Review Article

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Anatomical, Mechanical and Clinical Evidence for Straight Leg Raise Neurodynamic Testing: Implications for Orthopaedic Examination

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Abstract

The objective of this review paper was to provide an evidence informed overview on the anatomical, mechanical and clinical basis for straight leg raise (SLR) as a neurodynamic test in the evaluation and treatment of neuroorthopaedic disorders. There were four anatomical studies that measured nerve-specific strain and excursion during different movement combinations of SLR, four mechanical studies that evaluated responses to structural differentiation in asymptomatic participants, and seven clinical studies that reported interlimb differences, measurements using ultrasonography and handheld inclinometer, and psychometric properties in people with lumbar disc herniation, lumbar radiculopathy and/or sciatica. There is scope for further research using modified SLR techniques for common peroneal, sural and saphenous nerves.

Keywords: Straight Leg Raise; Physical Examination; Neurodynamic Testing; Clinical Orthopaedics.

The objective of this review paper was to provide an evidence informed overview on the anatomical, mechanical and clinical basis for straight leg raise (SLR) as a neurodynamic test in the evaluation and treatment of neuroorthopaedic disorders.

Neuroanatomical Evidence

Coppieters et al [1] studied eight embalmed cadavers to measure sciatic, tibial and plantar nerves excursion and strain during the modified SLR (ankle dorsiflexion is performed before hip flexion) and found that ankle dorsiflexion resulted in a significant strain and distal excursion of the tibial nerve. With the ankle in dorsiflexion, the proximal excursion and tension increase in the sciatic nerve associated with hip flexion were transmitted distally along the nerve from the hip to beyond the ankle.

Gilbert et al [2]described the displacement and strain of the of L4, L5, and S1 nerve roots in the lateral recess during straight leg raise (SLR) in 5 unembalmed cadavers and found that the lumbosacral nerve roots in the lateral recess moved less and experienced less strain during SLR, with significant distal displacement occurred at hip positions greater than 60 degrees of flexion at all nerve root levels.

Gilbert et al [3] compare the displacement and strain of the L4, L5, and S1 nerve roots during SLR with no preposition (SLR NPP) of the ankle and SLR with dorsiflexion preposition (SLR DF) as two different conditions of straight leg raise (SLR) in 5 unembalmed cadavers. SLR NPP was found to produce larger distal displacement at L5 and S1, compared with SLR DF.

Boyd et al [4] evaluated sciatic and tibial nerves strain and excursion during variations in sequencing of ankle dorsiflexion in the straight leg raise (SLR) test. The proximal-to-distal sequence consisted of hip flexion followed by ankle dorsiflexion (HIPFLEX/ ANKLEDF); the distal-to-proximal sequence consisted of ankle dorsiflexion followed by hip flexion (ANKLEDF/HIPFLEX). Although the end position did not differ between sciatic and tibial nerves, nerve strain was found to increase earlier and maintained longer in regions closest to the joint that was moved first in the movement sequence.

Neuromechanical Evidence

Boyd et al [5] investigated the biomechanics of the sciatic nerve (excursion and strain)with sequential hip flexion and ankle dorsiflexion in live and euthanized Sprague-Dawley rats after traumatic nerve injury. Significant strain and proximal excursion of the sciatic nerve were observed in all groups during hip flexion, and additional increased strain was noted during dorsiflexion which was further increased at 7 days after nerve injury.

Cameron et al [6] studied the influence of contralateral hip flexion versus extension, active versus passive testing, and trial repetitions on the SLR in 22 healthy subjects. Hip position affected SLR relative to horizontal and pelvis relative to horizontal, with an increase in measurement occurring with the opposite hip flexed. Nature of the trial (active vs. passive) affected SLR to pelvis and pelvis to horizontal with an increase in measurement for passive SLR.

Boyd et al [7] studied 20 healthy subjects and explored how ankle position affects lower extremity neurodynamic testing. "Onset of symptoms (P1) and at the point of maximally tolerated symptoms (P2) during straight-leg raise tests performed with ankle dorsiflexion (DF-SLR) and plantar flexion (PF-SLR) were assessed and found that hip flexion was reduced during DF-SLR by 5.5 degrees at P1 and 10.1 degrees at P2, compared to PF-SLR. DF-SLR induced distal muscle activation and broader proximal muscle contractions at P1 compared to PF-SLR."

Herrington et al [8] assessed the effect of structural differentiation or sensitizing manoeuvres on responses to straight leg raise (SLR) of 88 normal subjects by measuring hip flexion angle in two conditions; ankle dorsi-flexion and neutral.A significant reduction in hip flexion occurred following structural differentiation in SLR for both groups, though showed no difference between sides.

Clinical Evidence

Boyd and Villa [9] measured the limb elevation angle during SLR that involved pre-positioning the ankle in plantar flexion (PF/SLR) and neutral dorsiflexion (DF/SLR) anddetermined normal asymmetries between limbs in 40 healthy individuals (20 in research testing conditions, 20 in clinical testing conditions). The range of motion during SLR was related to sex, weight, BMI and activity level, with inter-limb differences during SLR neurodynamic testing falling below 11 degrees in 90% of the general population of healthy individuals. In addition, inter-limb differences were not found to be affected by demographic factors.

Ridehalghet al [10] evaluated the reliability of a frame-by-frame cross correlation method of assessing longitudinal sciatic nerve excursion motion using real time ultrasound imaging during knee extension at 30° and 60° of hip flexion (HF) SLR test in 18 asymptomatic participants and found excellent repeatability of in vivo sciatic nerve excursion measurements.

Boyd [11] assessed the psychometric properties of a hand-held inclinometer for measurement of range of motion in SLR testing in 20 asymptomatic participants on whom SLR was performed in two ankle positions (plantar flexion and dorsiflexion). "Intra-rater reliability for the hand-held inclinometer during SLR testing was excellent. 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)."

Walsh and Hall [12] studied 45 subjects with unilateral leg painto determine agreement and correlation between the SLR and slump tests and found a substantial agreement between the 2 tests with good correlation in ROM on the symptomatic side. In subjects who had positive results, ROM for both tests was significantly reduced compared to ROM on the contralateral side and ROM in subjects who had negative results.

Capra et al [13] assessed the validity of SLR using magnetic resonance imaging (MRI) results as a reference standard in a group of patients with L4-L5 and L5-S1 lumbar-herniated disks and sciatic pain through a retrospective chart review of 2352 patients. "Sensitivity was 0.36, whereas specificity was 0.74. Positive and negative predictive values were 0.69 and 0.52, respectively. Positive LR was 1.38, and negative LR was 0.87. Diagnostic odds ratio was 1.59, and ROC analysis showed an area under the curve (AUC) of 0.596."

Rabin et al [14] compared the sensitivity of supine SLR and seated SLR in 71 patients with lumbar radiculopathy who underwent MRI examination as the criterion standard assessment. The sensitivity of the supine SLR test was .67 compared with a sensitivity of .41 of the seated SLR test. "The traditional SLR test performed in a supine position is more sensitive in reproducing leg pain than the seated SLR test in patients with lumbar radiculopathy and MRI evidence of nerve root compression."

Scaiaet al [15] assessed the diagnostic accuracy of pain responses during SLR in patients with lumbar disc herniation, lumbar radiculopathy, and/or sciatica through a systematic review which identified 7 articles with variable reports of sensitivity and specificity with 4 suggesting that a pain response SLR is sensitive whereas 3 suggested it is a specific measure.

There were four anatomical studies that measured nerve-specific strain and excursion during different movement combinations of SLR, four mechanical studies that evaluated responses to structural differentiation in asymptomatic participants, and seven clinical studies that reported interlimb differences, measurements using ultrasonography and handheld inclinometer, and psychometric properties in people with lumbar disc herniation, lumbar radiculopathy and/or sciatica. There is scope for further research using modified SLR techniques for common peroneal, sural and saphenous nerves.

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