어깨와 견갑대 근육의 등척성 근력 평가

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Assessment of Isometric Muscle Strength of Shoulder Girdle : A Reliability Study

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Purpose: To evaluate the quantitative isometric muscle strength of shoulder girdle and the test reliability using by the equipment, named 'IsoTrack', which was selected by authors in the former studies.

Methods: Thirty healthy subjects (9 men, 21 women) were recruited in two sessions, one for intratester and intertester reliability tests and the other quantitative isometric muscle strength tests. The neck flexion, extension and scapular elevation muscle strength was measured using a force measuring device as IsoTract.

Results: Intraclass correlation coefficients for intratester reliability of the all subjects ranging between 0.96 and 0.97. For intertester reliability, the ICC and Pearson correlation correspond to 0.84 and 0.78. We gauged muscle strength of shoulder girdle muscles based on it and indicated quantified isometric muscle strength of women and men in left and right side.

Conclusion: We concluded that there were high reiliability of isometric muscle strength of neck and shoulder girdle. Also, we gauged muscle strength of shoulder girdle muscles based on it and indicated quantified isometric muscle strength in left and right side in women and men. So this findings may assist in the measure of whole body muscle strength.

Key Words: isometric muscle strength, reliability, shoulder girdle

I. Introduction

Muscle strength is gradually decreased not only by the lesions of muscular tissue and nerve. But also by the lesions in joint and the increase of age. And, muscle strength is also decreased due to the disuse of muscle. On the other hand, it is increased by resistive exercise. Muscle strength test grasps the pathological state of nerve, muscle and skeletal system as it also provides the informations for exercise prescription and devise the rehabilitation plan for the impaired patient as well. This muscle strength test is one if the essential evaluation skills in functioning assessment which is used to evaluate every disease in clinical practice that all of physical therapists should be able to know and perform (NIMS Database Consortinm, 1996).

Muscle testing have been of great interest to ergonomic and rehabilitation scientists for many years (Essendrop et al, 2001). Isotonic muscle tester or dynamometer can be using to measure

muscle strength, except for manual muscle testing (MMT) which has been used to (Brinkmann, 1994; Hislop et al, 1995; Kendal et al, 1993). Isometric muscle strength test gauges the maximum moment as muscle group is being tested isometrically. Isometric muscle strength has been researched focusing on hand grip, back strength and leg strength. And handheld dynamometer has been used as a general examination which proves reliability (Brinkmann, 1994; Essendrop et al, 2001). But, many studies discussing the reliability of isometric muscle strength testing are of limited use, since only a correlation coefficient is given without sufficient study details (Armstrong et al, 1992; Karras, 1997). isometric muscle strength test remains the favored method in many workplace studies. It has been reported that isometric test is simple to perform and has high correlation between isometric strength and dynamic strength (Nygård et al, 1994).

There are various isometric muscle strength tests that we selected two tests through literature investigation in this study. We got two experimental results based on these two tests. First one is comparison with muscle strength of neck and shoulder between healthy people and patients who have muscular weakness (Chiu et al, 2002; Garner & Shim, 2007). And, another one is the study between correlation and antropometric characteristics of subjects (Chuang et al, 1997; Xiao et al, 2005). They mainly used handheld dynamometer, tensiometer or electromyogram that showed the quantitative maximum muscle strength.

The main aim of this study was, Therefore, to evaluate the quantitative isometric muscle strength of neck and scapular muscles. The test reliability using by the equipment, named

'IsoTrack', which was selected by authors in the former studies.

II. Methods

1. Subjects

Healthy subjects (N=30) were recruited for this study from a Dong-Nam Health College. The subjects of this study have had no medical care related to musculoskeletal system and also haven't suffered from any lesion and exercised weight training. All subjects gave full informed consent before the experiments and gave their written consent to participate. A subset of 17 subjects was selected for the intertester study. The subject characteristics are reported in Table 1.

2. Procedure

Test was performed at the Dong-Nam Health college in laboratory settings. And its test for the

Table 1. Subject characteristics

			N	Mean	SD	SE
Intratester study	Age (y)	Males	9	22.33	3.12	1.04
		Females	21	2.76	2.98	0.65
		Total	30	21.93	2.98	0.54
	Height (cm)	Males	9	175.33	6.22	2.07
		Females	21	162.81	5.62	1.23
		Total	30	166.57	8.16	1.49
	Weight (kg)	Males	9	69.33	7.43	2.48
		Females	21	51.05	6.50	1.42
		Total	30	56.53	6.50	1.42
Intertester study	Age (y)	Males	4	21.25	3.20	1.60
		Females	13	21.08	1.98	0.55
		Total	17	21.12	2.20	0.53
	Height (cm)	Males	4	177.25	5.91	2.95
		Females	13	163.54	5.92	1.64
		Total	17	166.76	8.30	2.01
	Weight (kg)	Males	4	70.25	7.80	3.90
		Females	13	50.15	2.85	0.79
		Total	17	54.88	9.73	2.36

SD : Standard Deviation
SE : Standard Error

subjects was performed by IsoTrack (Tracker, ver 4.5, Jtechmedical, the US). The examiners were received an education about the purpose and the procedure of muscle strength test. And they also minimized the error could be happened in the test. One examiner performed scapular elevation on thirty-subjects four times in each left and right side to gauge intratester reliability. To gauge the intertester reliability, two of examiners measured the maximum score after measuring the isometric muscle strength of neck flexor and extensor on seventeen subjects three times with one week interval.

The posture for isometric muscle strength test was that subjects seated in the chair, holding with a safety belt and neck region took a mid-position between flexion and extension for accurate mea-surement. All muscle strength tests attempted for 5 sec. But the initial one-second which is a strength leading to contraction by stages was excluded in calculating of the maximum score and the mean. Thus, we practically used the measured score in the rest of 4 sec.

3. Statistics

Statistical analysis was performed using SPSS 13.0 and the significance level was set at p=0.05. In order to evaluate the reliability of the isometric strength tests in this study several statistical methods were used. Pearson correlation and Intraclass corrlation (ICCs) were calculated to give information about the relation between testers, test and retest. And 95% confidence intervals were calculated in order to evaluate the sensitivity of the isometric strength tests. Finally, we indicated means and standard deviations to evaluate the isometric mus-cle strengths of shoulder and scapular by descriptive statis-tics.

Table 2. Intratester reliability for isometric muscle strength of scapular elevation on male and female, all subjects

Scapular elevation	ICC(3,1)	95% C. I	r. Pearson			
			First times	Second times	Third times	Forth times
Male (n=9) Left	0.97	0.91-0.99	1.000	0.979*	0.980*	0.923*
Male (n=9) Right	0.92	0.81-0.98	1.000	0.915*	0.929*	0.942*
Female (n=21) Left	0.95	0.91-0.98	1.000	0.983*	0.953*	0.949*
Female (n=21) Right	0.94	0.88-0.97	1.000	0.974*	0.940*	0.948*
Total (n=30) Left	0.97	0.95-0.99	1.000	0.985*	0.976*	0.953*
Total (n=30) Right	0.96	0.93-0.98	1.000	0.963*	0.961*	0.964*

ICC : Intraclass correlation coefficients
95% C. I : Confidence interval
r. Pearson : Peason correlation coefficients
*p<0.05

Table 3. Intertester reliability and paired t-test for neck flexion and neck extension

movement	ICC(3,1)	95% C. I	r. Pearson	Paired t-test	1st tester Mean±SD(kg)	2nd tester Mean±SD(kg)
Neck flexion (n=17)	0.84	0.61-0.94	0.842*	-2.244*	6.94±3.38	7.94±3.05
Neck exten-sion (n=17)	0.78	0.49-0.91	0.787*	2.348*	11.24±4.10	9.53±4.84

ICC : Intraclass correlation coefficients
95% C. I : Confidence interval
r. Pearson : Peason correlation coefficients
*p<0.05

Ⅲ. Results

The results of this study are presented and disscussed below. All reliability indices for the intratester reliability study are in table 2. For male sub-jects, the ICC were ranged from 0.92 to 0.97 and the female subjects were ranged between 0.94 and 0.95. The all subjects generally yielded higher values, ranging be-tween 0.96 and 0.97. Also, Pearson's correlation coeffi-cient was indicated at each measures based on the first measurement. High correlation coefficients between 4-times test were found. All ICC and Pearson correlation coeffi-

Table 4. Isometric muscle strength of shoulder girdle

			N	Mean(lbs)	SD	SE
Scapular elevation	Left	Males	4	27.75	9.03	4.52
		Females	10	11.40	4.45	1.41
	Right	Males	4	28.75	12.12	6.06
		Females	10	11.70	5.36	1.69
Shoulder flexion	Left	Males	4	19.00	6.48	3.24
		Females	10	8.00	3.16	1.05
	Right	Males	4	17.75	6.70	3.35
		Females	10	8.11	2.47	0.82
Shoulder extension	Left	Males	4	13.25	2.36	1.18
		Females	10	8.11	1.69	0.56
	Right	Males	4	13.75	2.50	1.25
		Females	10	8.44	3.28	1.09

SD : Standard Deviation
SE : Standard Error

cients showed r-values above 0.9.

Table 3 shows the All data from the intertester study. The correlation between the two testers was high for neck flexion and neck extension. ICC and Pearson correlation correspond to 0.84 and 0.78. But, means and standard deviations evaluated isometric muscle strength of cervical with one-week interval by two examiners. As a result, paired t-test showed a significant difference. ($p < 0.05$)

Means and standard deviations for the isometric strength of shoulder and scapular movements are summarized in table 4. It shows when quantified each of left and right side of isometric muscle strength in women and men that men are about double stronger than women, except for shoulder extension.

Ⅳ. Discussion

This study evaluated shoulder girdle muscles by IsoTrack which is the tester for isometric muscle strength evaluated intratester and intertester reliability.

The tester used in this study gauges not only muscle strength, but also range of motion and hand grip as well. And It has a merit that can also gauge the maximum and average of each muscle strength in correct position. Thus, we valued reliability and indicated high correlation coefficient and ICC to quantify the measured muscle strength by this tester and to support the result of the former study.

The term reliability generally defines how consistently a measurement can be repeated on the same subject. Reliability is further divided into intratester and intertester reliability dependent on whether focus is on one tester making repeated measures on the same subjects, or more than one tester making the same measurements (Essendrop et al, 2001). So, I make it clear that this result just indicates agreement among examiners and it was a limitation in it. And, we think that it is needed to apply a result to population after randomly selecting examiners, So that can be generalized to solve these kind of limits in the next studies.

The analysis showed Shrout & Fleiss (1979), interclass correlation coefficients ICC (2.1) of 0.79 to 0.95 (good to excellent) for force measurements. This is an general standard, not absolute standard, shows that ranged about 0.75 is usually good, under 0.75 is weak or moderate reliability. And, in Pearson correlation, r-value ranged between 0.80 to 1.0 is very reliable, between 0.60 to 0.79 shows moderate reliability and under 0.59 shows lower reliability than others (Richman et al, 1980).

All reliabilities of intratesters were over 0.90 and Pearson correlation coefficients were also over 0.90 in the study that resulted in very significant reliability. And it's very similar to other researcher's results. Strimpakos et al (2004) gauged maximum isometric strength of neck muscle by A custom-made isomyometer device. And the result of analysis on intratester and intertester reliability was above 0.84 for all tests in any movement and position. And for intertester reliability, the ICC (2,1) ranged from 0.88 to 0.94.

Intratester reliability of this study was above 0.90 that similar to this result. Intertester reliability was 0.84 and 0.78 that showed little bit lower reliability than this study. The equipment they used is familiar with ours in which evaluate muscle strength by pressuring force on load cell. Thus, it considers that their result is also similar to ours and the comparison between them was adequate. Michener et al (2005) gauged scapular muscle strength by hand held dynamometer. So intraclass correlation coefficients for intratester reliability of measurements of isometric force obtained ranged from 0.89 to 0.96. As a result of analysis with normal isometric strength data, The National Isometric Muscle Strength (NIMS) Database Consortium (1996) demonstrated high intratester and intertester reliability. With considering all the results, We think that it's necessary to evaluate reliability of various equipments for measuring isometric muscle strength and generalization with randomly arranging examiner is needful for the next study.

V. Conclusion

Reliability of Isometric from the result of this study showed high reiliability as results of other studies have been done. As a result of analysis on intratester and intertester reliability through intraclass correlation coefficients, showed high reliability of above 0.90 and Pearson's correlation coefficients which gauged for intraclass correlation coefficients also showed same result like ICC. We gauged muscle strength of shoulder girdle muscles based on it and indicated quantified isometric muscle strength of women and men in left and right side. The results from this study and the former results were muscle strength evaluation on some muscles and also have limitations. It seems that we need to make up for those limitations and then quantitatively evaluate and compare muscle strengths of healthy subjects and impared subjects in muscles.

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