What Does the Single Leg Step Down Test Measure? Contributions of Core and Hip Strength

Jeremy M Burnham MD1, Michael C Yonz MD1, Kaley Robertson2, Akash Patel2, Mary Lloyd Ireland MD FACS1, and Brian Noehren PhD2

1Department of Orthopaedic Surgery and Sports Medicine, College of Medicine, University of Kentucky
2Division of Physical Therapy, BioMotion Laboratory, College of Health Sciences, University of Kentucky

INTRODUCTION

Lower extremity injuries are an increasingly common, and potentially devastating, occurrence among athletes of all ages. These sports-related injuries have significant personal, societal, and economic impacts. The implications are even more sobering when focusing on specific injuries, such as anterior cruciate ligament (ACL) tears. There are over 200,000 ACL injuries in the US each year1 and some estimate that over 175,000 ACL reconstructions (ACL-R) are performed annually at a total cost of over $2 billion. This has led to an increased focus on injury prevention mechanisms and a call for more objective and cost-effective measures of readiness for return-to-play (RTP).

Research has shown a connection between lower extremity injury and weak hip strength, as well as decreased trunk control. Although several studies have examined the connection between hip strength and performance on single leg squats or step-downs, few studies have examined the relationship between trunk strength and these single leg activities. The goal of this study was to evaluate the relationship of hip and trunk strength with performance on the timed Single Leg Step Down test (SLSD).

METHODS

71 participants, aged 19 to 45 years of age (mean 25.49 ± 1.24, 33 females, 38 males) completed this study. Isometric testing of hip abduction strength, hip external rotation strength, and hip extension strength was performed with a handheld dynamometer. Trunk strength was measured using timed plank and side plank bridging tests. The participant was required to hold the described plank positions for as long as possible. The Single Leg Step-Down test (SLSD) was performed by having the participant stand on a 20 cm riser with a five cm tall platform placed directly in front of the riser. A single step-down repetition consisted of the participant flexing the stance (right) knee, touching the scale with the left heel with no more than 10% of body weight, and then returning to the start position. Performance on the test was recorded as the number of successful repetitions completed in a 60 second period.

Figure 1: Demonstration of (A) hip external rotation (B) hip abduction, (C) hip extension, (D) plank, (E) side plank, and (F) step-down tests

KEY POINTS

• Plank time was a significant predictor of SLSD performance
• This effect was strongest in females
• Plank and side plank times, hip abduction, hip external rotation, and hip extension strength were all significantly correlated with SLSD performance in univariate analysis
• The SLSD test can be used as a screening tool to identify individuals with weak trunk and hip strength, and may be useful in injury prevention and return-to-play screening in the setting of ACL injury

METHODS

71 participants, aged 19 to 45 years of age (mean 25.49 ± 1.24, 33 females, 38 males) completed this study. Isometric testing of hip abduction strength, hip external rotation strength, and hip extension strength was performed with a handheld dynamometer. Trunk strength was measured using timed plank and side plank bridging tests. The participant was required to hold the described plank positions for as long as possible. The Single Leg Step-Down test (SLSD) was performed by having the participant stand on a 20 cm riser with a five cm tall platform placed directly in front of the riser. A single step-down repetition consisted of the participant flexing the stance (right) knee, touching the scale with the left heel with no more than 10% of body weight, and then returning to the start position. Performance on the test was recorded as the number of successful repetitions completed in a 60 second period.

METHODS

71 participants, aged 19 to 45 years of age (mean 25.49 ± 1.24, 33 females, 38 males) completed this study. Isometric testing of hip abduction strength, hip external rotation strength, and hip extension strength was performed with a handheld dynamometer. Trunk strength was measured using timed plank and side plank bridging tests. The participant was required to hold the described plank positions for as long as possible. The Single Leg Step-Down test (SLSD) was performed by having the participant stand on a 20 cm riser with a five cm tall platform placed directly in front of the riser. A single step-down repetition consisted of the participant flexing the stance (right) knee, touching the scale with the left heel with no more than 10% of body weight, and then returning to the start position. Performance on the test was recorded as the number of successful repetitions completed in a 60 second period.

METHODS

71 participants, aged 19 to 45 years of age (mean 25.49 ± 1.24, 33 females, 38 males) completed this study. Isometric testing of hip abduction strength, hip external rotation strength, and hip extension strength was performed with a handheld dynamometer. Trunk strength was measured using timed plank and side plank bridging tests. The participant was required to hold the described plank positions for as long as possible. The Single Leg Step-Down test (SLSD) was performed by having the participant stand on a 20 cm riser with a five cm tall platform placed directly in front of the riser. A single step-down repetition consisted of the participant flexing the stance (right) knee, touching the scale with the left heel with no more than 10% of body weight, and then returning to the start position. Performance on the test was recorded as the number of successful repetitions completed in a 60 second period.

METHODS

71 participants, aged 19 to 45 years of age (mean 25.49 ± 1.24, 33 females, 38 males) completed this study. Isometric testing of hip abduction strength, hip external rotation strength, and hip extension strength was performed with a handheld dynamometer. Trunk strength was measured using timed plank and side plank bridging tests. The participant was required to hold the described plank positions for as long as possible. The Single Leg Step-Down test (SLSD) was performed by having the participant stand on a 20 cm riser with a five cm tall platform placed directly in front of the riser. A single step-down repetition consisted of the participant flexing the stance (right) knee, touching the scale with the left heel with no more than 10% of body weight, and then returning to the start position. Performance on the test was recorded as the number of successful repetitions completed in a 60 second period.

RESULTS

Table 1: Multivariable Regression Analysis of Factors Influencing Single Leg Step Down Performance

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>SE</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plank†</td>
<td>0.017</td>
<td>0.023</td>
</tr>
<tr>
<td>Females†</td>
<td>0.093</td>
<td>0.051</td>
</tr>
<tr>
<td>Side Plank†</td>
<td>0.081</td>
<td>0.052</td>
</tr>
<tr>
<td>Females</td>
<td>0.026</td>
<td>0.016</td>
</tr>
<tr>
<td>Hip Abduction</td>
<td>0.078</td>
<td>0.046</td>
</tr>
<tr>
<td>Females</td>
<td>0.039</td>
<td>0.022</td>
</tr>
<tr>
<td>Hip External Rotation†</td>
<td>0.919</td>
<td>0.998</td>
</tr>
<tr>
<td>Females</td>
<td>0.317</td>
<td>0.268</td>
</tr>
<tr>
<td>Hip Extension†</td>
<td>0.791</td>
<td>0.758</td>
</tr>
<tr>
<td>Females</td>
<td>0.258</td>
<td>0.202</td>
</tr>
<tr>
<td>Hip Flexion†</td>
<td>0.201</td>
<td>0.197</td>
</tr>
<tr>
<td>Females</td>
<td>0.043</td>
<td>0.036</td>
</tr>
</tbody>
</table>

Figure 2: Univariate Correlational Analysis

Figure 3: Multivariable Linear Regression Analysis of Correlations Between Strength Tests and SLSD Performance

DISCUSSION AND CONCLUSIONS

To our knowledge this study is the first to correlate trunk strength to performance on these single-leg assessments. Trunk strength, as measured by plank time, is predictive of maximum step-down repetitions in males and females than hip strength, which had previously been connected with step-down performance.

The connection between weak hip muscles and lower extremity injury has been well studied, and the connection between trunk control and lower extremity injury is becoming more clearly understood. Previous research suggests that weak hip strength can lead to increased hip adduction, femoral internal rotation, and dynamic valgus of the knee, placing the lower extremity, and particularly the ACL, at risk for injury. Ligamentous knee injuries have also been associated with poor trunk control.

As we gain more knowledge about potentially dangerous knee movements and their "mechanistic connection" with the hip and core, we further understand the essential need for effective trunk control and core strength screening strategies. Single leg squats and step-downs have been described as screening tools for hip strength, but their association with trunk strength has not previously been studied.

Limitations of this study include the fact that the study population is one of convenience, and does not represent a single age group, sport, or athlete profile. Lack of standardized trunk strength and control measurements in the literature is another limitation. However, good data exists to validate the use of prone bridging tests such as the plank test for strength measurements.

Additionally, this study did not directly examine the correlation between SLSD performance and injury risk.

In conclusion, the Single Leg Step-Down test has many characteristics of an ideal injury prevention and RTP screening tool, and can be used to identify individuals with weak hip and trunk strength.