

# The effects of finger extension on shoulder muscle activity

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**Abstract.** [Purpose] This study aims to examine the effects of the extension of the fingers (distal upper limb) on the activity of the shoulder muscles (proximal upper limb). [Subjects and Methods] This study involved 14 healthy male adults with no musculoskeletal disorder or pain related to the shoulders and hands. The subjects in a sitting posture abducted the angle of the shoulder joints at 60° and had their palms in the front direction. Electromyography (EMG) was comparatively analyzed to look at the activities of the infraspinatus (IS) and rhomboid major (RM) when the fingers were extended and relaxed. [Results] The activity of the IS was statistically significantly higher when the fingers were extended than when they were relaxed. [Conclusion] According to the result of this study, finger extension is considered to affect the muscles for connected shoulder joint stability.

**Key words:** Infraspinatus, Rhomboid major, Finger extension

(This article was submitted Apr. 17, 2015, and was accepted May 25, 2015)

## INTRODUCTION

For appropriate stability of the shoulder complex, interaction and static-dynamic balance between various joints and muscles around the shoulders are required. The scapulothoracic joints increase the range of motion of the arms and provide stability for the movement of the upper limb<sup>1)</sup>. For this reason, some clinicians proposed that patients with a protracted scapular posture needed appropriate scapular retraction exercises<sup>2)</sup>. The retractors of the scapulothoracic joints, target muscles of such exercises, are composed of the middle trapezius, the rhomboids, and the lower trapezius<sup>3)</sup>. In addition, the glenohumeral joint has a high degree of motion in the upper extremity and therefore has the possibility of various potential damages<sup>4)</sup>. Therefore, most exercises devised to prevent and treat shoulder injuries have been considered strengthening the rotator cuff (RC) muscles important<sup>5, 6)</sup>. In particular, the infraspinatus (IS), one of the RC muscles, stabilizes the shoulder joints during the shoulder external rotation and acts as the prime mover of movement<sup>3, 5)</sup>.

Much research on exercises and therapeutic approaches effective for shoulder joint stabilization has been performed.

Lee et al.<sup>7)</sup> reported that during a push-up plus exercise, the neutral position, internal rotation position, and external rotation position of the hand differently affected the stabilization of the scapulothoracic, and push-up plus during external rotation was more effective for strengthening the serratus anterior. Jang and Oh<sup>8)</sup> verified changes in the muscle activity ratios of the IS and posterior deltoid muscle while performing shoulder external rotation according to shoulder flexion at 45°, 90°, and 135°. Many studies verified the effects of postural changes of the shoulder joints, differences in the base of support, and changes in the angles of the upper limbs on shoulder joint stability or changes in muscle activity. However, in the clinical field, diverse connected methods of treating the shoulders and upper extremity have been effectively applied. Among the muscles of the upper extremities, the middle trapezius, rhomboid major (RM), triceps brachii, and finger extensors were proposed as connective muscles identified in the upper extremity posterior surface<sup>9)</sup>. In particular, in treatment methods to improve the upper extremities of cerebral palsy patients, the dynamic stability of the shoulder joints, the proximal part, has been improved through postural adjustments of the hands, the distal part<sup>10, 11)</sup>. However, evidence-based research on such novel treatment methods is very insufficient.

Accordingly, the purpose of this study is to examine the effects of the extension of the fingers, the distal part of the upper extremities, on the activities of the IS and the RM, shoulder stabilization muscles of the proximal part.

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**Table 1.** Comparing muscle activities of shoulder muscles with respect to finger extension

Muscle % RVC	IS. R.	IS. L.	RM. R.	RM. L.
Extension/relaxation RVC (%)	206.2* (±213.3)	225.0* (±297.6)	179.8 (±185.6)	178.8 (±162.7)

\* Significant:  $p < 0.05$ 

IS. R.: infraspinatus right, IS. L.: infraspinatus left, RM. R.: rhomboid major right, RM.L.: rhomboid major left

## SUBJECTS AND METHODS

The subjects were 14 adult males who had not experienced orthopedic and neurological damage for the past six months. Those who were equipped with appropriate muscle strength and range of motion to perform the exercises required in this experiment and those who did not show winged scapula symptoms and had no pain in the hands and shoulder joints were selected. The mean age of subjects was  $23.78 \pm 0.80$  years, their mean height was  $177.35 \pm 5.37$  cm, and their mean weight was  $75.57 \pm 11.46$  kg. All participants voluntarily signed an informed consent form prior to their participation. This study was conducted in accordance with the Declaration of Helsinki. The protocol for this study was approved by the Ethics Committee of Catholic University of Daegu.

WEMG-8 (Laxtha Inc. Korea), a surface EMG, was used, and surface electrodes were attached to the IS and the RM. The collected EMG signals were filtered and rectified using a Telescan program (version 3.06), and then an integral average EMG was calculated to be used for analysis. For the normalization of each data, the RVC method whose standard was the condition of finger relaxation was used.

The subjects maintained an upright sitting posture. The subjects comfortably lowered the bilateral upper extremities, faced their palms toward the front, and abducted and maintained the shoulder joints at  $60^\circ$ . A measurement was taken once for five seconds with the finger relaxed and a measurement was taken again for five seconds with the finger extended. All tasks were repeated three times and one resting period for one minute between each task was provided.

A paired t-test was used to examine muscle activity of the muscles around the shoulders during finger relaxation and extension. Statistical analysis was performed using SPSS, version 20 for Windows (SPSS Inc., Chicago). Statistical significance was accepted for values of  $p < 0.05$ .

## RESULTS

IS right (IS.R.), IS left (IS.L.), RM right (RM.R.) and RM left (RM.L.) were 206.20%, 225.05%, 179.88% and 178.89%, respectively. The right and left muscle activities of the IS were statistically significantly higher than when they were relaxed ( $p < 0.05$ ), but the muscle activity of the RM was not statistically significant (Table 1).

## DISCUSSION

Much research on the methods to activate muscles related to the scapulothoracic joint or the glenohumeral joint aimed

at dynamic-static stabilization of the shoulder complex has been performed<sup>2, 5, 7, 8</sup>. These studies have focused on the activity of certain muscles and upper extremity movements or angle changes. However, some researchers recently proposed that the muscle activity of various relevant muscles be evaluated in a global view when muscle activity is assessed while performing exercises<sup>9, 12</sup>. In the clinical field, as well, treatment should not be made in a local view, and diverse treatment methods of connecting the proximal and distal parts in consideration of connected muscle activity have been applied. For example, to improve the abnormal posture of the neck and shoulders, an effective intervention is applied by utilizing the actions of the elbow and hands, the proximal part, as well as the activation of the surrounding relevant muscles to improve the abnormal posture of the neck and the shoulders<sup>9-12</sup>. This study intended to approach the theoretical basis for such novel treatment methods using the connected activity of the proximal and distal muscles used in the clinical field. The result was that the extension of the fingers, the distal part of the upper extremities, increased the muscle activity of the IS and RM, the shoulder stabilization muscles of the proximal part. Among them, the activity of the IS statistically significantly increased. Such a result shows that only the actions of finger extensors improve the activity of IS. In previous studies, such a connected action of the upper extremity muscles was explained with myofascial continuity, which was shown by most research using anatomical studies with cadavers<sup>13, 14</sup>. However, as a process to perform actual exercises, this study maintained the shoulders and the upper extremities in a proper posture and applied only finger extension as a variable. To verify changes in the muscle activity of delicate movements, the change amount of each muscle was verified with RVC values. Such a research method is considered a very sophisticated procedure to verify the connectivity of diverse muscles.

Selective strengthening of the IS has been considered important in the rehabilitation of the shoulder joints<sup>8, 15, 16</sup>. Ha et al.<sup>16</sup> reported that increasing the shoulder flexion angle promoted EMG of the IS. Jang and Oh<sup>8</sup> reported that the action of the IS was very crucial to shoulder stability in the external rotation of the shoulder joints, and performing external rotation with the shoulder flexion at  $45^\circ$  was more efficient. However, such research presented a result confined to the shoulder joints, and the effects of the activity of the muscle connected with other muscles of the upper extremities and the action of the hands were not considered. Therefore, based on the result of this study, it is thought to be more efficient to consider the direction and action of the hands in exercises devised for shoulder complex stability. In particular, in exercises to stimulate the activity of the

IS, finger extension will be a useful method to increase the activity of the muscles.

The limitations of this study are as follows. First, the number of subjects was small and they were confined to adult males; therefore, it is difficult to generalize this study result. Second, research was confined to the IS and RM with high relevance to finger movement. Future research is considered necessary on changes in activity of diverse muscles around the shoulders according to finger movement.

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