Hamstring Muscle Tightness

Reliability of an Active-Knee-Extension Test

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The purpose of this study was to examine intratester reliability of a test designed to measure tightness in the hamstring muscles. The test measures the angle of knee flexion with a pendulum goniometer after active knee extension with the hip stabilized at 90 degrees flexion. The angle of knee flexion represents hamstring tightness. After an instruction session for the subjects, the hamstring muscle tightness of both extremities of 15 men was measured during test and retest sessions. The reliability coefficients for test and retest measurements were .99 for the left extremity and .99 for the right extremity. High reliability resulted from strict body stabilization methods, a well-defined end point of motion, and accurate instrument placement. If conducted properly, the test should provide therapists with an objective and reliable tool for measuring hamstring muscle tightness.

Key Words: Knee, Leg, Muscles, Physical therapy, Thigh.

Tests for measuring hamstring muscle tightness reported in the literature are variations of the straight-leg-raising (SLR) test. These variations include the passive bilateral SLR test, the passive toe-touch test, the active unilateral SLR test, and the passive unilateral SLR test. All of these tests measure hamstring tightness by the angle of hip flexion with the knee extended. Questions must be raised, however, about using the SLR test to examine hamstring muscle tightness. A comprehensive review of the literature by Urban revealed that in addition to measuring hamstring tightness, the SLR test is also widely used as a neurological test, because the SLR test causes elongation of the sciatic nerve and associated structures. Consequently, one should consider the problem of stretching neurological tissue during SLR testing. In addition, a recent study using cinematographic analysis of the passive unilateral SLR test concluded that because of pelvic rotation during the test, measurements of the SLR/horizontal angle do not give a valid indication of hamstring length.

Because of the confusion over what limits hip flexion with SLR tests (muscular or neurological tissue) and because of the recently reported doubt that the passive unilateral SLR test is valid for measuring hamstring length, we believe alternative methods of measuring hamstring tightness should be considered. We designed a test that measures hamstring tightness by the angle of knee flexion after active knee extension while the hip is stabilized at 90 degrees flexion. We believe this active-knee-extension (AKE) test is more objective than the SLR test for measuring hamstring tightness. The purpose of this study was to investigate intratester reliability of the AKE test.

METHOD

Subjects and Instructions

Fifteen healthy men ranging in age from 18 to 26 years, with a mean age of 21 years, volunteered to participate in this study. Subjects were limited to men with "normal" muscle strength and range of motion of the hips and knees who had no history of orthopedic or neurological disorders. All data were gathered in the physical therapy complex on the University of Montana campus.

To learn the test procedures, the subjects attended one instruction session the evening before the day of testing. They were instructed to restrict excessive physical activity, such as recreational running and bicycling, and to wear loosefitting gym trunks for the tests.
The test session included both a test and a retest on the same day between 12 noon and 4 PM. Three subjects were tested each afternoon. They relaxed supine on beds for 5 minutes before the initial tests and for 30 minutes between tests and retests. Neither physical activity nor sleep was allowed during the rest periods. One investigator tested hamstring tightness of both extremities.

**Starting position.** Each subject was positioned supine on an examination table, and the lower extremity not being measured was secured to the table with a cloth strap across the thigh. Another cloth strap was placed over the anterior superior spines of the ilia to stabilize the pelvis (Fig. 1).

The examiner drew a line between the fibular head and lateral malleolus of the leg to be examined. This line represented the longitudinal axis of the leg and provided a reference for accurate placement and replacement of a pendulum goniometer.* The goniometer was then placed along the line and secured by two elastic straps with Velcro fasteners, and the extremity was positioned in a parasagittal plane. The goniometer responded to gravity, thus the need to establish an axis of motion was eliminated.

With assistance from the subject, the hip was flexed 90 degrees (the angle was confirmed with a universal goniometer). A cross wire on a metal frame apparatus was then placed in contact with the distal anterior surface of the thigh (Fig. 1). The subject actively held the position with the knee relaxed in flexion and the ankle in plantar flexion.

**Movement and end point.** With the hip stabilized at 90 degrees flexion and the ankle relaxed in plantar flexion, the subject actively extended the knee while maintaining contact with the cross wire. Active knee extension stretched the hamstring muscles until these muscles contracted to prevent further lengthening. Because of simultaneous effort to continue knee extension, a temporary myoclonus of alternating contraction and relaxation of the quadriceps femoris and hamstring muscle groups occurred (Fig. 2). At this time, the subject was instructed not to force the leg past the point of initial, mild resistance. The subject was then told to slightly flex the knee until myoclonus stopped. At the first point of no shaking, the degree reading of knee flexion was observed and recorded (Fig. 3). The angle of knee flexion represented the point of hamstring tightness. Although each subject reported a stretch sensation and resistance when myoclonus was initiated, these were not reported at the end point of motion.

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During the instruction session we found that when the knee was extended and forced past the end point of motion, the thigh naturally moved into slight extension. Therefore, during data collection each subject was instructed to maintain contact with the cross wire to prevent this unwanted movement.

DATA ANALYSIS AND RESULTS

The mean, range, and standard deviation were tabulated for the angle of knee flexion for tests and retests of both extremities (Table). The Pearson product-moment correlation coefficient was used to determine intratester reliability. Intratester correlation coefficients for test and retest measurements were .99 for the left lower extremity and .99 for the right lower extremity.

DISCUSSION

In goniometry, locating the end point of motion is essential and must be exact to ensure accurate repeatability of measurements. In the AKE test, locating the end point of motion was reliable because we used strict body stabilization of adjacent joints. Securing the pelvis with a cloth strap and stabilizing the thigh at 90 degrees flexion isolated movement to the knee. Because knee extension was active and subjects were instructed not to force the leg past the point of initial mild resistance, we believe motion in the hip of the tested extremity, the sacroiliac joints, and the low back was eliminated. Distal to the knee, the ankle was in relaxed plantar flexion, thus preventing the gastrocnemius muscle from limiting knee extension.

In addition to the use of stabilization procedures, high reliability resulted from an end point of motion that was well defined and easily observed by the examiner. Subjects did not feel a noxious sensation, and the test required no force from subjects' body weight, gravity, or the examiner. Locating the end point of motion was therefore objective and precise.

Drawing a line between the fibular head and lateral malleolus and securing the pendulum goniometer along the line assured accurate placement and replacement of the instrument. The need to establish an axis of motion was eliminated because the goniometer adjusted to gravity. Accurate instrument placement and using a pendulum goniometer also contributed to high reliability.

The AKE test should provide both clinicians and researchers with a reliable method for measuring tightness of the hamstring muscles, and reliable measurements will permit documentation of this tightness and change in muscle tightness after a specific course of treatment. Therapists should realize that the described procedure is limited to persons with active hip flexion and knee extension; the test may not be appropriate for some patients with muscular or neurological impairment. The test may also be impractical for patients who have difficulty following directions.

We anticipate that changes may be made in the test for adapting it to some clinical settings. For example, a standard universal goniometer may be substituted for the pendulum goniometer, and an assistant's index finger or some device may be used in place of the metal frame apparatus and cross wire. If these or other changes are made, reliability may be influenced and not as high as reported in this study. Therefore, if changes are made, we recommend additional studies to establish reliability.

<table>
<thead>
<tr>
<th>Tests</th>
<th>x</th>
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<td>Right extremity</td>
<td></td>
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<tr>
<td>Test</td>
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<tr>
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<td>38.27</td>
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<td>16.71</td>
<td>.99</td>
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Fig. 3. After myoclonus the end point of motion was reached by slight knee flexion. Subjects maintained contact with cross wire, and ankle remained in plantar flexion. Angle of knee flexion was observed on degree dial of pendulum goniometer.
SUMMARY

The AKE test is an objective and reliable tool for measuring hamstring muscle tightness when conducted by one examiner under controlled conditions. High reliability depends on strict body stabilization, a well-defined and easily observed end point of motion, and precise instrument placement. The test, if conducted properly, should provide therapists in the clinic or research setting with a reliable method for measuring hamstring tightness.

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REFERENCES

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Commentary

The authors' contribution to improving the techniques by which we measure patients is commendable. Although most of the methods for testing hamstring muscle tightness that have been suggested in the literature do provide a general indication of hamstring muscle length, they do so while affecting and measuring other structures. The test for hamstring tightness suggested by the authors is a viable alternative that may test hamstring tightness more selectively than some other recommended tests. Several aspects of the test are particularly worthy of support. The test is reliable, at least when applied and reapplied within a half-hour. The test uses active knee extension with a reasonably well-defined end point. This ensures that the force applied to the hamstring muscles is relatively constant from test to test. When passive tests are used to test muscle length and joint angles, the results obtained are partially dependent on the force that is applied during measurement. As a result the clinician may find changes in muscle length simply because of day-to-day variations in the force applied to the muscle. When accurate repeated measurements of muscle length (or joint angle) are to be obtained, retesting should be performed with the same lengthening loads as are used in the initial test.

The authors reported that the test examiner drew a line along one of the axes of motion. Drawing such a line provided, as the authors suggested, a reference for accurate placement of the goniometer. Such lines can be helpful in a clinical setting as well, provided they do not move over underlying bones as nearby joints move. Particularly during early trials of a clinical regimen, such markings can provide, as they did for the authors, a more certain replacement of the goniometer. This placement allows greater confidence in judgments made regarding the efficacy of the clinical regimen. Generally, the closer the lines on the skin are to a joint, the more likely they are to migrate in relation to underlying structures. For example, a short line over the lateral malleolus will migrate anteriorly and posteriorly with ankle dorsiflexion and plantar flexion, respectively.

Other comments made by the authors may require verification. The authors stated that a cloth strap was placed over the anterior superior iliac spines to stabilize the pelvis. Such an attempt is in order; however, the ability of such a strap to prevent pelvic rotation is doubtful. Observations made firsthand and from film reveal that even with the pelvis stabilized as stated, it will rotate as the hip flexes. If the knee is straight, the pelvis may begin to rotate as hip flexion reaches 45 degrees with the horizontal (in a subject with an 80° straight leg raise). If the knee is bent, the pelvis may still rotate as hip flexion approaches 90