The effects of elbow joint angle and resistance point on muscle activation of the contralateral shoulder muscles while performing the ulnar thrust PNF pattern exercise

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| Abstract |

PURPOSE: This study researched the effects of the changes of elbow joint angle and of arm position in PNF pattern on muscle activation of the contralateral shoulder muscles while performing PNF pattern exercise.

METHODS: The research subjects were 16 male physical therapists who had no neuromuscular or neurological disorders. To measure the muscle activation of the contralateral shoulder muscles, EMG electrodes were attached to the muscle valley of the middle and posterior areas of the deltoid and triceps muscles of the arm. Muscle activation while performing the ulnar thrust PNF pattern exercise was measured with the elbow joint positioned at angles of 30°, 45°, and 60°. Resistance points were at the initial, middle, and end ranges of PNF pattern exercise.

RESULTS: Muscle activation of the middle and posterior portions of the deltoid muscle increased significantly according to the changes of elbow joint angle. In each resistance point the middle range was significantly higher than at other points. A significant difference on muscle activation was demonstrated throughout each range depending on the type of muscle. Muscle activation of the middle and posterior portions of the deltoid muscle was higher than muscle activation of the triceps.

CONCLUSION: The results of this study demonstrate that the PNF pattern exercising method used in this study is a selective exercising method focusing on the deltoid muscle over the triceps muscle. In order to increase the muscle strength to the maximum level, it is necessary to provide the maximum level of resistance in the middle range of the elbow joint.

Key Words: The ulnar thrust PNF pattern, Elbow joint angle, Muscle activation

1. Introduction

Most of the exercises designed to focus on improvement of movement and muscle strength consist of directly progressive strength training, resistance exercise, isokinetic exercise, etc. on the affected side (Häkkinen et al, 1998; Inaba et al, 1973; Kim et al, 2001; Kisner and Colby, 2001). On the other hand, new methods for improving muscle strength of one side of the body by enhancing
muscle strength on the opposite side of body have recently been developed (Carroll et al., 2006). In the view of biomechanics, resistance exercises on one side of the body cause muscular contraction to secure stability of the body trunk and of the limbs on the opposite side of the body (Hellebrandt, 1951). Therefore, theoretical grounds have been suggested as to how muscular exercise on one side of the body might improve muscle activation on the opposite side (Zhou, 2000). Using such principles clinics have been implementing resistance exercises on strong muscles performing indirect isometric contraction exercises which in turn cause muscle activation on physically weak areas (Kim and Yi, 2001). Likewise, contralateral effect is the reinforcement of one side of the body by training the opposite side of the body (Lee and Caroll, 2007). Proprioceptive Neuromuscular Facilitation (PNF) is the representative treatment method in the use of such principles. In general, PNF is considered to be a useful treatment for improving the coordination of muscles and reinforcing muscle strength by using diagonal and spiral exercise patterns (Adler et al., 2008; Knott and Voss, 1968). Furthermore, Knott and Voss (1968) have introduced the concept of irradiation for reinforcing weaker areas by applying resistance used at the time of indirect treatment on stronger areas. Therefore, PNF has been widely using contralateral effect for reinforcing muscle strength and exercise function by promoting the activity of muscles that are not directly trained through resistance exercise. In regard to contralateral effect, Munn et al. (2004) have insisted that muscular exercise on one side of the body can improve muscle strength on the opposite side. Ress et al. (2007) reported that muscle strength of not-trained ankles was increased by 26% when exercising with PNF. According to Kofotolis and Kellis (2007), muscle strength and stamina of one leg was significantly increased by applying PNF leg pattern on the opposite side. Therefore, contralateral effect has already been verified in clinical settings. It is therefore regarded as a generalized treatment by therapists. However, most of the studies dealing with contralateral effect have not considered the joint angle of the side being exercised.

Increase of muscle strength is influenced by intensity, time, and frequency of repetition of muscular contraction, as well as by joint angle. This has been demonstrated by studies indicating how joint angles are closely related to increase of muscle strength (Bandy and Hanten, 1993; Song and Kwon, 2006). In considering the length-tension relationship, it has been demonstrated that changes in joint angle cause changes in muscle length that determine physical strength or tensile power. In this regard Song and Kwon (2006) have conducted a study dealing with the effect of joint angle on muscle strength and muscular fatigue. This study demonstrated that muscle activation of the quadriceps muscle of the thigh was increased by 68% at 90° of knee flexion posture as compared to 30° of knee flexion posture. It was also confirmed that muscular fatigue was higher at 30° of knee flexion posture. In addition, Kang et al. (2013) have confirmed that changes in elbow joint angle influenced the activation of elbow flexion muscle. Yang et al. (2014) also confirmed that changes in elbow joint angle influenced both muscle strength and activation on elbow flexor and extensor. Therefore, exercise focusing on contralateral effect is needed to require resistance exercise at the proper joint angle to improve muscle strength.

Nevertheless, no studies have been performed dealing with how muscle activation is affected depending on the joint angle in exercising the opposite side of the body using the PNF approach. Therefore, this study was performed to investigate how changes in elbow joint angle and resistance point on the exercising side can influence the activation of shoulder muscles on the opposite side.