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RESEARCH ARTICLE

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An Investigation of The Acute Effect of Self and Physiotherapist-Performed Upper Extremity Neural Mobilization on Reaction Time in Healthy Young Adults

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ABSTRACT

Purpose: This study was planned to investigate the acute effect of neural mobilization on reaction time in healthy young adults.

Methods: A total of 120 university students with a mean age of 21.75±2.2 years were included in the study. The subjects were divided into four groups; self-mobilization (Group 1), self-placebo mobilization (Group 2), mobilization by physiotherapist (Group 3), and placebo mobilization by physiotherapist (Group 4) in which ulnar, median, and radial nerve mobilizations were applied. SWAY mobile application was used to evaluate the reaction time. Ulnar, median and radial nerve mobilizations were applied to the dominant upper extremities of the participants with 5 repetitions of 5 seconds each. Measurements were taken before and immediately after mobilization with the SWAY mobile application.

Results: It was determined that the demographic characteristics and measured reaction time of each group were similar at the beginning and the difference between the groups was not statistically significant ($p>0.05$). In the measurements made after the applications, it was seen that neural mobilization did not cause a statistically significant change on the reaction time in the self-mobilization, self-placebo mobilization and mobilization by a physiotherapist groups ($p>0.05$), and there was a statistically significant difference in the placebo mobilization group by a physiotherapist. ($p<0.05$).

Discussions: it was found that neural mobilization caused a decrease in reaction time in the short term, but this change was statistically significant only in the placebo mobilization group performed by the physiotherapist, and it was thought that it may be due to the effect of static stretching on reaction time, as it has been the subject of some studies in the literature. It was thought that further studies were needed for more definitive results regarding the effect of upper extremity neural mobilization on reaction time.

Key Words: Young Adult; Reaction Time, Mobilization; Placebo Effect.

INTRODUCTION

Neural mobilization (NM) is a practice used for the manual treatment of soft tissue, neural tissue, and tissues surrounding the nervous system (1). NM is one of the manual methods that aims to create a balance between the connected movements of neural tissues and surrounding structures, allowing the internal pressure of the neural tissue to decrease and thus regulating physiological functions (1), ensuring the continuation of normal physiological functions of nerve cells (2). Many studies (3-6) have successfully used neural mobilization to increase flexibility or create different amounts of neural mobility in both healthy individuals (4) and clinical populations (5). A reaction is a purposeful, voluntary response to an external stimulus (7). Reaction time is the total time it takes an individual to observe an external stimulus, decode this information, make an appropriate decision, and initiate a motor activity in response to the stimulus (8), and is not a movement related to a specific action (9). Since the signal can be related to any sensory system (sight, hearing, or touch) (9), it requires an intact sensory system, cognitive processing, and motor performance (7). It is a good indicator of an individual's sensorimotor coordination and performance and determines their alertness (7). It is important in people with diabetes or osteoporosis (10), in people with intellectual disabilities, hearing loss, or visual impairment (11), in preventing falls, and in daily activities such as participating in sports, driving, and in emergencies (12). Reaction time assessment has long been used to assess cognitive, neurological, and motor function and provides information about the neurocognitive and functional health of the individual (12).

The SWAY mobile application, which Burghart et al. proved its validity and reliability in 2019, is a United States Food and Drug Administration (FDA)-approved application developed to assess balance using the integrated three-axis accelerometers of mobile devices (13). In addition to balance tests, neurocognitive tests in this mobile application evaluate reaction time, stimulus control, observation time, and memory (14).

In the literature, no study was found that similarly investigated the effect of neural mobilization on reaction time in the upper extremity.

Therefore, this study aimed to investigate whether self or physiotherapist-administered mobilizations involving the upper extremity nerves would affect reaction time in healthy young individuals.

METHODS

Study Design

The interventions were conducted in the practice clinic of the Department of Physiotherapy and Rehabilitation of SANKO University between 12:30 and 1:30 pm when the students were on their lunch break. All of the participants were seated/placed on the treatment beds in the laboratory.

With the personal data collection form, the participant's age, gender, height, body weight, dominant side, department and class of study, regular sports habits, surgical history, and neurological-orthopedic disorders that may concern the upper extremity were asked and the answers obtained, the Chalder Questionnaire results and the SWAY Mobile application results were also recorded on the form.

The Chalder fatigue questionnaire is an easy, quick, and useful scale that evaluates the fatigue felt by the individual in the last 1 month by self-report. It consists of 11 items in total. The individual was asked to answer the statements using the phrases less than usual, as usual, more than usual, and much more than usual. The first two columns (less than usual, as much as usual) were scored as "0" and the last two columns (more than usual, much more than usual) were scored as "1". Individuals with a total score of 4 and above were considered tired (15).

When we look at the studies evaluating reaction time, computer systems were frequently used, but it is mentioned that there were unavoidable delays during the measurement. Systems developed to overcome this have their methods for recording data and transferring the analysis of the results to the computer; the disadvantages of these systems are the need for additional specialized hardware, manual data transfer, and organization, which can lead to data loss or corruption due to human error (16). The fact that mobile applications are frequently used in the field of health in parallel with technological developments has been the main reason for the use of the SWAY mobile application in this study. In addition, this application has many advantages such as minimizing the human error rate, ease of use and accessibility, providing test results as numerical values, no data loss due to saving the data, and easy access to the desired data.

Ulnar, median, and radial nerve mobilizations were applied to the participants in each group for 5 repetitions (17, 18) and each repetition was continued for 5 seconds (19). Ardıç stated in his review "Exercise Prescription" that for effective static muscle stretching, stretching should be continued for at least 15 seconds and at most 60 seconds (20). In the study, since the aim during the applications was to mobilize the nerve, not to stretch the muscle, the applications were applied for 5 seconds to prevent the placebo applications from affecting the results by revealing the muscle stretching effect.

Tables 1. Age, height, body weight and BMI distribution of the groups.

	Group 1 X ± SD	Min-Max	Group 2 X ± SD	Min-Max	Group 3 X ± SD	Min-Max	Group 4 X ± SD	Min-Max	p
Age (year)	22.4±2.5	18-28	21.47±1.9	18-27	21.62±2.2	19-30	21.53±2.1	18-28	0.265
Height (cm)	168.7±7.4	157-190	166.4±8.0	155-190	165±7.4	151-181	168.6±7.9	150-185	0.129
Body Weight (kg)	65.3±14.2	40-97	61±11.2	45-95	59±12.3	44-98	64.5±10.6	44-85	0.086*
BMI (kg/m^2)	22.8±4.1	16-32	21.8±2.4	17-26	21.5±3.6	16-33	22.5±2.8	17-28	0.415

*p<0.05 is statistically significant, X mean, SD: Standard Deviation, Group 1: Self-administered mobilization, Group 2: Self-administered placebo mobilization, Group 3: Mobilization by physiotherapist, Group 4: Placebo mobilization by physiotherapist

Participants in Group 1 and Group 2 self-administered the mobilizations in the sitting position under the supervision of a physiotherapist as previously shown. Participants in Group 3 and Group 4 underwent mobilization in the supine position by a physiotherapist. Reaction times of all participants before and immediately after mobilization were assessed with the SWAY mobile application. Participants were seated in a comfortable and upright position while holding the phone with both hands and reading the instructions on the screen. The researcher verified that each participant understood the instructions on the screen and demonstrated the appropriate shaking motion (13). Participants held the phone horizontally and were asked to shake the phone as fast as possible when the screen color changed from white to orange (21). Each test block consisted of five trials (13). The test was initiated by the system after a variable delay of 2-4 seconds to prevent participants from anticipating the stimulus. Participants completed a total of five trials. The fastest and slowest trial response times were excluded by the system to remove outliers and better capture the typical response times of the person being assessed (21). Following these exceptions, the values from the remaining three trials were averaged to calculate the test score. Each subject completed four test blocks with the first test block being a trial (4 test blocks x 5 trials), the trial block was excluded by the system and the remaining three test blocks were averaged (13).

Subjects

For the study conducted in the practice clinic of Sanko University, Department of Physiotherapy and Rehabilitation. Participants were randomized into 4 groups using the minimization method. For the minimization method, the male/female ratio and the values of younger than 20 years of age/ 20 years of age and older were equalized in the groups. The groups were formed as self-mobilization (Group 1), self-placebo mobilization (Group 2), mobilization by a physiotherapist (Group 3), and placebo mobilization by a physiotherapist (Group 4) groups according to the mobilization methods to be performed on the participants. Ethics committee permission was obtained from the Sanko University Non-Interventional Clinical Studies Ethics Committee for the study with the decision numbered 2022/10 session and 12 on 12.10.2022. The study was conducted between December 2022 and May 2023. The study was conducted in accordance with the Principles of the Declaration of Helsinki. All volunteers were informed about the study protocol and signed an informed consent form before participating in data collection.

Tables 2. Gender, dominant side distribution of the groups.

	Gender		Dominant side	
	Female n (%)	Male n (%)	Left n (%)	Right n (%)
Group 1	25 (83.3)	5 (27.6)	6 (20)	24 (80)
Group 2	25 (83.3)	5 (27.6)	3 (10)	27 (90)
Group 3	25 (83.3)	5 (27.6)	2 (6.7)	28 (93.3)
Group 4	25 (83.3)	5 (27.6)	3 (10)	27 (90)

Group 1: Self-mobilization, Group 2: Self-administered placebo mobilization, Group 3: Mobilization by physiotherapist, Group 4: Placebo mobilization by physiotherapist

Voluntary individuals over the age of 18, studying at SANKO University, who scored below 4 on the Chalder Fatigue Questionnaire and were determined not to be tired were included in the study. Those who had undergone a surgical operation involving the shoulder, arm, forearm, or hand in the last 6 months, those who had any neurological or orthopedic problem that would prevent them from performing the tests, those who were involved in regular sports activities requiring the use of upper extremities were excluded. None of the students who participated in our study were professionally or regularly involved in a sportive activity.

Intervention Protocol

The interventions were conducted in the practice clinic of the Department of Physiotherapy and Rehabilitation of SANKO University between 12:30 and 1:30 pm when the students were on their lunch break. All of the participants were seated/placed on the treatment beds in the laboratory.

With the personal data collection form, the participant's age, gender, height, body weight, dominant side, department and class of study, regular sports habits, surgical history, and neurological-orthopedic disorders that may concern the upper extremity were asked and the answers obtained, the Chalder Questionnaire results and the SWAY Mobile application results were also recorded on the form.

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When we look at the studies evaluating reaction time, computer systems were frequently used, but it is mentioned that there were unavoidable delays during the measurement. Systems developed to overcome this have their methods for recording data and transferring the analysis of the results to the computer; the disadvantages of these systems are the need for additional specialized hardware, manual data transfer, and organization, which can lead to data loss or corruption due to human error (16). The fact that mobile applications are frequently used in the field of health in parallel with technological developments has been the main reason for the use of the SWAY mobile application in this study. In addition, this application has many advantages such as minimizing the human error rate, ease of use and accessibility, providing test results as numerical values, no data loss due to saving the data, and easy access to the desired data.

Ulnar, median, and radial nerve mobilizations were applied to the participants in each group for 5 repetitions (17, 18) and each repetition was continued for 5 seconds (19). Ardıç stated in his review “Exercise Prescription” that for effective static muscle stretching, stretching should be continued for at least 15 seconds and at most 60 seconds (20). In the study, since the aim during the applications was to mobilize the nerve, not to stretch the muscle, the applications were applied for 5 seconds to prevent the placebo applications from affecting the results by revealing the muscle stretching effect.

Participants in Group 1 and Group 2 self-administered the mobilizations in the sitting position under the supervision of a physiotherapist as previously shown. Participants in Group 3 and Group 4 underwent mobilization in the supine position by a physiotherapist.

Tables 3. Reaction time measurement results according to gender.

		Female (n=100) X ± SD	Male(n=20) X ± SD	U	p
Reaction time (ms)	**PreM**	261.942±67.8	238.89±44.7	-1.074	0.283
	PostM	246.953±54.9	227.655±44.9	-1.282	0.200

*p<0.05 is statistically significant, X; mean, SD; Standard Deviation, U; Mann-Whitney U Test, PreM; Pre-mobilization, PostM; Post-mobilization.

Reaction times of all participants before and immediately after mobilization were assessed with the SWAY mobile application. Participants were seated in a comfortable and upright position while holding the phone with both hands and read the instructions on the screen. The researcher verified that each participant understood the instructions on the screen and demonstrated the appropriate shaking motion (13). Participants held the phone horizontally and were asked to shake the phone as fast as possible when the screen color changed from white to orange (21). Each test block consisted of five trials (13). The test was initiated by the system after a variable delay of 2-4 seconds to prevent participants from anticipating the stimulus. Participants completed a total of five trials. The fastest and slowest trial response times were excluded by the system to remove outliers and better capture the typical response times of the person being assessed (21). Following these exceptions, the values from the remaining three trials were averaged to calculate the test score. Each subject completed four test blocks with the first test block being a trial (4 test blocks x 5 trials), the trial block was excluded by the system and the remaining three test blocks were averaged (13).

Statistical analysis

In the article titled "Effect of total and local classical massage on reaction time", using the simple reaction time averages of basketball players and a healthy group, a sample size of 120 participants was calculated, 30 for each group, taking into account an effect size of 0.83 with α = 0.05 power = 0.80 analysis. (22). The data obtained in the study were analyzed using the Statistical Package for Social Sciences (SPSS) for Windows 25.0 program. Mean (±) and standard deviation (X±SS) values were calculated for descriptive statistical information and quantitative variables were determined by measurement; number (n) and percentage (%) values were calculated for non-measurable variables determined by counting. The conformity of the data to normal distribution was analyzed by Kolmogorov-Smirnov tests. Since it was determined that the data did not show normal distribution in these analyses, the Mann-Whitney U test was used to compare the data between groups according to gender, the Wilcoxon Signed Ranks Test was used to compare the data before and after within groups and Kruskall Wallis test was used for intergroup comparisons. Tukey test was used to determine which group or groups were different in the post-intervention measurement results. Statistical analysis of the data was performed by an expert blinded to the groups. The statistical significance value was accepted as $p<0.05$.

RESULTS

A total of 120 university students were included in the study in which the effects of neural mobilization on reaction time in healthy young adults were examined. When the age, height, body weight, and BMI values of the participants were analyzed by the Kruskall Wallis Test, it was found that the groups were similar ($p>0.05$) (Table 1). Of the subjects who participated in the study, 100 were female and 20 were male and the mean age of 21.75±2.2 years. 14 subjects had a left dominant hand and 106 had a right dominant hand. According to their dominant hand, the mean reaction time before the application was 259.4±65.8 milliseconds (ms) in right-handers and 248.0±59.5 ms in left-handers (Table 2).

Tables 4. Reaction time measurement results of groups.

		Group 1 (n=30)	**Group 2 (n=30)**	**Group 3 (n=30)**	**Group 4 (n=30)**	**p^b**
Reaction time (ms)	**PreM**	262.2±71	247.9±62.9	272.3±70.2	249.8±54.5	0.439
	PostM	247±50	237.2±55.1	263.8±63.7	226.8±38.3	0.140
	p^a	0.136	0.136	0.360	0.036*	
	Z	-1.491	-1.491	-0.915	-2.098	

*$p<0.05$ is statistically significant. p^a, intragroup comparison: Wilcoxon test; p^b, intergroup comparison (PreM*PostM): Kruskall Wallis test. PreM: Pre-mobilization, PostM: Post-mobilization, Group 1: Self-mobilization, Group 2; Self-placebo mobilization, Group 3; Mobilization performed by physiotherapist, Group 4: Placebo mobilization performed by physiotherapist.

Tables 5. Comparison of post-mobilization measurements between groups.

Main Group	Other group	Mean Difference	p[a]
Group 1	Group 2	-16.7667	0.606
	Group 3	9.7700	0.889
	Group 4	20.1833	0.449
Group 2	Group 1	16.7667	0.606
	Group 3	26.5367	0.212
	Group 4	36.9500	0.037*
Group 3	Group 1	-9.7700	0.889
	Group 2	-26.5367	0.212
	Group 4	10.4133	0.869
Group 4	Group 1	-20.1833	0.449
	Group 2	-36.9500	0.037*
	Group 3	-10.4133	0.869

*p<0.05 is statistically significant. p[a]: intergroup comparison Tukey test. Mean difference: main group post-mobilization-other group post-mobilization. Group 1: Self-mobilization, Group 2: Self-placebo mobilization, Group 3: Mobilization performed by a physiotherapist, Group 4: Placebo mobilization performed by a physiotherapist.

According to the reaction time measurement results of the 120 participants included in the study, the mean reaction time was 261.942±67.8 ms in 100 female participants and 238.89±44.7 ms in 20 male participants. When the genders were compared in terms of reaction time, it was found that the difference was not statistically significant (p>0.05) (Table 3). No difference was found between the groups in the measurements before neural mobilization and after neural mobilization (p>0.05). It was observed that the reaction times of the students participating in the study decreased after neural mobilization compared to the measurements made before neural mobilization. This decrease was statistically significant only in the placebo mobilization group performed by the physiotherapist (p<0.05) (Table 4).

When the post-intervention measurements were compared, significant differences were observed only between group 2 and group 4. (p<0.05) (Table 5).

In 193 children, 149 (77.20%) children had forearm pronation posture, and 44 (22.80%) children had supination posture. There was a statistical difference in the distribution of the resting position of the forearm according to Narakas types (p<0.001): 149 children who had pronation posture; there was a difference between Narakas type 3/4 and all other Narakas types. 44 children who had pronation posture; there was a difference between Narakas type 3/4 and all other Narakas types. Table 2 shows the distribution of the forearm resting position by Narakas type.

The relationship between internal rotation posture of the shoulder and function was investigated in both upper trunk injuries and total plexus injuries. The change in internal rotation posture was monitored with the MMC's upper extremity resting position grading system. Grade 1 indicates maximum internal rotation, grade 5 indicates decreased internal rotation posture and the affected side has a symmetrical posture with the healthy side. There was only one child with an upper trunk injury classified as grade 6 which reflects shoulder external rotation posture, and this child was not included in the analysis of the relationship between shoulder internal rotation posture and function. In upper trunk injuries, there was a moderate positive correlation between upper extremity resting grade and total function (p<0.001, r=0.605); there was a moderate positive correlation between upper extremity resting grade and active joint movements (p<0.001, 0.422<r<0.625). In total plexus injuries, there was no correlation between upper extremity resting grade and function (p=0.248). Table 3 shows the correlation analysis between motor function and shoulder internal rotation posture.

The relationship between age and upper extremity resting position was also analyzed. There was a moderate negative correlation between age and upper extremity resting position score (grade) in children with total plexus injury (p=0.016, r=-0.423). In children with upper trunk injuries, there was no correlation between age and upper extremity position score (p=0.895, r=0.010).

DISCUSSION

Our study is the only study that used placebo control groups for the intervention groups, compared self-administered and physiotherapist-administered interventions as neural mobilization techniques, and used the SWAY mobile application for reaction time measurement. The main findings of this study showed that neural mobilization had no acute effect on reaction time.

A reflex is an involuntary and almost instantaneous movement in response to a stimulus (23). The reaction is a voluntary response to an incoming stimulus. Reaction time is a measure of the speed of response (24). The creation of purposeful reactions by performing voluntary motor skills at appropriate speed, distance, and duration requires the cooperation and integrity of both the sensory system and the motor system (25). Reaction time in response to a situation can significantly affect life due to its practical consequences (26).

When the literature on reaction time research was reviewed, it was seen that the studies mainly examined the athlete population and investigated the effects of reaction time on sports performance (27). However, considering that reaction time is an important need in daily life for every population, the study was conducted with university students.

Since there are no studies in the literature investigating the effect of neural mobilization on reaction time using a placebo group as a control group, placebo mobilizations were performed in this study. In the placebo groups, feedback was received that the participants felt a tension in the forearm muscles similar to that in stretching applications during the opposite movement of mobilization in the distal part. Therefore, it was thought that this decrease in reaction time may have occurred due to the stretching of the antagonist muscles during mobilization, and the reason why the results were significant in the placebo mobilization group, which was performed only by the physiotherapist, may be due to more stretching of the muscle at the endpoint. When the existence of any studies supporting these results was investigated, it was seen that there were studies in the literature investigating the effect of static stretching on reaction time. When these studies were examined, it was determined that the methods they used for stretching and the results they found differed (28). In the literature, no study was found to support the results obtained from our placebo groups and it was observed that studies investigating the effects of muscle stretching on simple reaction time are needed.

In the studies in the literature, it was observed that lower extremity neural mobilization was generally performed (29), the Nelson hand reaction test (30) or computerized measurement methods were used as measurement methods (31), and the included participants were only female or male.

Limitations

The most important limitations of the study are that the mobilizations and evaluations were performed for a short period and in healthy individuals.

Due to the variety of repetition numbers used for neural mobilization in literature, it was difficult to choose the appropriate repetition number. Therefore, there are question marks as to whether the results obtained can be similar with different repetition numbers.

While examining the effects of neural mobilization on reaction time, the fact that we did not come across a study using a placebo group made it difficult to interpret our findings.

The limited number of studies using the reaction time test of the SWAY mobile application.

CONCLUSION

This study may be instructive for further research investigating the effect of neural mobilization in the treatment of different clinical problems that require a reduction of reaction time.

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