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Measurement properties of a hand-held inclinometer during straight leg raise neurodynamic testing

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Abstract

Objectives The most common lower quarter neurodynamic test is the straight leg raise (SLR) test. Quantification of limb motion during SLR testing should utilize reliable and valid measurement tools that are highly sensitive to change. The purpose of this study was to determine the psychometric properties of a hand-held inclinometer commonly utilized during SLR testing.
Design Cross-sectional measurement, intra-rater reliability and validity study.
Setting Research laboratory.
Participants Twenty individuals without pain in their low back or extremities and no history of nerve injury participated in the study.
Main outcome measures Two repetitions of the SLR were performed in each limb in two ankle positions (plantar flexion and dorsiflexion). A digital inclinometer and digital goniometer were utilized as the comparisons for range of motion measurements.
Results Intra-rater reliability for the hand-held inclinometer during SLR testing was excellent (ICCs, 0.95 to 0.98). The standard error of measurement was between 0.54° and 1.22° and the minimal detectable change was between 1.50° and 3.41°. Construct validity revealed hand-held inclinometer measurements were highly correlated with both the digital inclinometer and digital goniometer measures. The mean difference scores between hand-held inclinometer and digital inclinometer (∼1.5°) and digital goniometer (∼10°) suggest that the hand-held inclinometer better matches the construct measured by the digital inclinometer (limb elevation angle) compared to the digital goniometer (hip flexion angle).
Conclusions The hand-held inclinometer is a valid method for measuring limb elevation angle during the SLR neurodynamic test in a research setting. The hand-held inclinometer has high reliability and low minimal detectable change when used in healthy individuals.

Keywords: Validity; Reliability; Minimal detectable change; Mechanosensitivity; Neural tension

Introduction

Passive straight leg raise (SLR) neurodynamic testing is commonly utilized to investigate the mechanosensitivity of the lower quarter nervous system [1–3] and involves passively flexing a patient's hip with the knee held in full extension [4]. In order to be confident that the limitations in motion and symptoms provoked are related to the nervous system, additional sensitizing maneuvers are utilized for purposes of structural differentiation [5]. For instance, the addition of passive neck flexion or ankle dorsiflexion are often used to add additional stress to the posterior neural structures in the lower limb, without changing the stress to the hamstring musculature or hip joint [1,2,6,7]. Ankle dorsiflexion can be applied after performing the SLR to the onset of symptoms or prior to the SLR to create a "sensitized" test which can be compared to a SLR with ankle plantar flexion. If this additional movement or pre-positioning alters symptoms or reduces available hip flexion range of motion, the limitation is thought to be related to neural structures.

Quantifying the range of motion during SLR neurodynamic testing is useful to establish baseline status for mechanosensitivity of the nervous system and track change after intervention. It is important to have a reliable and valid measurement tool for quantifying SLR range of motion that is also responsive to measuring change after intervention. The tool should have a high reliability and responsiveness to change so that improvements measured can be confidently attributed to real change and not measurement error. Ideally that tool will also represent a valid measurement of the construct under investigation, limb motion.

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Two reviews in the past decade have identified that the reliability of determining a positive SLR neurodynamic test was quite variable and depends upon the testing procedures, study participants and the measurement device used [3,8]. One of these reviews focused on range of motion measurements during SLR [8]. Because the measurement tools in the studies reviewed included standard goniometry or various forms of inclinometry (either a pendulometer or a hydrogoniometer to measure the limb angle relative to gravity) as well as other methodological variability and limitations, it was not possible to pool the data and determine overall reliability [8]. A hand held inclinometer (pendulometer type) that measures in 1° increments was chosen for the present study because it is both inexpensive (~$20) and easy to manipulate by a single examiner during SLR testing. The purpose of the present study was to determine the validity, intra-rater, intra-session reliability, and measurement error properties of a hand-held inclinometer during neurodynamic testing in a research setting.

Methods

Twenty healthy participants, 17 female and 3 male between the ages of 24 and 62 with a mean (SD) age of 36.9 (12.8) (median age: 32), were recruited from the local medical and academic communities. Exclusion criteria included current or recent (greater than 3 consecutive days in past 6 months) low back or lower extremity pain. Additionally, volunteers were excluded if they had a diagnosis of peripheral neuropathy, diabetes mellitus, complex regional pain syndrome, chemical dependence or alcohol abuse, a history of lower extremity nerve trauma, lumbar spine surgeries, or chemotherapy use. Participants had to meet flexibility requirements of isolated hip flexion (greater than 90°) with the knee flexed, full knee extension, and ankle range of motion greater than 0° dorsiflexion and greater than 30° plantar flexion. The institutional review board at Samuel Merritt University approved this study and assured ethical treatment of participants and that the rights of the participants were protected. Informed written consent was obtained from all participants prior to testing.

Experimental procedures

The participant was positioned in supine with a standardized foam head support (2.5 cm thick) on a padded plinth. Care was taken to assure the participant's spine was in neutral in the coronal plane (no side bending), upper arms were resting at their side, and lower limbs were in neutral abduction. Measurement devices were secured to the limb prior to SLR testing (Fig. 1). A hand-held inclinometer[1] was held against the anterior aspect of the mid-tibia during testing. A digital inclinometer was affixed to the anterior tibia, distal to the tibial tuberosity, and a digital goniometer was placed laterally across the hip joint to measure sagittal and coronal plane motion (Fig. 1).[2] The digital goniometer was placed with the proximal end parallel to the participant's torso on the lateral pelvis and with the distal end on the lateral thigh in line with the lateral femoral condyle [1,2]. The digital inclinometer and digital goniometer were held in place with double-sided tape and straps. The digital inclinometer and digital goniometer are highly precise devices that have been previously utilized to quantify limb motion during SLR [1,2,9,10] and were therefore utilized as the comparisons for range of limb motion in this study. The participants held an electronic trigger button in their dominant hand resting on their abdomen, which was used to indicate when symptoms were elicited. Prior to utilization of the hand-held inclinometer, digital inclinometer and digital goniometer, the devices were placed on a flat, horizontally leveled surface and zeroed. The digital inclinometer, digital goniometer and hand-held trigger data were acquired at 1000 Hz using a Myosystem 1400 unit.[3]

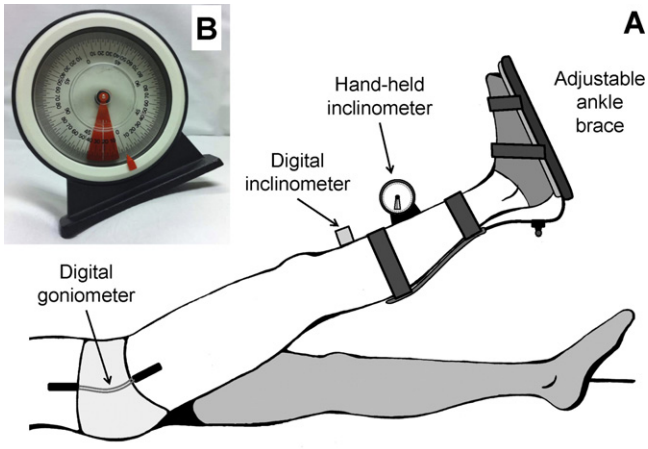

Fig. 1. The passive straight leg raise (SLR) neurodynamic test (A). The subject's ankle was placed in an ankle brace that could be adjusted to 30° of plantar flexion for the PF/SLR test or to neutral (0°) ankle dorsiflexion for the DF/SLR test. The digital goniometer was positioned over the lateral aspect of the hip joint. The hand held inclinometer and the digital inclinometer were positioned on the anterior surface of the tibia. The hand-held inclinometer produces measurements in 1° increments (B), indicating limb motion relative to horizontal.

The ankle was secured in relative dorsiflexion (DF: 0°) or plantar flexion (PF: 30°) by use of an APU® PRAFO® ankle brace with outrigger bar and straps in order to minimize the effect of variations in ankle positioning on the test outcomes (Fig. 1).[4] Dorsiflexion to 0° was chosen for the "sensitized" SLR due to the common limitation of ankle dorsiflexion with the knee in full extension and has been used previously

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