Reliability and Comparison of Spinal End-Range Motion Assessment Using a Skin-Surface Device in Participants With and Without Low Back Pain

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Abstract

Objective: The purposes of this study were to determine the reliability of using a skin-surface device to measure global and segmental thoracic and lumbar spine motion in participants with and without low back pain (LBP) and to compare global thoracic and lumbar motion between the 2 groups.

Methods: Forty participants were included in the study (20 adults with LBP and 20 age- and sex-matched adults without LBP). On the same day, 2 raters independently measured thoracic and lumbar spine motion by rolling a skin-surface device along the spine from C7 to S3, with participants at their end range of standing flexion and extension.

Results: In participants with LBP, global thoracic and lumbar flexion and extension end-range motion testing yielded fair-to-high intrarater reliability (intraclass correlation coefficient [ICC] = 0.76-0.96) and good-to-high interrater reliability (ICC = 0.82-0.98). Interrater reliability was fair to high (ICC = 0.77-0.93) for segmental lumbar flexion measurements in participants with LBP. No significant differences were found in global thoracic and lumbar flexion or extension end-range mobility between participants with and without LBP.

Conclusions: Global thoracic and lumbar end-range motion measurement using a skin-surface device has acceptable reliability for participants with LBP. Reliability for segmental end-range motion measurement was only acceptable for lumbar flexion in participants with LBP. (J Manipulative Physiol Ther 2016;39:434-442)

Key indexing terms: *Low Back Pain; Range of Motion; Spine; Reliability of Results*

Introduction

Spinal motion may be assessed using kyphometers, goniometers, or dual inclinometers.[1] Although these devices measure global spine mobility,[2,3] they do not allow for the objective assessment of segmental spine mobility. Radiographic assessment has been considered a gold standard for measuring static segmental spine motion. However, several studies have suggested that repeated measures of vertebral angles using radiographs can yield variation in results.[4–7] Furthermore, radiographic imaging is not the most practical assessment of mobility owing to its costs and the risks of radiation exposure to the patient.[8,9]

Alternative methods for end-range segmental motion assessment include manual evaluation of joint gliding during passive accessory intervertebral motion (PAIVM) testing or manual palpation of movement between spinous processes during passive physiological intervertebral motion (PPIVM) testing.[1] These techniques may be applied by physical therapists, chiropractors, and osteopathic physicians to determine which areas of the spine may benefit from mobilization or manipulation treatment.[10] Although manual assessment techniques can be applied in a clinical setting, they have not consistently demonstrated satisfactory reliability or validity.[11] Prior studies report poor reliability for PAIVM assessments of spinal mobility when raters were asked to compare each segment's motion to "normal," or when 9- to 11-point Likert scales were used to grade mobility.[12,13] When comparing each segment with normal, the reliability of PPIVM testing in the lumbar spine was only marginally superior to the poor levels noted for PAIVM testing.[12,14]

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A skin-surface device such as the ValedoShape (idiag AG, Fehraltorf, Switzerland) could possibly provide accurate detection of movement between spinous processes.[15,16] The ValedoShape contains accelerometers that record intersegmental distance and change of inclination of spinous processes when the device is rolled along the spine from C7 to S3. This information is wirelessly transmitted to a personal computer, where the individual's segmental and global thoracic and lumbar motion is displayed for analysis and where the individual's spinal motion can be compared with a range of sex- and age-based normalized values created by the original developer of the device.[16]

Several studies have investigated the reliability and validity of this skin-surface device in participants without reported pain. The first and largest study was conducted by Post and Leferink,[16] who tested 111 participants to determine the same-day interrater reliability for global and segmental range of motion (ROM) of spinal flexion and extension. Although global flexion and extension yielded excellent reliability as evidenced by intraclass correlation coefficients (ICCs) of 0.95 and 0.92, respectively, poor agreement ($\kappa = 0.22$) was reported for determining when segmental flexion and extension values fell outside the range of normalized values provided by the computerized system.[16] Subsequent studies have largely supported the initial findings of Post and Leferink.[16] Between-day intrarater reliability and interrater reliability of global and segmental spinal ROM assessment using this skin-surface device have been tested in 2 separate studies on 81 children and 20 adults.[15,17] The studies reported very similar ICCs, indicating good reliability for global ROM assessment, with pooled intrarater ranges from 0.57 to 0.96 and pooled interrater ranges from 0.62 to 0.94.[15,17] Both studies also showed similarities in the standard error of measurement (SEM) for spinal ROM, with values generally between 10% and 15%, but occasionally exceeding 20%.[15,17]

Although consistently high reliability has been reported for global spinal ROM assessment using the skin-surface device, a wide range of reliability was reported for segmental spinal ROM assessment. Mannion et al[15] reported the between-day intrarater and interrater reliability for segmental flexion to be poor to excellent, with reliability values ranging from 0.39 to 0.90 and 0.28 to 0.81, respectively. The SEM for these same measurements averaged 2.3°. A more recent article reported a more favorable reliability of segmental lumbar flexion, with ICCs for same-day intrarater and interrater reliability of L1 to S1 ranging from 0.63 to 0.97 and from 0.60 to 0.83, respectively.[18]

Although acceptable reliability has been reported for using a skin-surface device to measure spinal mobility in healthy asymptomatic individuals, evidence is lacking on the reliability of using a skin-surface device to assess spinal motion in participants with low back pain (LBP). Therefore, the purposes of this study were to determine the reliability of global and segmental thoracic and lumbar end-range motion measurements using a wheeled skin-surface device in participants with and without LBP and to compare end-range spinal motion measurements between the 2 groups of participants.

Methods

Participants

Adult participants with and without LBP in the prior 2 weeks were recruited from a convenience sample of patients, students, and staff at the University of Texas Southwestern Medical Center and Texas Woman's University campuses in Dallas, Texas. Sex and age matching between groups was implemented to account for the potential influence of these variables on mobility. Therefore, participants with LBP were recruited first and then age- and sex-matched individuals without LBP were solicited for participation in the study. Participants were excluded from the study if they met any of the following criteria: (1) presence of red flag signs or symptoms such as tumor, infection, or cauda equina syndrome; (2) previous spinal surgery; (3) presence of spinal fracture, ankylosing spondylitis, or rheumatoid arthritis; (4) pregnancy; (5) unable to complete segmental mobility testing owing to pain; and (6) older than 75 years. These criteria were chosen to eliminate participants who may have serious spinal pathology or who may have more significant limitations of spinal motion than the general population. Institutional review board approval for this study was obtained from the data collection site at Texas Woman's University prior to the commencement of the study. All participants were provided with information regarding the study and signed consent forms prior to undergoing testing.

An a priori power analysis was performed using G*Power 3.1.3.[19] Using a medium effect size of 0.55 and an α level of .05, approximately 40 participants (20 with LBP and 20 without LBP) were required in order to obtain a power of 0.80. Forty-five adult participants met the inclusion criteria and agreed to participate in the study. After participants signed a written consent form, 1 investigator (J.Z.) screened each participant for the exclusion criteria. Five participants were excluded, including 1 who was older than 75 years, 1 for the presence of a spinal fracture, and 3 for a previous spinal surgery. All 40 eligible participants completed the study, 20 with LBP and 20 without LBP. The 20 participants with LBP (29.95 ± 10.35 years; 15 women; body mass index, 24.7 ± 3.9 kg/m^2) reported the presence of low back or leg pain of lumbosacral spine origin at the time of testing and for an average duration of 50.6 ± 58.4 months. Twenty participants without LBP (29.90 ± 10.18 years; 15 women; and body mass index, 22.9 ± 3.2 kg/m^2) denied the presence of low back or