Make Tests and Break Tests of Elbow Flexor Muscle Strength

RICHARD W. BOHANNON

The purposes of this investigation were 1) to compare the forces produced by the elbow flexor muscles during make tests and break tests and 2) to determine the reliability of each of the test procedures. I used a hand-held dynamometer to perform two make tests and two break tests on 27 young women. The forces produced by the elbow flexor muscles during break tests were significantly larger than \((p < .001)\), albeit correlated with \((r > .80)\), the forces produced during make tests. Each testing procedure was reliable \((r = .909\) for make tests; \(r = .922\) for break tests). On the basis of reliability, one type of testing cannot be considered clearly superior to the other.

Key Words: Motor activity; Muscle performance, measurement; Physical therapy.

Two types of tests using hand-held dynamometers have been performed historically. Early tests were primarily of the break type. Break tests require that the examiner push against a subject's limb until the subject's maximal muscular effort is overcome and the joint being tested gives way. Make tests have been performed more recently with hand-held dynamometers. In these tests, the examiner holds the dynamometer stationary while the subject exerts a maximal force against it. Mayhew and Rothstein have written that break tests and make tests appear to differ. Smidt has stated that break tests involve eccentric contractions by preloaded muscles, break tests require more force application by the examiner than make tests. The extent to which external force differs under the two conditions, however, has not been documented. Information is also needed about the relative reliability of make tests and break tests. Although the reliability of each of the test procedures has been reported, the reliability of the two tests performed on the same muscles of the same subjects has not been publicized.

If clinicians are to make informed decisions about the type of strength tests to perform and interpret the results of such tests, they must have more objective information with which to compare the tests. The purposes of this investigation were 1) to compare the forces produced by the elbow flexor muscles during make tests and break tests and 2) to determine the reliability of each of the test procedures. My expectations were that more force would be generated during break tests than during make tests, but that the forces produced under the two conditions would be correlated significantly and the reliability of the two procedures would be high and comparable.

METHOD

Subjects

Twenty-seven healthy female subjects participated in this study after providing an informed consent. Their mean age was 29.0 \(\pm\) 5.2 years (range = 21–40 years), their mean height was 163.6 \(\pm\) 8.6 cm (range = 132.1–180.3 cm), and their mean weight was 60.6 \(\pm\) 6.6 kg (range = 51.7–74.8 kg). To eliminate any bias that might accompany the testing of a single side, subjects were randomly assigned so that 16 had their right elbows tested and 11 had their left elbows tested.

Procedure

Each subject performed four maximal voluntary elbow flexion efforts while lying supine with the elbow at 90 degrees of flexion and the forearm in neutral supination. During each effort, the subjects were to develop maximal force over a few seconds' time and to continue exerting maximal effort during a four- to five-second time period. I used a digital hand-held dynamometer* to measure the force of the subjects' efforts. The dynamometer was tested before the study and found to be linear and accurate within 0.1 kg. The pad of the dynamometer was placed just proximal to the subject's radial styloid process during testing. I provided consistent verbal encouragement to the subjects during testing and manually stabilized the tested arm of each subject. I performed a pair of make tests and a pair of break tests on each subject. Each test of a pair was separated by a 30-second interval, and each pair of tests was separated by a 2-minute interval. The order of testing was determined randomly in advance. Twelve subjects performed make tests first, and 15 subjects performed break tests first.

Data Analysis

Descriptive statistics and a two-way analysis of variance (ANOVA) for repeated measures were calculated to determine whether the force produced during make tests and break tests and during the first and second trials of each test pair differed significantly. Pearson product-moment correlation coefficients \((r)\) were calculated to determine the relationship between the force produced during make tests and break tests and to determine the reliability of the two types of strength testing.

---

RESULTS

The forces produced during the first and second make tests and break tests are summarized in Table 1. The ANOVA (Tab. 2) demonstrated a significant difference in the force produced during make tests and break tests, with a greater force produced during break tests. The forces produced during make tests and break tests were correlated significantly ($r = 0.807$–$0.868, p < .01, two-tailed test). The coefficients of determination ($r^2$) between the two tests revealed that over 65% of the variance in the force produced during one type of test could be explained by the force produced during the other type of test.

The ANOVA revealed no difference in the force produced during the first and second trials. The correlation between the forces of the two make tests was $r = .909$. The correlation between the forces of the two break tests was $r = .922$.

DISCUSSION

The mean force measured in this study during make tests ($\bar{X} = 19.2$ kg) was comparable to that measured during make tests in two recent studies that used similar subject samples. Consistent with the posits of Mayhew and Rothstein and Smidt, the force produced during the make tests differed from that produced during break tests; that is, the make-test force was lower than the break-test force. The correlation between the forces measured during the two types of tests, however, indicates that the tests do not measure independent variables. Both tests presumably measure the maximal voluntary strength of the muscle, albeit under different conditions.

Both the nonsignificant ANOVA trial effect and the correlations between the forces of the two trials established the reliability of the hand-held dynamometer tests performed. The findings of reliability in this study are not particularly surprising because the reliability of hand-held dynamometry has been substantiated previously. The test-retest reliability of the make tests in this study ($r = .909$), however, was lower than the test-retest ($r = .99$) and interrater ($r = .94$) reliability previously reported for hand-held dynamometer measurements of elbow flexion force. The lower correlation in this study may be due to differences between the subjects used in this study and those used in the previous studies. The two earlier studies involved patients who demonstrated a more diffuse intersubject distribution of force measurements (coefficients of variation exceeding 50%) than the healthy subjects in this study (coefficients of variation of less than 22%). The patients in the earlier studies were also considerably weaker than the healthy subjects in this study and, therefore, were easier to test. Because the reliability of the make tests and break tests was similar (ie, differing by less than 1.5%), one testing method cannot be interpreted as easier to perform or preferable to the other based on relative reliability.

Although the reported results of this study do not provide a basis for selecting one test over another, clinicians may have other reasons for selecting one test in lieu of another. These reasons should be communicated and, where appropriate, tested for validity.

<table>
<thead>
<tr>
<th>Test</th>
<th>Trial</th>
<th>$\bar{X}$</th>
<th>$s$</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Make</td>
<td>1</td>
<td>19.13</td>
<td>3.35</td>
<td>(13.97–29.48)</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>19.20</td>
<td>3.23</td>
<td>(14.15–28.44)</td>
</tr>
<tr>
<td>Break</td>
<td>1</td>
<td>25.55</td>
<td>5.38</td>
<td>(16.83–37.74)</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>24.75</td>
<td>4.72</td>
<td>(17.01–34.93)</td>
</tr>
</tbody>
</table>

*Force in kilograms.

CONCLUSIONS

As other writers have suggested, break tests were accompanied by higher force production than make tests in this study. If the tester has adequate muscle strength, both make tests and break tests can be repeated reliably with a hand-held dynamometer. Because the reliability of one procedure was not clearly superior to the other in this study, other factors must determine whether clinicians use make tests or break tests with hand-held dynamometers.

REFERENCES