Comparison of Two Methods of Goniometry

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This investigation was conducted to determine if there are significant differences between the lateral and the over-the-joint methods of goniometry for measurements of the elbow joint. Forty physical therapy students with previous goniometric training were divided randomly into four goniometric measurement groups: 1) lateral method for an obtuse angle, 2) lateral method for an acute angle, 3) over-the-joint method for an obtuse angle, and 4) over-the-joint method for an acute angle. All students in each group participated in four sessions during which a proctor’s elbow joint was measured according to the method of the assigned goniometric measurement group. The joint was held in a fixed position by a plywood stabilizing device. The results of a three-factor analysis of variance with repeated measures on one factor showed that there was no difference between the lateral and the over-the-joint methods of goniometric measurement of the elbow joint.

Key Words: Elbow joint, Goniometry, Physical therapy.

Goniometry, the measurement of joint motion, is an essential tool for assessing a patient with muscular, neurological, or skeletal disability. Goniometric measurements may be used to quantify functional loss, physical disability, progression of a disease process, or effectiveness of a treatment program. To be useful as a clinical evaluation tool, however, goniometric measurements must be reliable and fairly easy to perform.

The accepted lateral method of measurement, as described by Moore, calls for sighting specific landmarks and aligning the goniometer arms with these landmarks. Another method, the over-the-joint method of goniometric placement, was recommended by Moore for use with small joints, such as finger and toe joints. According to the latter method, the goniometer is placed over the dorsal or extensor surface of the joint being measured.

Use of the over-the-joint method for measuring larger joints is not supported in the literature, except in a study by Fort on the reliability of measurements of the knee joint. In this study, four physical therapy students measured the stabilized knee joint of 40 subjects using both the lateral and the over-the-joint methods of goniometry. The knee joint of 20 of the subjects was positioned to form an obtuse angle, and the other 20 formed an acute angle. Mean square values from an analysis of variance (ANOVA) with repeated measures were used to construct the reliability coefficients. With both the acute angle and the obtuse angle, the over-the-joint method of measurement was found to be more reliable than the lateral method.

In a study by Hamilton and Lachenbruch, seven physical therapists measured the angles of three joints on the index and the long fingers with the subject’s hand held in position by a stabilizing device. One observation with each of three goniometers (a universal type, a brass dorsal goniometer, and a pendulum goniometer) was made on four consecutive days. The ANOVA showed mean differences among the instruments to be nonsignificant. The investigators concluded that the three types of goniometers used in their study measured with the same degree of reliability. Using the universal goniometer and the dorsal finger goniometer may be compared in their placement to the lateral and the over-the-joint methods, respectively, in the present study.

Hamilton and Lachenbruch emphasize that the problems inherent in using both the lateral and the over-the-joint methods of goniometric placement with certain clinical conditions must be given special consideration when choosing a goniometric method. Factors such as edema, scars, immature wounds, and joint irregularity may contribute to inaccurate goniometric measurements with the “recommended” method of measurement for that joint. If it is determined that there is no difference in the reliability of these two methods, the therapist will be free to choose either the over-the-joint method or the lateral method according to the patient’s particular clinical problems.

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The need for further study comparing the lateral and the over-the-joint methods of goniometric measurement of large joints is apparent from the paucity of studies found in the literature. The purpose of this study was to see if there are significant differences between the lateral and the over-the-joint methods of goniometric measurement of the elbow joint.

**METHOD**

**Testers**

Forty testers, all student volunteers from programs in physical therapy, were used in this study. Each tester had training in both the lateral and the over-the-joint methods of goniometry from physical therapy lectures and practical labs.

**Materials**

A one-sided, half-circle metal goniometer with 12-in arms and 2.5-degree increments was used by each tester. Reliability tests of this type of goniometer have been reported in the literature. Hamilton and Lachenbruch found an average variance of 2.81 degrees for the four repeated measurements of seven physical therapists using this type of goniometer. A plywood stabilizing device was built to hold the proctor's elbow in a fixed midposition for all measurements (Fig. 1). The use of this device or similar devices is necessary because of the influence of changing dynamics of joint motion on repeated tests. The following materials were used to make this stabilizing device: one piece of ¾-in plywood 12 in by 24 in, five 5-in wooden dowels, and five nails. The dowels were inserted into the board at positions corresponding to an obtuse angle of approximately 125 degrees and an acute angle of approximately 45 degrees. Both an obtuse and an acute angle were used because the reliability of measurement may differ depending on whether the angle being measured is acute or obtuse. The dowels were positioned so that for each of the two angles used, one dowel lay in the axilla of the person using the stabilizing device, another in the elbow crease, and the third in the distal wrist crease of the hand (Figs. 2, 3). The dowel positioned in the elbow crease of the obtuse angle was made to be removable so it would not hinder measuring the acute angle.

**Procedure**

The 40 testers were randomly assigned to one of four groups. Each group had a different combination of method of measuring and type of angle to measure: 1) lateral method for an obtuse angle, 2) lateral method for an acute angle, 3) over-the-joint method for an obtuse angle, and 4) over-the-joint method for an acute angle.

Training. In the training sessions the testers were given specific instructions by the proctor for their particular group's method. The instructions for the lateral method were given according to Moore. The testers were told to align the stationary arm of the goniometer with the lateral midline of the humerus and the acromial process and to align the moving arm with the lateral midline of the radius and the styloid process. The testers were also told that the axis of the goniometer would be located over the approximate...
TABLE 1

Analysis of Variance for Differences Between Two Methods of Goniometric Measurements of the Elbow Joint

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intertester</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Method (M)</td>
<td>0.98</td>
<td>1</td>
<td>0.98</td>
<td>NS</td>
</tr>
<tr>
<td>Angle (A)</td>
<td>214073.48</td>
<td>1</td>
<td>214073.48</td>
<td>4858.87*</td>
</tr>
<tr>
<td>M X A</td>
<td>53.48</td>
<td>1</td>
<td>53.48</td>
<td>NS</td>
</tr>
<tr>
<td>Error between</td>
<td>1586.10</td>
<td>36</td>
<td>44.06</td>
<td>...</td>
</tr>
<tr>
<td>Intrasitter</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trials (T)</td>
<td>7.30</td>
<td>3</td>
<td>2.43</td>
<td>NS</td>
</tr>
<tr>
<td>M X T</td>
<td>5.12</td>
<td>3</td>
<td>1.71</td>
<td>NS</td>
</tr>
<tr>
<td>A X T</td>
<td>5.74</td>
<td>3</td>
<td>1.91</td>
<td>NS</td>
</tr>
<tr>
<td>M X A X T</td>
<td>3.87</td>
<td>3</td>
<td>1.29</td>
<td>NS</td>
</tr>
<tr>
<td>Error within</td>
<td>560.78</td>
<td>108</td>
<td>5.19</td>
<td>...</td>
</tr>
</tbody>
</table>

*p < .05.

joint center if the goniometer arms were correctly placed.

The groups performing the over-the-joint method received instructions to apply the goniometer to the midline of the dorsal or extensor surface of the joint, to adjust the arms until contact was made along each of the goniometer arms, and to use equal, firm pressure under each part of the goniometer. They were told to avoid using excessive pressure and that the axis would fall outside the joint.

After receiving instructions in the training session, the testers were required to demonstrate the technique to the proctor. The testers were considered proficient when they could demonstrate knowledge and skill in each of these specific criteria: 1) correct identification of landmarks, 2) correct placement of the goniometer arms, and 3) appropriate pressure of goniometer placement.

Testing. The testers participated in four testing sessions, one on each of four days. In each session, the testers measured the proctor's stabilized elbow joint using the assigned method and angle. Only one measurement was performed at each session. The goniometer was closed after each tester's measurement, and the blank side was always toward the tester. At no time were the testers told the value of the measurement. The proctor, with his arm in the stabilizing device, read and recorded each measurement that the testers made on his elbow joint. Complete extension was defined as zero degrees, and flexion as 180 degrees. The same room, the same proctor, and the same goniometer were used for each tester in each of the four testing sessions.

Analysis of Data

A three-factor analysis of variance with repeated measures on one factor (Lindquist Type III True Experimental Design) was used, and the F ratios were computed. The ANOVA was conducted to test the significance of the main effects (method of measurement, angle measured, and trials) and the interaction effects. The mean square values were computed as estimates of intratester and intertester variance. The means and standard deviations for each group were also computed.

RESULTS

The results of the ANOVA are presented in Table 1. The only significant F ratio was for the main effect of the angle. The ANOVA revealed no significant intratester variance according to the F ratios of the trials factor and its interactions. The intratester variance was less than the intertester variance using the mean square values as estimates of variance. The means and standard deviations of the measurements according to method and joint angle are presented in Table 2.

DISCUSSION

In this study with 40 testers and one subject the two methods of goniometric measurement, the lateral and the over-the-joint methods, did not lead to significantly different tester performance when all data associated with each method were combined for the angle and then averaged over the four trials. These findings compare favorably with the results found by Hamilton and Lachenbruch in their study comparing the reliability of a dorsal finger goniometer, a universal goniometer, and a pendulum goniometer. Using the universal goniometer and the dorsal finger goniometer may be compared to the lateral and the over-the-joint methods, respectively, in the present study.

TABLE 2

Means and Standard Deviations of Goniometric Measurements*

<table>
<thead>
<tr>
<th>Method</th>
<th>Obtuse Angle</th>
<th>Acute Angle</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>X</td>
<td>s</td>
</tr>
<tr>
<td>Lateral</td>
<td>120.69</td>
<td>4.24</td>
</tr>
<tr>
<td>Over-the-Joint</td>
<td>119.69</td>
<td>4.21</td>
</tr>
</tbody>
</table>

*n = 10 for each method/angle combination.
The $F$ value of the meter factor in their study was not significant and can be compared with the nonsignificant $F$ value of the method factor in the present study. They concluded that the types of goniometers used in their investigation measured with the same degree of reliability.

Conversely, the results of the present study do not support those of the study by Fort on the reliability of the lateral versus the over-the-joint method of goniometric measurement of the knee joint. Fort uncovered differences in the two methods of goniometric measurement, which were described in terms of estimates of reliability. The estimate of reliability for the lateral method at an acute angle was .84, and the estimate for the over-the-joint method at the acute angle was .93. With the obtuse angle, the lateral method had a reliability coefficient of .18, and the over-the-joint method a coefficient of .95. No test of significance was performed. Fort studied measurement of the knee joint, a larger joint than the elbow joint used in this study. In the knee joint, the bony landmarks are slightly more widely separated than in the elbow joint, making it more difficult for the tester to attain and retain correct alignment of the goniometer using the lateral method. This may account for Fort’s finding that the lateral method was less reliable and for the present study finding no difference between the two methods.

The ANOVA in this study revealed no significant intratester variance. This finding supports claims in the literature that an individual tester is capable of making accurate repeated observations to provide reliable information of joint function. Using the mean square values as estimates of variance, the intratester variance with the variation due to the trials and their interactions removed (5.19) was less than the intertester variance with variation due to the method, angle, and their interaction removed (44.06). These statistics are supported in the literature in many investigations.

In this study, the means for the two methods at each angle were not significantly different either statistically or practically. As shown in Table 2, the differences between the means were less than two degrees; a difference of greater than five degrees has been assumed to indicate practical significance. An advantage of the lateral method is that edema and scars do not contribute significantly to goniometric difficulties as they do with the lateral method.

CONCLUSION

Most authors recommend the lateral method for measuring large joints. This study, however, did not find the lateral method to be significantly different from the over-the-joint method with measurements of the elbow joint of one subject without clinical problems. Investigations should be undertaken of all the joints, using various types of patients, particularly those with clinical problems that might hinder accurate measurements. Even though the over-the-joint method of goniometric measurement is not currently recommended for use with larger joints, the results of further investigations in this area may alter this recommendation.

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