrated biomechanical, physiological, and morphological functions of the nervous system are now referred to by this term, which has gained wider acceptance. If the nervous system is presenting neurodynamic harmony, this indicates that mechanical and physiological properties are normal and in accordance with each other (Plaza-Manzano et al., 2020; Valente et al., 2014. Neural mobilization is a component of manual therapy utilized for a variety of diseases, including pain, lateral epicondylitis, cubital tunnel syndrome, carpal tunnel syndrome, tarsal tunnel syndrome and osteoartrtithis (Beneciuk et al., 2009; Kim et al., 2016; Yılmaz et al., 2022; Oskay et al., 2010, Ballestero-Perez et al., 2017; Leblebicier et al.,2022; González-Matilla et al., 2022). Through the positioning and movement of numerous joints, neurodynamic treatments are a type of manual therapy that target the neurological structures (Villafañe et al., 2012). Neural mobilization involves raising the nervous system's tension through specific postures, then moving slowly and rhythmically to target the spinal cord and peripheral nerves for better nerve impulse conduction (Valente et al., 2014).

Neurodynamic procedures can be applied in two ways: sliding and tensioning. The movements of at least two joints are alternately combined to form sliding techniques. One movement loads the peripheral nerve, increasing the nerve's tension, while the second action unloads the nerve at the same time, lowering tension (Villafañe et al., 2017; Villafañe et al., 2012). The study's use of tensioning procedures, which entail elongating the space between either end of the nerve bed, is thought to be more forceful than sliding approaches (Beneciuk et al., 2009). Since nerves are viscoelastic structures, they may react to mobilization techniques and treatments similar to those of the musculoskeletal system, with the goal of reestablishing the natural movement of neural tissue and reducing such inappropriate neural tensions (Kostopoulos, 2004). Nerve mobilization techniques are performed to reduce nerve mechanosensitivity and increase the compliance of nerve tissues by increasing neural flexibility (Kim, Cha and Ji, 2016). Nerve mobilization improves axonal transport and nerve conduction via this mechanism. Mobilization of a nerve may help lower internal pressure, which might then increase the nerve's ability to receive blood (Alam et al., 2018; Wang et al., 2015). Several studies in the literature have investigated the effects of neural mobilization on pain. It has been shown to reduce pain when used in compression syndromes, particularly in carpal tunnel syndrome (Beddaa et al., 2022) However, few studies have investigated the effects of neural mobilization on muscle strength; we did not encounter any studies on reaction time in asymptomatic, healthy subjects.

MATERIAL and METHODS

Purpose and Type of the Study

The aim of this study; to investigate the effect of neural mobilization on pain, muscle strength and reaction time. This study was an experimental, prospective study.

Sampling and Participant

Asymptomatic, healthy volunteers aged 18-25 years were included in the study. In order to demonstrate the isolated effect of neural mobilization, healthy asymptomatic subjects were selected considering the analgesic effect of physiotherapy applications and pain medication use in diagnosed individuals. Persons who had any neuromusculoskeletal pathology in their upper extremities, had pain in the neck and upper extremities and were using analgesic drugs were excluded from the study. All participants were informed before the study and written informed consent was obtained from all of them. After the first assessment of subjects, neural mobilization was applied to the dominant extremity. Assessments were repeated subsequent to mobilization. The control group consisted of the non-dominant extremities of each subject to which mobilization was not applied. All assessments were made by the same physiotherapist (BK) who had no knowledge of the groups.

Data Collection Tools

After participants' sociodemographic data were recorded on the assessment form during face-to-face interview, handgrip strength, reaction time, and pain threshold were evaluated using a dynamometer, the Nelson Hand Reaction Test, and a digital algometer, respectively.

Handgrip strength: Assessment was conducted by physiotherapist and repeated three times with a 1-minute break between each; the arithmetic mean was recorded. Measurement was made with the participant sitting comfortably in the chair, with the arm close to the trunk, the elbow flexed to 90º, and the forearm in the mid-position. Data were recorded in kilograms and the device (Baseline Hydraulic Hand Dynamometer 300 LB) was calibrated before and after each measurement.

Reaction time: Reaction time was evaluated using the Nelson Hand Reaction Test. Participants' reaction time was evaluated while sitting in a chair with the forearm placed comfortably on the table. The thumb and index fingertips were positioned in parallel and 8–10 cm outside the table. A physiotherapist held the test ruler between subjects' thumb and index fingers and asked subjects to look directly to the midpoint of the ruler and to catch the ruler with the thumb and index fingers when the ruler was released. When the subject caught the ruler, the line at the top edge of the thumb was read and recorded. This measurement was repeated five times and the average was recorded (Aranha et al., 2017; Eckner et al., 2009).

Pain threshold: Pain threshold was defined as the amount of minimal pressure that turns the pressure sensation into pain (Nussbaum and Downes, 1998; Ylinen, 2007). Pain threshold was evaluated using an algometer (Jtech Commander, USA) over the supinator muscle. The device is a digital pain threshold and consists of a sensor connected to a 1-cm diameter rigid tip. The measurements were repeated three times at intervals of 30 seconds and the average was recorded.

Median nerve mobilization technique: The median nerve mobilization technique was applied as upper extremity neural mobilization. The subject was positioned on their back with the dominant extremity placed at 90° abduction of shoulder and 90° flexion of elbow. A physiotherapist (NG) performed shoulder elevation, elbow supination, wrist extension and ulnar deviation while holding the subject's hand by their web interval and supporting the elbow with their other hand. The participant was asked to turn their head to the opposite side and the stretching effect was increased while applying this technique. The mobilization was terminated by waiting 3 seconds at the last point, and the same process was repeated three times (Kim et al., 2016; Nunes et al., 2016). The neural mobilization technique was always applied by the same physiotherapist (NG) who trained in manual therapy. The measurements of pain threshold, handgrip strength, and reaction time were repeated immediately following application of the neural mobilization technique.

Statistical Analysis

SPSS version 21 (SPSS IBM) was used for statistical analyzes. Statistical significance was assessed at a 95% confidence interval and $p < 0.05$. One-sample Kolmogorov-Smirnov tests and histograms were used to determine whether data were normally distributed. Since data were found to be normally distributed, analysis of data before and after neural mobilization was carried out using paired t-tests. Independent-samples t-tests were used to compare pre- and post-treatment data between groups.

Ethical Approval

Ethical approval for the study was granted by the Marmara University Health Sciences Institute Ethical Ethics Committee (28.03.2016-26).

RESULTS

The sample consisted of 50 subjects (female = 28, male = 22) with an average age of 20.96 (± 1.27) years. Average height was 168.96 ± 7.42 cm and average bodyweight was 64.18 ± 11.43 kg (Table 1).

Comparison of measurements pre- and post-mobilization indicated that handgrip strength was increased ($p<0.01$) and reaction time was decreased after mobilization ($p<0.001$); whereas differences in pain threshold score were not statistically significant ($p>0.05$). In the control group, there was no statistically significant difference between handgrip strength pre- and post-neural mobilization ($p> 0.05$); however, a statistically significant difference was detected in reaction time and pain threshold score ($p<0.05$) (Table 2).

There were no statistically significant differences between groups at pre- or postmobilization parameters ($p> 0.05$) (Table 3).

Table 1. Participant demographic data

	N	Min.	Max.	Mean±SD
Age (year)	50	19	25	20.96±1.27
Height (cm)	50	157	185	168.96±7.42
Weight (kg)	50	44	90	64.18±11.43

Min: minimum, Max: maximum, SD: standard deviation

Table 2. Comparison of data at pre- and post- mobilization between groups (n = 50)

Neural Mobilisation Group	**Mean±SD**	***t***	***p***
Handgrip strength (kg)- before	31.25±10.48	-2.82	**.07**
Handgrip strength (kg) - after	32.32±10.77		
Nelson hand reaction test (cm)-before	17.69±5.31	4.25	**.000**
Nelson hand reaction test (cm)- after	14.99±5.45		
Algometer (kg/cm²)- before	22.59±9.66	0.17	0.86
Algometer (kg/cm²)-after	22.36±11.77		
Control Group	**Mean±SD**	***t***	***p***
Handgrip strength (kg)- before	28.87±9.19	-0.92	.358
Handgrip strength (kg) - after	29.21±9.72		
Nelson hand reaction test (cm)-before	18.01±4.58	3.85	**.000**
Nelson hand reaction test (cm)- after	15.59±35.6		
Algometer (kg/cm²)- before	20.84±9.45	-2.41	0.019
Algometer (kg/cm²)-after	23.74±13.41		

t: paired t test

Table 3. Comparison of pre- and post- mobilization data between groups (n = 50)

		Group	**Mean±SD**	***t***	***p***
Before	**Handgrip strength (kg)**	Neural Mob.	31.25±10.48	1,0.	0.230
		Control	2887±9.19		
	Nelson hand reaction (cm)	Neural Mob.	17.69±5.31	-0.325	0.746
		Control	18.01±4.58		
	Algometer (kg/cm²)	Neural Mob.	22.59±9.66	0.915	0.363
		Control	20.84±9.45		
After	**Handgrip strength (kg)**	Neural Mob.	32.2±10.77	1.52	0.132
		Control	29.21±9.72		
	Nelson hand reaction (cm)	Neural Mob.	14.99±5.45	-0.649	0.518
		Control	15.59±3.56		
	Algometer (kg/cm²)	Neural Mob.	22.36±11.77	-0.547	0.586
		Control	23.74±13.41		

t: t-test in independent groups

DISCUSSION

This study was conducted to investigate the immediate effects of neural mobilization on pain threshold, handgrip strength, and reaction time in healthy subjects. Measuring the value of an individual's sensation during algometric assessment as the change in the pressure sensation to a pain sensation in kg/cm^2 allows the objective assessment of pain, which is an otherwise subjective experience. Pain pressure threshold was assessed by algometer in this study. Examination of the literature revealed that some studies used the threshold of vibration perception or thermal perception as a criterion for the sense of pain (Beneciuk et al., 2009; Kumar et al. 2010); however, some studies have assessed the pain threshold with an algometer-as was the case in the present study (Lalouni et al., 2021; de Dios Perez-Bruzon et al., 2022). Studies that selected subjects with similar pathologies have found that the pain decreased with the application of neural mobilization (Pedersini et al., 2021; Peacock et al., 2022); whereas in studies with healthy cases, the results of neural mobilization on pain varied from effective to ineffective (Beneciuk et al., 2009; Nunes et al., 2017; Sousa Filho et al., 2017). Kumar et al. suggested that the efficacy mechanism of neural mobilization on pain might be caused by firing afferent kinesthetic impulses with motion components during neural mobilization. However, this effect is minimized by the presence of a sham-controlled group, and the authors recommended investigation of the role of cognitive-perceptual and placebo effects (Kumar et al., 2010). Beneciuk et al. looked into how thermal pain sensitivity was affected by upper extremity neural mobilization. The findings revealed that whereas A delta fiber-mediated pain perception was not affected by neural mobilization employing a tensioning approach, C fiber-mediated pain perception (temporal summation) was immediately hypoalgesic (Beneciuk et al., 2009). Patients with painful diseases have increased temporal summation of C fiber-mediated pain compared to healthy controls. Inhibiting temporal summation is therefore thought to have therapeutic benefits (Beneciuk et al., 2009). Despite these findings, the fact that there was no difference between groups in the pain threshold variable was attributed to our cases being asymptomatic. The number of sessions of neural mobilization is assumed to be another factor; other studies showing therapeutic effects of neural mobilization have conducted multiple sessions in contrast to our one-session studies (Jeong et al., 2016, Peacock et al., 2022). We believe that the stimulated central structures send impulses in increasing intensity and frequency to the alpha motor neurons, which is believed to result in more frequent firing of the motor unit, and thus more muscle fiber contraction as an effect mechanism of neural mobilization on muscle strength. That is, this increase may be a result of increased spinal reflex response to nociceptive stimulation (Hartley et al., 2015). According to some researchers, this reaction to muscle is also produced as a defense mechanism to prevent nerve damage. This notion is supported by trials in which people who were asymptomatic underwent increased muscular activity during neural testing (Gupta and Chahal, 2021). After mobilization, there was no obvious change in reaction times between the two groups, despite a discernible difference between pre- and post-mobilization in both the control group and the neural mobilization group. The repeated repetitions of the Nelson Hand Reaction Time test to get the average value may have had a learning impact on both groups, causing an increase in reaction time. To our knowledge, this result does not coincide with any other studies in the literature that have investigated the effects of neural mobilization on reaction time.

One of the limitations of our study is that we investigated the effects of neural mobilization after only one session. Unlike the present study design, Kumar et al. investigated the effects of neural gliding and massage on vibration, heat, and cold perception thresholds in patients with painful diabetic peripheral neuropathy While they found a statistically significant difference between pre- and immediately post- and pre- and 15 minutes postneural gliding and massage, they did not find any difference between immediately post- and 15 minutes post-treatment (Kumar et al., 2010) Although the literature includes more single-session efficacy studies after neural mobilization, there have also been follow-up studies conducted in different time periods (Pereira et al., 2021; Ballestero-Perez et al., 2017; Basson et al., 2019; Plaza-Manzano et al., 2020). One of these studies, published by Oskay et al., examined seven individuals with cubital tunnel syndrome. After 12-month follow-up, there was a significant change in parameters between the evaluations pre- and 12 months post-treatment, but it was also reported that the difference was significant only in some parameters between immediately post-treatment and 12 months post-treatment (Oskay et al., 2010). A second limitation of our study is that the sample consisted of asymptomatic, healthy individuals. Although this can be viewed as a limitation, it can also be considered a strength. To put forward the effects of neural mobilization on muscle strength and reaction time in healthy subjects will be a guide as a protective protocol to prevent injuries. Future studies with larger sample sizes may lead to the consideration of neural mobilization as a treatment option, resulting in effective treatment outcomes. Although many studies in the literature examined the effects of neural mobilization on pain and muscle strength (Cuenca-Martinez et al., 2022; Souza et al., 2020; Sharma et al., 2016) there has been no investigation of its effect on reaction time.

Moreover, although some studies have investigated the effects of neural mobilization on healthy subjects, there has been limited study on its use as a therapeutic neurodynamic approach in symptomatic situations in which nerve mechanosensitivity has changed (Huang et al., 2015). As a result, as a continuation of this preliminary research on healthy cases, we plan to evaluate the effect of neural mobilization on reaction time in pathological conditions.

Studies examining the effects of neural mobilization on handgrip strength are very few and there are no studies on the effect of reaction time. As such, our research is unique and makes clinical contributions to the field of neuromusculoskeletal physiotherapy. Furthermore, while some studies have investigated neural mobilization in different pathologies, there are no specific protocols that describe the time, duration, or frequency of neural mobilizations. This gap in the evidence base suggests the need for multidisciplinary studies on this subject and its clinical significance.

CONCLUSION

Neural mobilization may increase grip strength in healthy individuals but has no effect on pain threshold. Its effect on reaction time can be explained by motor learning. New studies are needed in different disease groups.

Conflict of Interest

There is no conflict of interest, according to the authors

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