Research Report

JMST

Reliability of Hamstring Flexibility Test with Hip Inferior Glide Mobilization in Patients with Low Back Pain

Jun-seok Kim, BSc[1]; Ui-jae Hwang, PT, Ph.D[2]; Oh-yun Kwon, PT, Ph.D[3]; Kyue-nam Park, PT, Ph.D[1]

[1]Department of Physical Therapy, College of Medical Science, Jeonju University, Jeonju, South Korea
[2]KOREATECH & Yonsei R&D Center, Department of Smart KEMA Station, Seoul, South Korea
[3]Laboratory of Kinetic Exercise based on Movement Analysis, Department of Physical Therapy, Graduate School, Yonsei University, Wonju, South Korea

Background Hamstring tightness is a major cause of low back pain (LBP). The active knee extension (AKE) test is frequently used to measure hamstring tightness in supine-positioned subjects. In patients with musculoskeletal pain, it is important to maintain the axis of rotation for accurate range of motion assessment.

Purpose The purpose of this study was to investigate the intrarater test-retest reliability of an AKE test with belt-guided inferior gliding of the hip, which was designed to minimize excessive anterior-superior gliding of the hip in LBP patients with hamstring tightness. We also compared the range of AKE with versus without inferior gliding of the hip in this study population.

Study design Reliability study.

Methods Thirty-eight patients with LBP and hamstring tightness were recruited to this study. Hamstring tightness was measured in a supine AKE test, with and without inferior gliding of the hip, using the Smart KEMA device. Test–retest reliability was assessed by the intraclass correlation coefficient (ICC). Significant differences in the range of AKE between the groups were detected using a paired sample *t*-test.

Results The hamstring flexibility tests with and without inferior gliding of the hip exhibited good to excellent test-retest reliability (ICC=0.89 for both). The range of AKE with inferior gliding of the hip was significantly less than that of AKE without inferior gliding of the hip.

Conclusions Assessment of hamstring flexibility via an AKE test with inferior gliding of the hip is reliable when applied to patients with LBP; the range of AKE was lower in this test compared to those that do not incorporate inferior gliding of the hip.

Key words Active knee extension; Hamstring tightness; Inferior gliding; Lower back pain; Range of motion.

JMST
2019; 3(1): 26-30
Published Online
Jun 30, 2019
pISSN 2635-8573
eISSN 2635-8581

Article History
Received 03 May 2019
Revised 03 May 2019 (1st)
Revised 20 May 2019 (2nd)
Accepted 21 May 2019

CONTACT
knpark@jj.ac.kr
Kyue-nam Park ,
Department of Physical Therapy, College of Medical Science, Jeonju University, Jeonju, South Korea

INTRODUCTION

Low back pain (LBP) is a leading cause of disability worldwide and is associated with major economic costs.[1,2] Approximately 90% of adults will suffer from LBP during their lifetime.[3] Individuals with hamstring tightness are at an increased risk of developing LBP.[1] Hamstring tightness promotes increased lumbar flexion during forward-bending tasks and reduces lumbar lordosis, which contributes to LBP.[3,4]

To assess hamstring flexibility in LBP patients, the active knee extension (AKE) and straight leg raise test are commonly administered to subjects in the supine position.[5] Both tests showed excellent reliability for individuals with hamstring tightness.[6] However, unwanted pelvic rotation during the straight leg raise test may promote neurological symptoms and LBP.[7]

Previous reports suggested that the axis of rotation remains constant during performance of the active straight leg raise test in the supine position.[8,9] Excessive hip anterior-superior gliding (femoral head anterior translation) during performance of the active straight leg raise test in the supine position is minimized by co-activation of hip stabilizer and hip flexor muscles.[9] Maitland and Mulligan utilized a belt to support inferior hip gliding during performance of the active straight leg raise in the supine position, which prevented excessive femoral head anterior translation and maintained the axis of rotation.[10,11]

The reliability of the AKE test with belt-guided inferior gliding of the hip, as performed by LBP patients with hamstring tightness, has not been investigated. Therefore, the primary purpose of this study was to investigate the intrarater test-retest reliability of the AKE test with inferior gliding of the hip, supported by a belt to minimize anterior-superior gliding, as performed by LBP patients with hamstring tightness. In addition, this study compared the range of AKE with and without inferior gliding of the hip. We hypothesized that the AKE test with inferior gliding of the hip would show high reliability and increase hamstring length.

METHODS

Participants

Thirty-eight subjects with chronic LBP and hamstring tightness participated in this study. The inclusion criteria were (1) pain intensity greater than 3 on a visual analog scale (VAS; score range: 0–10 points) and (2) hip flexion of less than 80° with knee extension during the passive straight leg raise.[12] Participants were excluded if they required medical attention for a hamstring injury within the past year, or had severe joint pain other than LBP, a history of acute LBP within the previous 2 months, or a cardiovascular or neurological disorder. All subjects signed an informed consent form, which was approved by the Institutional Review Board of Jeonju University (jjIRB-2018-1202).

Instrumentation

To record the range of AKE, we used the Smart KEMA motion sensor (KOREATECH Co, Ltd., Seoul, Korea). The inertial measurement unit (IMU) contained a tri-axillar gyroscope, a magnetometer, and an accelerometer. Data from the motion sensor were recorded at a 25-Hz sampling frequency and transmitted to an Android tablet running Smart KEMA software. Additionally, to monitor the force of inferior gliding of the hip, we used a Smart KEMA tension sensor (KOREATECH Co, Ltd., Seoul, Korea), which transmitted data at a 10-Hz sampling frequency to a tablet personal computer (PC) running Smart KEMA software. The tension sensor contained a load cell with a measurement range of 0–1,960 N (accuracy of 4.9 N).

Procedure

Each subject provided information regarding their height, weight, age, and medical history, and LBP intensity was measured using the VAS pain scale; LBP duration and level of disability were measured using the Oswestry Disability Index (Table 1). The test-retest reliability data were collected later on the same day. The order of the tests was randomized using the randomize function in the Microsoft Excel program.

1) Active knee extension test with inferior gliding of the hip

A hard wooden plate was positioned under the treatment table to anchor and stabilize the belt. Subjects were placed in the supine position on the treatment table and asked to flex their hip and knee at 90°. The non-test leg was maintained at 0° hip and knee flexion. The distal part of the anterior thigh touched the stationary bar, which was then moved toward the thigh to maintain 90° hip flexion. A motion sensor was strapped above the lateral malleolus line.[13] Inferior gliding of the passive hip was achieved using two non-elastic belts, one of which was fastened at the inguinal line of the test leg. The second belt was fastened to the hook of a hardwood plate (Figure 1A). A tension sensor was fastened tightly at a point between the two belts and inferior gliding of the hip of the passive hip was achieved

Table 1. Subject characteristics

Characteristics	Value
Gender (M/F)	23/18
Age (years)	22.63±1.89
Height (cm)	171.64±9.68
Weight (kg)	69.79±18.37
Duration of pain (years)	2.56±1.41
VAS (0–10)	3.74±0.90
ODI	18.05±7.62

Data are expressed as mean±standard deviation.
Abbreviations: AKE, active knee extension; M, male; F, female; VAS, visual analogue scale; ODI, Oswestry disability index.

Figure 1. Range of active knee extension with (A) versus without (B) inferior gliding of the hip, measured using the smart KEMA system (C).

using 10 N of force. This force was determined according to the results of a pilot study. For habituation, each subject performed five AKE tests with their resting ankle in the plantar position. Readings from the tablet PC confirmed that subjects began the test with 90° of knee flexion. The subjects were asked to actively perform knee extension and then maintain the position until the end of the AKE test. We recorded the range of AKE during the final 5 s of the test. Subjects performed three consecutive AKEs, with a 1-min rest between each test. The range of AKE in the two conditions was recorded as 0° at the starting position, which flexed knee at 90°.

2) Active knee extension test without inferior gliding of the hip

The AKE tests without inferior gliding of the hip were administered exactly as described above, except that the steps describing inferior gliding of the hip were omitted (Figure 1B).

Statistical analysis

The results of three AKE tests, with and without inferior gliding of the hip, were averaged for analysis of the range of AKE. To investigate within-day intrarater test-retest reliability, data from the first and second trial of each AKE test were analyzed. The Kolmogorov–Smirnov test confirmed a normal data distribution. The intraclass correlation coefficient (ICC [3,1]) was used to measure intrarater test-retest reliability. A correlation coefficient ≥0.75 was considered "good to excellent," 0.50–0.75 was considered "moderate to good," 0.25–0.50 was considered "fair," and 0.00–0.25 indicated "little or no relationship".[14] A paired sample *t*-test was used to compare the AKE range between the two test conditions. All statistical analyses were performed using SPSS software (ver. 21.0; IBM Corp., Armonk, New York, USA). The significance threshold was set at $p<0.05$.

RESULTS

Both versions of the AKE (with and without inferior gliding of the hip) showed good to excellent intrarater test-retest reliability (ICC=0.89, 95% confidence interval [CI]: 0.78–0.94, $p<0.05$; and ICC=0.89, 95% CI: 0.78–0.94, $p<0.05$, respectively). The range of AKE with inferior gliding of the hip was significantly reduced compared to that without inferior gliding of the hip (mean difference, 5.59±10.04°) (Table 2).

DISCUSSION

This study investigated the within-day intrarater test-retest reliability of a AKE hamstring flexibility test with belt-guided inferior gliding of the hip, as performed by LBP patients with hamstring tightness. The method exhibited good to excellent intrarater test-retest reliability, which agrees with previous studies on healthy subjects (range of ICC: 0.86–0.92) and those with short hamstring muscles.[5,15] In addition, the test with inferior gliding of the hip showed a reduced AKE range compared to that without.

A key difference between the studies mentioned above and our study was that we used an IMU sensor, rather than a goniometer or electrogoniometer, because the IMU sensor is a more accurate measurement tool.[16] Thus, we recommend

Table 2. Range of active knee extension with versus without inferior gliding of the hip

	AKE without inferior gliding	AKE with inferior gliding	Mean of difference	*p*-value
Range of AKE (°)	50.41±10.62	44.54±12.14	5.59±10.04	0.001

Abbreviations: AKE, active knee extension.

that the IMU sensor be used for AKE tests with inferior gliding of the hip, to reliably measure hamstring tightness in LBP patients.

In this study, the range of AKE without inferior gliding of the hip was 50.14±10.61°. In a previous study, the range of AKE in healthy subjects (mean age, 20.8 years) was measured at 44.70° using a goniometer[7], versus 54.92° in LBP patients (mean age, 38.8 years) measured using an electrogoniometer; this latter result is similar to that of our AKE method that excluded inferior gliding of the hip (50.14°).[16] Interestingly, the range of AKE with inferior gliding of the hip (44.55±11.98°) was significantly reduced compared to that without inferior gliding of the hip (50.14±10.61°). Maintaining the path of instantaneous center of rotation is important when assessing precise motion during active movement[5]; However, patients with musculoskeletal pain have difficulty in this regard during hip flexion in the supine position. Uncontrolled femoral head translation during the straight leg raise occurs during initial hip flexion, and with hip flexion below 45°.[9] Tactile feedback from the posterior greater trochanter or anterior region of the hip can minimize femoral head translation and reduce the range of hip flexion by altering motor control.[9] Our study indicates that belt-guided inferior gliding of the hip may maintain the path of instantaneous center of rotation and prevent uncontrolled superior gliding during AKE, thus reducing AKE range compared to similar methods not including inferior gliding of the hip.

Our study had some limitations. First, the subjects were all relatively young, with only mild cases of LBP. Therefore, whether our findings are applicable to older populations with more severe LBP is not known. Second, we did not measure joint stability during AKE in the supine position because we had difficulty in imaging the femoral head using ultrasonography. Lastly, we set the force as 10N for inferior gliding based on a pilot study. Future study should investigate which force is proper to move femoral head inferiorly during AKE using radiography. Additionally, future studies should measure inter- and intra-rater reliability when AKE is applied in combination with inferior gliding of the hip.

CONCLUSIONS

A hamstring flexibility test that incorporates AKE and inferior gliding of the hip proved reliable for younger patients with mild LBP. Performance of this test reduced AKE range relative to the control. Therapists and clinicians should bear these findings in mind during the performance of flexibility assessments for LBP patients with hamstring tightness, to minimize unwanted femoral head translation.

Key Points

Question How reliable is an active knee extension test with belt-guided inferior gliding of the hip for assessing hamstring flexibility in patients with low back pain?

Findings The active knee extension test with inferior gliding of the hip exhibited good to excellent intrarater test-retest reliability.
The incorporation of inferior gliding of the hip maintains joint stability and reduces knee extension range during the active knee extension test.

Meaning We recommend incorporation of inferior gliding of the hip into the active knee extension test as an alternative and reliable method for assessing hamstring flexibility in clinical practice.

Article information

Conflict of Interest Disclosures: None.
Funding/Support: None.
Acknowledgment: None.
Ethic Approval: IRB was approved (Jeonju University institutional review board; jjIRB-2018-1202).

REFERENCES

1. Sadler SG, Spink MJ, Ho A, et al. Restriction in lateral bending range of motion, lumbar lordosis, and hamstring flexibility predicts the development of low back pain: a systematic review of prospective cohort studies. *BMC Musculoskeletal Disorders*. 2017;18(1):179.
2. Raftry SM, Marshall PW. Does a 'tight' hamstring predict low back pain reporting during prolonged standing? *Journal of Electromyography and Kinesiology*. 2012; 22(3):407-411.
3. Alston W, Carlson KE, Feldman DJ, et al. A quantitative study of muscle factors in the chronic low back syndrome. *Journal of American Geriatrics Society*. 1966;14(10): 1041-1047.
4. Johnson EN, Thomas JS. Effect of hamstring flexibility on hip and lumbar spine joint excursions during forward-reaching tasks in participants with and without low back pain. *Archives of Physical Medicine and Rehabilitation*. 2010;91(7):1140-1142.
5. Gajdosik RL, Rieck MA, Sullivan DK, et al. Comparison of four clinical tests for assessing hamstring muscle length. *Journal of Orthopaedic & Sports Physical Therapy*. 1993;18(5):614-618.
6. Neto T, Jacobsohn L, Carita AI, et al. Reliability of the active-knee-extension and straight-leg-raise tests in subjects with flexibility deficits. *Journal of Sport Rehabilitation*.

2015;24(4):pii:2014-0220.
7. Gajdosik R, Lusin G. Hamstring muscle tightness. Reliability of an active-knee-extension test. *Phys Ther*. 1983; 63(7):1085–1090.
8. Sahrmann SA. *Diagnosis and treatment of movement impairment syndromes.* St. Louis, MO: Mosby Inc; 2002.
9. Comerford M, Mottram S. *Kinetic control. The management of uncontrolled movement.* Sydney: Elsevier; 2012.
10. Maitland G. *Peripheral manipulation*. London, United Kingdom: Butterworth; 1991.
11. Mulligan B. *Manual therapy: "nags", "snags", "mwms" ect.* Wellington: Plane View Services Ltd.; 2010.
12. Castellote-Caballero Y, Valenza Maríe C, Puentedura Emilio J, et al. Effects of neurodynamic sliding versus muscle stretching on hamstring flexibility in subjects with short hamstring syndrome. *Journal of Sports Medicine*. 2014;2014:127471.
13. Jung SH, Kwon OY, Yi CH, et al. Predictors of dysfunction and health-related quality of life in the flexion pattern subgroup of patients with chronic lower back pain. *Medicine*. 2018;97(29):e11363.
14. Portney LG, Watkins MP. Foundations of clinical research. Upper Saddle River, NJ: Prentice Hall; 2009.
15. Hamid MS, Ali MR, Yusof A. Interrater and intrarater reliability of the active knee extension (AKE) test among healthy adults. *Journal of Physical Therapy Science*. 2013;25(8):957-961.
16. Shamsi M, Mirzaei M, Khabiri SS. Universal goniometer and electro-goniometer intra-examiner reliability in measuring the knee range of motion during active knee extension test in patients with chronic low back pain with short hamstring muscle. *BMC Sports Science. Medicine and Rehabilitation*. 2019;11:4.