The Reliability of Standing Sagittal Measurements of Spinal Curvature and Range of Motion in Older Women With and Without Hyperkyphosis Using a Skin-Surface Device

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Abstract

Objective: The purpose of this study was to investigate the intrarater reliability of a skin-surface instrument (Spinal Mouse, Idiag, Voletswil, Switzerland) in measuring standing sagittal curvature and global mobility of the spine in older women with and without hyperkyphosis.

Methods: Measurements were made in 19 women with hyperkyphosis (thoracic kyphosis angle ≥50°), mean age 67 ± 5 years, and 14 women without hyperkyphosis (thoracic kyphosis angle <50°), mean age 63 ± 6 years. Sagittal thoracic and lumbar curvature and mobility of the spine were assessed with the Spinal Mouse during neutral standing, full spinal flexion, and full spinal extension. Tests were performed by the same examiner on 2 days with a 72-hour interval. The intrarater reliability of the measurements was analyzed using the intraclass correlation coefficient, standard error of measurement and minimal detectable change.

Results: Intraclass correlation coefficients ranged from 0.89 to 0.99 in both groups. The standard errors of measurement ranged from 1.02° to 2.06° in the hyperkyphosis group and from 1.15° to 2.22° in the normal group. The minimal detectable change ranged from 2.85° to 5.73° in the hyperkyphosis group and from 3.20° to 6.17° in the normal group.

Conclusions: Our results indicated that the Spinal Mouse has excellent intrarater reliability for the measurement of sagittal thoracic and lumbar curvature and mobility of the spine in older women. (J Manipulative Physiol Ther 2017;40:685-691)

Key Indexing Terms: *Spinal Curvatures; Range of Motion; Aging; Kyphosis; Reliability of Results*

Introduction

Age-related hyperkyphosis can greatly influence functional independence in older persons.[1,2] Hyperkyphosis was initially viewed as equivalent to osteoporosis and vertebral compression fracture[3,4]; however, new evidence highlights the important role back extensor muscles serve in preservation of normal spinal alignment and mobility, as well as prevention of spinal deformity.[5] Also, the benefits of therapeutic interventions on age-related hyperkyphosis have been reported.[6-8] Taken together, reliable methods are needed to assess spinal alignment and mobility and the response to treatment of age-related hyperkyphosis.

The current gold standard for quantification of hyperkyphosis is measurement of the Cobb angle of kyphosis from lateral spine radiographs.[9,10] However, this method is limited by the inability to clearly locate bony landmarks on poor-quality images,[11] dependence of the Cobb angle on

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endplate tilt of upper and lower vertebrae at the target curve,[3,10] and the high costs and high exposure to potentially harmful doses of radiation.[12] Many non-invasive external methods have been developed including the Debrunner kyphometer,[13] the flexicurve,[14] the inclinometer[15] and the Spinal Mouse.[16] Several studies have reported high reliability for the flexicurve ruler (intraclass correlation coefficient [ICC] 0.86-0.96)[14,17,18] and the Debrunner kyphometer (ICC 0.95-0.98)[14,19,20] tools for measurement of kyphosis among older women, and 2 studies reported no difference in the reliability of these devices.[14,17] The Debrunner kyphometer is no longer manufactured, and measurement with the kyphosis angle from the flexicurve requires additional time and a special formula.[16] Azadinia reported that the intrarater reliability of the flexicurve is acceptable (ICC >0.80) and that the inclinometer has higher intrarater reliability (ICC >0.95) than the flexicurve for the measurement of thoracic kyphosis the in age groups 10-30 years and 50-80 years.[21]

Another tool for measuring kyphosis is the Spinal Mouse, a noninvasive electronic computer-aided device that is moved along the length of the spine to quantify thoracic, lumbar, hip, and trunk curvature and mobility. A relatively unique property of this device is that it provides quick measurements of thoracic, lumbar, hip, and trunk curvature and mobility.[22] Results of previous studies on the reliability of the Spinal Mouse indicated good reliability for the measurement of spinal curvature and mobility (ICC 0.63-0.96); however, these studies were done in children and young persons.[16,22,23] The reliability of the Spinal Mouse has not been investigated in older persons with and without hyperkyphotic posture. Before widespread use of this device in clinical assessment, further research should be performed to evaluate the reliability of Spinal Mouse measurements in older adults with and without hyperkyphosis.

Given these limitations, we investigated the intrarater reliability of the Spinal Mouse for measurement of sagittal thoracic and lumbar curvature and mobility of the spine in older women with and without hyperkyphosis.

Methods

Participants and Experimental Design

This reliability study was carried out in a university biomechanics laboratory. Participants consisted of healthy, community-based older women (N = 38), recruited through advertisements at urban entertainment districts. Inclusion criteria were age 60-80 years, body mass index 25-33, ability to walk without an assistive device, and ability to stand independently and hold the position for the duration of testing. Participants with scoliosis, kyphoscoliosis, a history of back pain within the last year requiring medical attention, previous surgical interventions on the spine, and any spinal disease or malignancy were excluded. The study was approved by the ethics committee of Shahid Beheshti University of Medical Sciences (Tehran, Iran) (Ethics Committee No. 93617). Prior to the study, each participant signed a written informed consent.

Although a power analysis is essential for hypothesis testing, we did not test a hypothesis in our reliability study. To determine reliability, approximately 15-25 participants are required and are an adequate number in each group.[24] Eligible women were assigned at enrollment to either a hyperkyphosis (n = 20) group or normal (n = 18) group, according to the Spinal Mouse kyphosis measurement. In this study, hyperkyphosis was defined as a thoracic kyphosis ≥50°.[25,26] Five participants withdrew from the study for personal reasons (1 in the hyperkyphosis group, 4 in the normal group); therefore, 33 healthy older women (hyperkyphosis group: n = 19, normal group: n = 14) completed the study and were included in the analysis.

Instruments

A computer-assisted skin-surface device (Spinal Mouse, Idiag, Voletswil, Switzerland) used to measure spinal curvature and mobility by gliding the device manually down the back.

Procedure

Participants were tested at 2 visits within a 72-hour interval. Before the initial test day, participants attended 1 session to be familiarized with the equipment and procedures. Measurements were performed by the same examiner experienced in using the Spinal Mouse. On both test days, equipment and assessment procedures were the same. During the second test, the examiner was blinded to the test results of the previous day.

Body Composition

Height (cm) using a standard stadiometer and weight (kg) using a standard scale were collected at the initial visit. body mass index was calculated (kg/m^2).

Spinal Curvature and Mobility

Measurements of spinal curvature and mobility in the sagittal plane were performed with the Spinal Mouse in 3 test positions (Fig 1A-C):

1. Neutral standing: The participant assumed a relaxed position with the head looking forward and focused on a marker at eye level, with the feet shoulder width apart, knees straight, and arms by the side (Fig 1A).
2. Maximal flexion: With the legs straight, the participant was asked to slowly flex the trunk as far as possible, aiming to curl the head into the knees and grip hands behind the back of the lower legs for stability (Fig 1B).
3. Maximal extension: With legs straight, the participant was asked to cross arms over the front of the body and extend the trunk as far as possible (head was kept in neutral) (Fig 1C).