



Original Article

Analysis of the reliability of the make test in young adults by using a hand-held dynamometer

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Abstract. [Purpose] The purpose of this study was to analyze intra-rater and inter-rater reliabilities of the make test, a manual muscle testing measurement method, using a hand-held dynamometer in Korean young adults. [Subjects and Methods] A total of 42 university students participated in this study. The make test, a manual muscle testing method, was conducted. A hand-held dynamometer was used to measure elbow joint flexion during the make test. [Results] Both intra-rater (the intraclass correlation coefficient=0.992) and inter-rater reliabilities (the intraclass correlation coefficient=0.949) were excellent, with values over 0.9. [Conclusion] The make test is a useful manual muscle testing method with high intra-rater and inter-rater reliability.

Key words: Muscle strength, Dynamometer, Reliability

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INTRODUCTION

Manual muscle testing (MMT) is simple and quick, and can be performed without specific tools. However, MMT only has 5 grades based on a gravity standard. Therefore, it is difficult to assess muscle strength at a grade higher than fair, which is any grade of muscle strength in excess of gravity. Since the evaluations are determined subjectively by therapists, there is a high likelihood of error^{1, 2)}.

A hand-held dynamometer is used to solve this problem. It is easy to use, shows high reliability, and measures force as a unit of pressure^{3, 4)}.

Two methods are used to measure muscle strength using a hand-held dynamometer: the break test and make test⁵⁾. The examiner and subject play opposite roles during the tests. The subject applies a maximal force against the examiner and the position is maintained by the examiner during the make test. During the break test, the subject holds a position and the examiner pushes until the subject's maximal force is overcome and the joint gives way⁵⁾. The 2 methods apply force in different ways; the dynamometer receives different amounts of force, and should generate different results⁶⁾. However, few studies about reliability have specified whether they used a make test or break test^{3, 4)}. In addition, previous make tests were only conducted with Caucasians or black people and those conducted with Asian people should show different results^{2, 5-8)}. Analysis should be performed to retain objectivity. Therefore, this study aimed to analyze intra-rater and inter-rater reliabilities of the make test, an MMT measurement method using a hand-held dynamometer.

SUBJECTS AND METHODS

A total of 42 students (6 males and 36 females) at U University in Gyeongsangnam-do, South Korea, participated in this study. The mean ages, heights, and weights of the participants were 21.4 ± 0.5 years, 162.6 ± 6.8 cm, and 55.6 ± 11.6 kg,

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respectively. The selection criteria were as follows: no disease that might affect the test; and no visual impairment, hearing damage, or nervous system or vestibular organ disorder. Those who were unable to understand the nature of the experiment were excluded. Information about the study was provided to the subjects before participation, in accordance with the ethical principles of the Declaration of Helsinki, and all agreed to participate in the project by providing written informed consent.

A hand-held dynamometer (Commander Muscle Tester, JTech, USA) was used for MMT of elbow flexor strength. The subjects were in a supine position with elbow flexion at 90° during the test to eliminate the effect of gravity and to enable movement parallel to the ground. The subject flexed the elbow and the examiner performed the make test⁷⁾. The assistant examiner stabilized the shoulder of the subject during the test. A dynamometer was placed just proximal to the wrist joint on the radial surface of the forearm¹⁾.

Two examiners sequentially measured elbow flexor muscle strength of a subject to determine inter-rater reliability. The elbow flexor muscle strength was measured by a single examiner once a day for 2 days to determine the intra-rater reliability. The subjects had sufficient rest before the test and were informed about the measurement procedure before the test. All measurements are reported as the mean value ± standard deviation.

IBM SPSS Statistics for Windows (version 22.0) was used to analyze the data. The intra-class correlation coefficient (ICC) was used to examine the intra-rater and inter-rater reliabilities. The statistical significance level was $\alpha=0.05$.

RESULTS

The intra-rater reliability results of the make test for elbow flexor muscle strength of in the first test were 30.88 ± 10.78 lbs, and 31.48 ± 10.63 lbs in the second test (ICC=0.992). The inter-rater reliability result for the first examiner was 31.48 ± 10.63 lbs, and 30.76 ± 10.96 lbs for the second examiner (ICC=0.949). Both reliabilities were excellent, with values over 0.9 ($p<0.05$) (Table 1).

DISCUSSION

Two methods for evaluating muscle strength using a hand-held dynamometer are the make test and break test. The subject flexes the muscles, but is stabilized by an examiner during the make test. The examiner pushes the dynamometer against the subject's limb until the subject's joint gives way during the break test⁵⁾. A previous study reported that the break test showed larger numbers than the make test⁶⁾.

This study analyzed intra-rater and inter-rater reliabilities for the make test using a hand-held dynamometer for the elbow flexors in young adults. This study showed excellent reliabilities, with ICC=0.992 (intra-rater reliability) and ICC=0.949 (inter-rater reliability). Previous studies also showed that the make test usually had greater reliability than the break test, and that its reliability level was very high⁵⁾. A study by Phillips et al. analyzed the reliabilities of the make test in 200 subjects aged 20 to 69 and showed that the ICC of the make test was over 0.85: the intra-rater reliability showed ICC=0.988, and the inter-rater reliability showed ICC=0.934 in the same joint as in this study⁸⁾. The numbers were similar for both studies.

The muscle strength level was 30 lbs (13 kg) in this study, and a study by Bohannon conducted with adults aged 20–79 showed 11 kg of elbow flexion¹⁾. The difference in the 2 studies was not great. Another study by Bohannon conducted among young women showed that the make test value was 19 kg in the 13–29 kg range. This amount is slightly greater than the amount in this study, but the present result was still in the 13–29 kg range⁷⁾.

In addition, a study by Stratford and Balsor conducted among adults in their twenties showed 173 N of elbow flexion, which was similar to the result in this study. The results of the make test using a hand-held dynamometer were computer-analyzed; there was no difference in reliabilities compared with the Kin-Com, which is large and fixes the body in a machine⁵⁾.

These results indicated that the make test using a hand-held dynamometer had high intra-rater and inter-rater reliabilities. Therefore, this is a useful method for measurement of muscle strength at a grade higher than fair. A limitation of this study was that the break test was not conducted; reliability analysis for the break test should be investigated in future.

Table 1. Intra-rater and inter-rater reliabilities of MMT using the make test

	Measurement (lbs)		ICC (95% CI)
	1st	2nd	
Intra-rater	30.88 ± 10.78	31.48 ± 10.63	0.992 (0.98–0.99)*
Inter-rater	Examiner 1	Examiner 2	0.949 (0.90–0.97)*
	31.48 ± 10.63	30.76 ± 10.96	

Mean ± SD, * $p<0.05$, ICC: intraclass correlation coefficient, CI: confidence interval, MMT: manual muscle test

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