Intrarater and Interrater Reliability of the Single-Leg Squat Test

Michael D. Kennedy, PhD; Lisa Burrows; and Eric Parent, PhD, PT • University of Alberta

Functional testing is widely used to assess recovery of normal joint function during rehabilitation or as a screening tool to detect impairments during a preparticipation evaluation. Functional testing can indirectly reveal deficiencies in muscular strength and power. Many lower extremity functional testing protocols include unilateral or bilateral squats. The single-leg squat (SLS) is often preferred, because it replicates a common athletic position, and it requires control of the trunk over a single leg thereby challenging all of the lower extremity joints. Three-dimensional (3D) kinematic analysis is considered the gold standard for assessment of lower extremity function. Because it is expensive and laboratory-based, its use for preparticipation screening of athletes is impractical. The SLS has been widely used for clinical assessment of lower extremity joint function, even though criteria to define an adequately performed squat are limited. The SLS has merit for preseason screening. It is simple to administer and may yield important information about an athlete’s lower extremity function.

Criterion-referenced assessment of the SLS by athletic trainers (0–3 rating: hip flexion < 65 degrees, hip adduction < 10 degrees, and knee valgus < 10 degrees) has been reported to yield poor interrater Kappa values for occurrence of knee valgus (0.28) and hip adduction (0.16). An acceptable level of interrater reliability has been reported for experienced physical therapists who rated a videotaped SLS performance as either good or poor. An acceptable level of intrarater reliability has been reported for the number of repetitions of a single-limb task performed in 30 seconds by patients with patello-femoral pain syndrome (antero-medial lunge ICC = 0.82; step down ICC = 0.94). Discriminate validity of SLS assessment has been established for 3D motion analysis of knee movement in subjects with and without patella-femoral pain syndrome, as well as acceptable test-retest reliability for frontal plane femoral angle (ICC = 0.74–0.83). Intrarater and interrater reliability of SLS performance assessment through repetition counts and subjective ratings have not been established. The purpose of this study was to determine the intrarater and interrater reliability of a standardized single-leg squat screening test that was used to assess a large cohort of varsity athletes.

Key Points

- Single-leg squat (SLS) reliability is adequate for evaluation of acceptable repetitions completed.
- Interrater reliability is poor for identification of a specific limiting factor.
- Interrater reliability improves when choice is either “perfect” or “with any limitation.”
- More standardized criteria are needed to reduce subjectivity assessment of SLS performance.
Procedures

Forty-two varsity athletes were randomly selected from a pool of 281 athletes, representing 11 varsity teams that included the following sports: men’s and women’s basketball, men’s and women’s hockey, men’s and women’s wrestling, men’s and women’s swimming, women’s volleyball, and women’s field hockey. Inclusion criteria included completion of a preparticipation medical questionnaire, active varsity athlete status, and participation in preseason fitness testing. The project was conducted in accordance with the research ethics board guidelines of the institution, and participants provided informed consent. Three board-certified athletic therapists (ATs) with 3–5 years of professional experience and a minimum of 5 years of university education administered the test. Training included an afternoon of pilot work that involved each therapist assessing SLS performance multiple times and collective feedback that included instructions to give to athletes during administration of the test.

Single-Leg Squat Test Administration

The SLS test procedure is depicted in Figure 1. Each participant was provided with a verbal cue at the beginning of the SLS test to “think about sitting on a chair and extend your non-weight bearing leg at the knee with your foot just off the floor.” Prior to assessment, one practice trial was performed on each leg, and the AT asked the participant if any clarification of instructions was needed. A metal bar was positioned at the level of the knee joint line in a standing position so that the participant’s buttocks touched it at full descent. The athlete was instructed to perform five repetitions on each leg, starting with the right leg. The AT stopped the athlete when loss of balance made performance of a subsequent squat impossible. The test was also stopped if the athlete did not achieve adequate squat depth (i.e., failure to touch the buttocks to the metal bar in > 3 seconds). All properly performed SLS repetitions were filmed in the frontal plane by a digital video camcorder (Panasonic, PV-S320) that was located 9 m from the center of the squat station and 1 m above the floor.

Reliability Evaluation

Four investigators reviewed the frontal plane video recordings of the test, including the AT who administered the test. All four of the investigators had a similar level of knowledge in the area of athlete health and performance. The investigators counted the number of repetitions adequately completed and selected the most significant factor that limited performance among the following: trunk, hip, knee, lower leg, and other (Table 1). Perfect performance was defined as the absence of any obvious abnormality in trunk, hip, knee, lower leg, or other lower extremity movement. The limiting factors were selected by a panel of clinicians that included the athletic therapy staff, a physical therapist, and an exercise physiologist.

Figure 1 Start position of single-leg squat test (A) and completion of descent into position of hip and knee flexion (B). Successful completion of a repetition required the buttocks to touch metal bar that was positioned at knee joint line when participant was standing. All videotapes were obtained in the frontal plane at a distance of 9 meters (C).