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Original Article

Effects on ROM and joint position sense of the neck of two different interventions

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Abstract. [Purpose] The purpose of this study was to evaluate whether neuromuscular joint facilitation (NJF) training is superior to NJF distal resistance training at improving the ROM and proprioceptive acuity of the neck. [Subjects] 10 healthy subjects (8 males, 2 females) participated in this study. [Methods] The participants were allocated to three groups: 10 in the control group, 10 in the NJF distal resistance training group, and 10 in the NJF training group. A miniature wireless motion recorder was used to record the maximum cervical range of motion and joint position error (JPE) before and after the interventions. The three interventions were tested on different days. [Results] No difference of ROM was observed among the three groups. A significant pre- to post-intervention decrease in JPE in extension was identified in the NJF group. No other significant differences were observed among the three groups. [Conclusion] The NJF training conferred remarkable benefits on the cervical JPE of healthy people. This result suggests that the best way to improve proprioceptive acuity is intervention together with proximal resistance training, such as NJF training.
Key words: Neck, Joint position sense, Neuromuscular joint facilitation (NJF)

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INTRODUCTION

Patients with neck pain often have impaired proprioception of the neck and reduced ROM, for which proprioception training and ROM training are usually prescribed in rehabilitation protocols. More and more researchers and clinicians are interested in the assessment[1)] and treatment of strength[2)], endurance, range of motion and proprioception[3)] of the cervical spine. Cervical ROM has been used to evaluate the severity of impairment or disability of patients as it is related to cervical disorders and injuries. It has also been used as part of the clinical criteria for classification of disease as well as the evaluation of the efficacy of a rehabilitation program[4)].

The joint position error (JPE) test is considered the primary measure of neck proprioception and has been widely used as an outcome measure for patients with chronic neck pain[5)]. Abnormal JPE has been detected in patients with neck pain using either tests of ability to relocate the neutral head posture after an active movement or to actively relocate a position within a movement plane[6)].

Neuromuscular joint facilitation (NJF) is a new therapeutic exercise based on kinesiology, and it integrates with the facilitation element of proprioceptive neuromuscular facilitation (PNF) with the joint composition movement, aiming to improve the movement of the joint through passive exercise, active exercise and resistance exercise. It is also used to increase the function of the neck. The NJF technique uses the same motion pattern as PNF, but NJF changes the resistance part. NJF applies proximal resistance to the spinous process of the neck[7)].

The purpose of this study was to examine the immediate effects of NJF training and NJF distal resistance training on cervical ROM and position sense.

SUBJECTS AND METHODS

Ten healthy people with an average age of (35.0±14.5) years, and an average height of (172.2±14.0) cm, an average body weight of (76.0±30.0) kg were recruited for this study. The subjects were selected randomly from among students attending a university. The characteristics of the subjects are shown in Table 1. All the subjects were able to independently perform activities of daily living. They all agreed to participate in the study, after the researchers had given them a verbal explanation of the study method and aims. This study was approved by the Research Ethics Committee of the International University of Health and Welfare. The Ethics Review Number is 13-Io-118.

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Table 1. Subject Characteristics (n = 10)

Age (yrs)	35.0±14.5
Height (cm)	172.15±14
Weight (kg)	76.0±30.0

Values are mean ± SD

The subjects were divided into three groups: 10 in the control group, 10 in the NJF distal resistance training group, and 10 in the NJF training group. A miniature wireless motion recorder was used to record the maximum cervical ROM and JPE before and after the interventions. Two miniature wireless motion recorders (MVP-RF8-GC, Microston Corperation, Japan) were used in this study to measure the angle change of the neck. One was placed on the middle of the forehead, and the other one was placed on the manubrium sterni. The tests and performance were based on similar tests used in previous studies which investigated the neck proprioception[8]. Subjects were comfortably positioned by sitting with their feet flat on the ground with their head in the neutral resting position. They were requested to focus on a target positioned at eye level. Subjects were familiarized with the tasks by performing a few practices in each test direction: extension, left rotation, and right rotation. For the formal tests, subjects were blindfolded, and their neutral head position was automatically set to zero by the sensor. In the three testing directions, the neck and head moved to the end of their range and returned as accurately as possible to the starting position. Three trials were performed of left and right neck rotation, and extension. Before each trial, subjects were allowed to remove the blindfold, open their eyes and face a big mirror to relearn the neutral position. Then, they were blinded again, and the head was repositioned back to the starting position the subjects by themselves. Prior to each new direction, the subject was able to recenter his starting position with the help of the mirror before being blindfolded again. Data were collected for two seconds at the starting 'neutral' position, the positions of maximum rotation (and extension), and the end position after the return to the 'neutral' position. The differences in angle between the starting and the maximum range positions were calculated to deduce the ROM of each movement at each sensor site. The differences in angle between the starting and the end range position were calculated to deduce the neck joint position error of each movement at each sensor site. JPE and ROM were calculated as the average data for the three trials in each direction (extension, right rotation, and left rotation). The test method followed those described in previous studies. The method that Gwendolen J[8] et al. used was the three directions method of the present study. It is considered that left and right lateral flexion allows the trunk muscle to affect the neck movement. It interferes too much with the proprioceptive sense of the neck, so it was not used in the present study. The focus of the present study was proprioception sense. In the cervical region, most of proprioceptors are distributed in the deep flexion muscle groups of the neck[9]. Test of neck position sense after the neck extension then back to the neutral position, involving neck flexion muscle group's activation, would be more persuasive for neck position ability in the present study.

Table 2. Comparison of ROM before and after intervention (°)

		Before	After
Extension	NJF	63.42±12.44	67.20±15.31
	NJF-D	64.53±11.30	62.88±15.04
	Control	67.57±12.25	63.85±13.23
Left rotation	NJF	74.94±13.83	77.29±15.81
	NJF-D	71.25±14.62	72.92±15.30
	Control	72.45±14.92	71.10±13.88
Right rotation	NJF	74.25±17.13	72.61±14.09
	NJF-D	72.98±12.54	75.21±15.01
	Control	76.36±12.52	74.39±15.36

Values are mean ± SD.
Comparison with before intervention: *: $p<0.05$; **:$p<0.01$.
NJF: neuromuscular joint facilitation group, NJF-D: NJF distal resistance group, Control: control group, ROM: range of motion

Table 3. Comparison of JPE before and after intervention (°)

		Before	After
Extension	NJF	10.16±4.2	6.46±4.37*
	NJF-D	5.95±4.04	3.40±2.79
	Control	2.65±1.14	3.05±1.65
Left rotation	NJF	3.01±2.01	3.65±1.42
	NJF-D	2.40±1.36	3.70±2.69
	Control	3.80±1.89	3.40±1.28
Right rotation	NJF	3.94±2.29	4.40±2.78
	NJF-D	3.40±1.91	2.60±1.36
	Control	3.00±1.89	2.20±2.18

Values are mean ± standard deviation.
Comparison with before intervention: *: $p<0.05$; **:$p<0.01$.
NJF: neuromuscular joint facilitation group, NJF-D: NJF distal resistance group, Control: control group, JPE: joint position error

The interventions for control group was two minutes' rest, for NJF distal resistant training group was NJF distal resistance training and for the NJF group was NJF neck flexion pattern training. Three interventions and tests were performed on different days.

Two-way repeated measures anova was used to compare joint position error between before and after the intervention. The two factors were group and intervention. If a significant interaction among groups was found, the Two-way repeated measures anova with the Bonferroni was performed to investigate the differences between before and after intervention. All statistical analyses were performed using SPSS Ver. 17.0 for Windows. A value of $p<0.05$ was accepted as indicating statistical significance.

RESULTS

No difference in ROM was observed among the three groups (Table 2). Two-way ANOVA showed that there were significant interactions of JPE from extension to the starting 'neutral' position among the groups ($p<0.05$), indicating that

the changes were different among the groups. A significant pre- to post-intervention decrease in JPE from extension to the starting 'neutral' position was identified for the NJF group ($p<0.01$). No other significant differences were observed among the three groups (Table 3).

DISCUSSION

In the current study, no difference was found in the neck range of motion of the different study groups. This finding may be due to the subjects being healthy individuals without any neck problems, who do not have any abnormal limited range motion of the cervical joint. Cervical spine studies have suggested that warm-up exercises which simulate the actual testing procedure can increase the compliance of neck soft tissues and minimize the process of creep related to repetitive measurements[10, 11]. Before the test and the intervention, therefore, subjects were allowed to practice the task and perform movements in each direction, to warm up the neck muscle to avoid tight muscles. Therefore, it is reasonable to assume that healthy people would have the similar normal cervical joint range of motion at both pre and post intervention. The joint position is based on the proprioceptive function. If a method improves the proprioceptive function of the neck, the positioning ability of the neck should show more acuity. The result of this study indicate that NJF training provides proprioceptive acuity that is superior to NJF distal resistance training. This is because, in NJF, proximal resistance is exerted, promoting the contraction of the neck multifidus thereby activating more proprioceptors. There was a pre- to post-intervention decrease in JPE of extension, possibly due to the patterns of NJF training, with focus much more on the directions of extension and flexion of the neck, and less on the left and right rotation. According to the results of our study, it is evident that NJF training can promote the proprioceptive function of the neck. NJF is suitable for neck dysfunction rehabilitation training and neck proprioceptive function disorder rehabilitation training. This finding is of great significance for rehabilitation training. Nevertheless, further investigations are necessary to find out the best approaches for improving proprioceptive function, and to investigate the different effects of different training programs after long-term interventions for healthy people and neck disorder patients. NJF training had remarkable benefits for cervical JPE of healthy people. This result suggests that the better way to improve proprioceptive acuity is an intervention together with proximal resistance training, such as NJF training.

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