Immediate effects of different treatments for the wrist joints of subdominant hands, using electromechanical reaction time

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Abstract. [Purpose] The aim of this study was to examine the immediate effects of muscle strength training and neuromuscular joint facilitation distal resistance training on wrist joints by using electromechanical reaction time. [Subjects and Methods] The subjects were 12 healthy young people (24.2 ± 3.1 years, 169.7 ± 6.5 cm, 65.3 ± 12.6 kg). Two kinds of isotonic contraction techniques were applied on the wrist joint: the wrist joint extension muscle strength training and the wrist joint extension pattern of neuromuscular joint facilitation. The electromechanical reaction time, premotor time, and motor time of the left upper limb were measured before and after each intervention session of muscle strength training and neuromuscular joint facilitation. [Results] The neuromuscular joint facilitation group showed significant shortening of the electromechanical reaction time and motor time after the intervention. [Conclusion] These results suggest that the electromechanical reaction time and motor time of the wrist joint can be improved by neuromuscular joint facilitation together with proximal resistance training, which can be used as a new form of exercise for improving the functions of subdominant hand wrist joints.

Key words: Neuromuscular joint facilitation, Electromechanical reaction time, Motor time

INTRODUCTION

Patients with cervical spinal cord injury or stroke often suffer from impaired proprioception of the upper limbs, and reduced muscle strength and range of movement (ROM). Proprioception, muscle strength, and ROM training are usually implemented in physical therapy programs for patients with cervical spinal cord injury and stroke1). A number of research studies have focused on increasing muscle strength and/or ROM of the upper limbs. After a stroke, the function of the hemiplegic side is always greatly affected, and part or all of the upper limb’s motor function disappears. Therefore, a handedness exchange is very important for patients with hemiplegia so they may better conduct activities of daily living. Subdominant hand proprioception training has already been used in clinical settings for handedness exchange3).

The electromechanical reaction time (EMG-RT) is an index of the shrinkage characteristic of the muscle. EMG-RT is composed of premotor time (PMT) and motor time (MT). The PMT is defined as the interval between the stimulation signal and the onset of voluntary electromyographic (EMG) activity of a response agonist. The MT is defined as the interval between the onset of voluntary EMG activity and the mechanical response. The PMT reflects the movement position, pattern,
Neuromuscular joint facilitation (NJF) is a new therapeutic exercise based on kinesiology that integrates proprioceptive neuromuscular facilitation (PNF) and joint composition movements, aiming to improve movements of the joint through passive, active, and resistance exercises\(^4\). NJF is used to increase strength, flexibility, and ROM, and thus improve wrist joint functions. NJF uses the same motion pattern as PNF, but the location of resistance is different. The proximal resistance is applied to the scaphoid or triangular bone in the wrist\(^5\).

The purpose of this study was to examine the immediate effects of strength training and NJF distal resistance training on wrist joints by using electromechanical reaction time.

**SUBJECTS AND METHODS**

The subjects were 12 healthy young people (8 males and 4 females). The subjects’ characteristics are detailed in Table 1. All of the subjects were right-handed. The purpose and content of this research were explained to the subjects, and they gave their informed consent to participate in the study. The study was approved by the Research Ethics Committee of the China Rehabilitation Research Center (IRB no. 2014–26).

The subjects sat on chairs and placed their left upper limbs on a table in front of them. The subjects’ shoulder joints were flexed at 45°, and their elbow joints were flexed at 45°. Two kinds of isotonic contractions were performed on the wrist joint extension: the wrist joint extension muscle strength training (MST) and the wrist joint extension pattern of NJF. All interventions were performed by the same physiotherapist. Resistance was applied at the highest possible level that allowed subjects to complete the isotonic exercise.

1. **MST group**: One hand of the examiner was placed against the subject’s dorsal palm, and the other hand was placed on the distal forearm to fixate the wrist joint. Resistance was applied as the subjects performed wrist joint extension.

2. **NJF group**: The wrist extension-radial drift (ERD) pattern was performed. In the ERD pattern, one hand of the examiner was placed against the patient’s distal second dorsal metacarpal, and traction and resistance were increased. The examiner’s other hand was placed on the triangular bone, which moved distally when the wrist joint was extended. While the subjects performed the wrist joint extension pattern, traction and resistance were applied throughout the process by two hands\(^6\).

The interventions were performed five times in both the MST and NJF groups. There was a one-hour rest between interventions in the MST and NJF groups, and two interventions and tests were performed within one day. All trials were performed randomly. EMG-RT was measured before and after each MST and NJF intervention.

In the EMG-RT evaluation, the subjects were given an oral warning of “set” for two to three seconds in advance of the stimulus vision signal. The subjects were required to respond to the vision cues by extending the wrist joint as quickly as possible.

The EMG-RT was measured by an sEMG system (Telemyo 2400T; Noraxon, Scottsdale, AZ, USA). After cleaning of the skin with alcohol and abrasion paste, Ag/AgCl disposable electrodes (ELR~604, ELR~608, Beijing Sanjack Company) were placed over the muscle bellies of the musculus extensor carpi radialis longus. The signal was turned on and off by contacting an electrode attached to the palm with an aluminum board. At the onset of voluntary wrist extension, the electrode lost contact with the aluminum board, and the signal was recorded. The EMG and the on-off signal of the palm switch were synchronized on the display of the sEMG system.

The EMG-RT, PMT, and MT were also measured. The PMT was between the onset of voluntary EMG activity and the stimulus vision signal, the MT was between the onset of voluntary EMG activity and the off signal, and the EMG-RT was between the stimulus vision signal and the off signal.

Two-way repeated-measures analysis of variance (ANOVA) was used to test for statistically significant differences, and the factors were intervention and group. If any significant interaction was found, the one-way ANOVA and multiple comparisons (Bonferroni test) was performed for each group. Data were analyzed using SPSS Ver. 17.0 for Windows (SPSS, Chicago, IL, USA). The level of statistical significance was set at 0.05.

### Table 1. Subject characteristics

|                  | Mean ± SD (N=12) |
|------------------|-----------------|
| Age (years)      | 24.2 ± 3.1      |
| Height (cm)      | 169.7 ± 6.5     |
| Weight (kg)      | 65.3 ± 12.6     |

SD: standard deviation.
RESULTS

In the two-way ANOVA analysis of variance, there were significant interactions between the EMG-RT and the MT of the groups, indicating that the change was different between groups. There were no significant differences among the results of the MST group. The NJF group showed significant shortening of the EMG-RT and MT after the intervention (Table 2).

DISCUSSION

Compared with the MT and EMG-RT of the MST group, that of the NJF group decreased significantly. These results can be attributed to the improvement in the functions of the periaricular muscles of subdominant hand wrist joints due to the application of proximal resistance. The shortened EMG-RT meant that attentiveness and movement levels were improved by NJF intervention. The reason for the shortened MT was that the contractile characteristic of the muscle could be immediately improved by NJF intervention. MT was influenced by muscle tone before the movement appeared7. The shortened MT was presumed to have been caused by an increase in muscular tension, which was induced by a change in proprioceptive sensor of the tissue8).

These results suggest that the EMG-RT and MT of the wrist joint can be improved by NJF together with proximal resistance training, which can be used as a new exercise for improving the functions of subdominant hand wrist joints.

Further studies are needed to investigate the change in the EMG-RT and MT of the wrist after a long period of NJF intervention.

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