

Effects of Head-neck Rotation and Kinesio Taping of the Flexor Muscles on Dominant-hand Grip Strength

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Abstract. [Purpose] The purposes of this study were to examine whether the asymmetrical tonic neck reflex affects the dominant-hand grip strength in healthy adults and to compare the results with the degree of grip strength achieved when Kinesio tape was applied to the flexor muscles of the dominant hands. [Subjects] The subjects were 20 men and 20 women who agreed to participate in the study. [Methods] Grip strength was measured using a Jamar dynamometer under 3 conditions: the neutral position, the head-neck system rotating toward the nondominant hand in the transverse plane, and after applying Kinesio tape to the flexor muscles of the dominant hand. [Results] In the neutral position, the grip strength of the dominant hand was significantly greater after applying Kinesio tape to the flexor muscles than that of the untaped dominant hand in the neutral position or the head-neck rotation condition in both males and females. [Conclusion] These results suggest that the muscle strength of the upper extremity in subjects with upper-extremity muscle weakness may be improved by clinical application of Kinesio taping as a supplementary measure.

Key words: Kinesio tape, Grip strength, Head-neck rotation

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INTRODUCTION

Grip strength is a measure of the muscle strength of the hand and it is assessed in order to evaluate upper-limb impairments, establish appropriate treatment plans, and prescribe appropriate treatments¹⁻³⁾. Decreased grip strength can be used to predict disability in the elderly⁴⁾, and is thought to be related to nutritional status⁵⁾ and cognitive decline⁶⁾. Grip strength is affected by many factors, including age, sex, body mass index, occupation, leisure activities, upper-extremity muscle strength, nutrition status, pain, and sensory loss^{1,2,5,7,8)}. Patients are asked to face forward when their grip

strength is being measured in clinical practice; however, sometimes the patients rotate the head-neck system as an associated movement. Studies of the effect of this head-neck rotation on grip strength are lacking.

The asymmetrical tonic neck reflex (ATNR) is a reflex phenomenon in which the tonus of the extensors of the upper and lower limbs on the side to which the face is directed increases, while that of the flexor muscles of the upper and lower limbs on the other side also increases when the head rotates sufficiently⁹⁾. This phenomenon normally occurs in infants up to 6 months after birth, but if it persists thereafter, it is a clinical indicator of abnormal

development¹⁰⁾. However, earlier studies have reported that even in normal infants and adults, persistent ATNR affects motion in specific states including relaxation and motion stress^{11,12)}. Macaluso et al.¹³⁾ reported that the ATNR affected the H-reflex of the temporal muscles of healthy adults, and Deutsch et al.¹⁴⁾ suggested that head-neck rotations should be considered when improving the muscle strength of the upper extremity in order to induce ATNR. However, the results of studies on the effect of head-neck rotations intended to induce ATNR on the muscle strength of the upper extremity are contentious.

One method of promoting the contractility of weakened muscles involves applying Kinesio tape directly to the skin over the area of musculoskeletal injury, and this method is being used not only for alleviating pain but also for improving functions such as muscle strength and muscle endurance^{15,16)}. For example, Hsu et al.¹⁵⁾ successfully applied Kinesio tape to the lower trapezius of an amateur baseball player with shoulder impingement syndrome to achieve increases in scapular motion and in the activities of the lower trapezius.

The aims of the present study were to examine the effect of ATNR, induced through head-neck rotations in the transverse plane, on the dominant-hand grip strength of healthy adults with the forearm supination position, and to compare the results with the degree of grip strength achieved during forearm supination when Kinesio tape was applied to the flexor muscles of the dominant hand, rather than inducing ATNR through head-neck rotation.

SUBJECTS AND METHODS

The subjects of this study were 20 males [age: 24.1 ± 2.6 years (mean \pm SD); height: 176.7 ± 4.9 cm; body weight: 67.7 ± 5.0 kg] and 20 females [age: 22.7 ± 1.9 years; height: 161.1 ± 3.5 cm; body weight: 51.2 ± 6.0 kg] who consented to participate in this experiment. The subjects were selected from a cohort with no limitation in the ranges of movement of the upper limbs that might remarkably affect grip strength, and no orthopedic disability such as deformity, fracture, arthritis, and tendonitis. Ethical approval for this study was obtained from the Inje University Faculty of Health Sciences Human Ethics Committee.

Grip strength was measured in the standard

position, as suggested by the American Society of Hand Therapists, except for the position of the forearm. All subjects were asked to assume an upright sitting position in which the hips and knees were flexed by 90° with no armrest to prevent use of the legs, the shoulder joints were adducted and rotated to the neutral position, and the elbow joints were flexed at 90° ^{17,18)}. According to Richards et al.¹⁹⁾, the forearm exhibits the highest muscle strength when in supination (compared to neutral position and pronation), and they suggested that supination should thus be considered when measuring grip strength, because supination is the position in which the long flexor muscles of the fingers, originating from the forearm, contract maximally¹⁹⁾. As such, in the present study the "neutral" measurement position was defined as the state where the forearm was in supination. A Jamar dynamometer (Hydraulic Hand Dynamometer, 5030J1, USA) was used to measure grip strength. This instrument is regarded as the most accurate and reliable for measuring grip strength²⁰⁾. A recent comparison of the Jamar and Gripper dynamometers (which are thought to be the most reliable of all grip-strength-measuring instruments) revealed strong correlations between all of the analyzed variables²¹⁾. Each subject completed the grip-measurement experiments under each of the following three conditions: (1) measurement of the grip strength of the dominant hand in the neutral position, (2) measurement of the grip strength of the dominant hand with head-neck rotations in the transverse plane toward the nondominant hand (henceforth referred to as the head-neck rotation condition), and (3) measurement of the grip strength of the dominant hand after applying Kinesio tape (Kinesio Tex, KT-X-050, Tokyo, Japan) to the flexor muscles (flexor carpi ulnaris, flexor carpi radialis, and biceps brachii) of the dominant hand. The Kinesio tape was applied by affixing Kinesio tape from the origins to the insertions of the flexor muscles, with approximately 15% to 25% stretch, according to the recommendations of Kase²²⁾. The order of the measurements was randomly determined using a computer-generated randomized table of numbers to minimize bias. All of the measurements were made by the same researcher to minimize errors; each measurement item was measured twice and the average value was used for analysis. The study subjects were allowed to rest for 5 min between each measurement so that

Table 1. Comparison of grip strength data of the neutral position, head-neck rotation condition and elastic taping applied to the flexor muscles of the dominant hands of male and female adults

	Mean \pm SD (lb)		
	Neutral position	Head-Neck rotation	Elastic taping
Grip strength (male)	118.85 \pm 17.99	120.33 \pm 15.71	125.38 \pm 16.07*
Grip strength(female)	62.33 \pm 11.42	63.28 \pm 12.16	65.83 \pm 12.07*

*p<0.05

they would not be fatigued.

Statistical analysis was performed using the SPSS statistical package (version 12.0; SPSS, Chicago, IL, USA). All grip-strength measurements were made on the dominant hand. The effects of the three conditions on grip strength were analyzed using a repeated one-way ANOVA. Multiple comparisons were based on Bonferroni's correction. The level of statistical significance was set at p<0.05.

RESULTS

The average grip strength of males was highest (125.38 \pm 16.07 lb) when Kinesio tape was applied to the flexor muscles of the dominant hand, followed by the head-neck rotation condition (120.33 \pm 15.71 lb), and the neutral position (118.85 \pm 17.99 lb; Table 1). The average grip strength of females was highest (65.83 \pm 12.07 lb) when Kinesio tape was applied to the flexor muscles of the dominant hand, followed by the head-neck rotation condition (63.28 \pm 12.16 lb), and the neutral position (62.33 \pm 11.42 lb; Table 1).

Application of Kinesio tape to the flexor muscles of the dominant hand significantly improved grip strength of males and females over that measured in the neutral position (p<0.05). The grip-strength of males and females measured in the head-neck rotation condition was not significantly different from that measured in the neutral position (p>0.05). Finally, the grip strength of males and females measured after applying Kinesio tape to the flexor muscles of the dominant hand was significantly greater than that measured without Kinesio taping in the head-neck rotation condition (p<0.05).

DISCUSSION

Grip strength was greatest when Kinesio tape was applied to the flexor muscles of the dominant hand,

followed by that measured in the head-neck rotation condition, and the lowest value was recorded in the neutral position. The grip strength in the head-neck rotation condition, although slightly increased, was not significantly different to that measured in the neutral position (p>0.05). Deutsch et al.¹⁴⁾ reported that diverse head-neck positions in the eyes-closed state affect elbow joint flexor muscle strength in adults, and that head-neck movements in the horizontal plane exert greater effects than movements in the sagittal plane. However, Wong et al.²³⁾ reported that head-neck rotations did not affect the muscle strengths of elbow flexion and extension in healthy young women. In a study on the effect of the tonic neck reflex (TNR) on vertical writing conducted with healthy female adults as subjects, Waterland et al.²⁴⁾ reported that the position of the shoulder girdle can suppress the TNR, and that since both the left and right shoulder girdles and upper extremities were fixed while grip strength was being measured, the effect of the TNR was obscured. Since the movements of the shoulder girdle and upper extremities were prevented under the head-neck rotation condition of this study, we think that ATNR was not activated; thus, grip strength was unaffected. In addition, Clopton et al.²⁵⁾ reported that the ATNR was activated in the upper and lower extremities through passive head turning in only 4.92% of newborns, and that it was activated in only 1–11% full-term neonates^{26, 27)}.

The application of Kinesio tape to the flexor muscles of the dominant hand significantly increased grip strength compared to that measured in the neutral position (p<0.05). According to Kenzo Kase, the creator of Kinesio tape, Kinesio taping corrects muscle function by strengthening weakened muscles^{28,29)}. Kinesio taping increase blood and lymph circulation in the taped area, and this physiological change may affect the muscle and myofascia functions^{28,30)}. The application of

Kinesio tape also is theorized to stimulate cutaneous mechanoreceptors³¹⁾, and Kinesio tape on select muscles may improve muscle excitability³⁰⁾. In the present study, the application of Kinesio tape may have provided cutaneous stimulation to the skin during flexion, thereby stimulating the afferent receptors in the skin, affecting the muscle activity of the flexor muscles and leading to an increase in grip strength.

Kase, the inventor of Kinesio taping, suggested that a combination of Kinesio taping and appropriate exercises may be more effective than taping alone²²⁾. Future studies should evaluate such issues. In addition, the effect of Kinesio tape applied to the upper-extremity muscles of subjects with weakness in these muscles should be determined. The results of the present study suggest that in the clinical field, Kinesio taping may be applied to subjects with muscle weakness in the upper extremities as a supplementary measure to improve the strength of upper-extremity muscles.

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