Comparison of Knee Kinematics and Kinetics During Different Landing Tasks

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METHODS

• Several tasks have been used to examine lower extremity biomechanics during landing for the purpose of evaluation and rehabilitation, especially in relation to ACL injuries. However, it can be difficult to compare results between studies utilizing different tasks and it is unclear which task may be most appropriate.

• Additionally, some tasks may have the advantage of simultaneously informing researchers on landing biomechanics and dynamic postural stability, such as the forward jump single-leg landing task.

STUDY DESIGN AND SETTING:

• Descriptive laboratory study
• University operated, Special Operations Forces human performance research laboratory

INTERVENTIONS:

• Kinematic and kinetic analysis of five different landing tasks (Figure 1):
  • (A) Double-Leg Drop-Landing (DDL)
  • (B) Single-Leg Drop-Landing (SLDL)
  • (C) Double-Leg Stop-Jump (SLSJ)
  • (D) Single-Leg Stop-Jump (SLSJ)
  • (E) Forward Jump Single-Leg Landing (FJSL)

EQUIPMENT:

• 3D Video-Based Motion Analysis System (Vicon Motion Systems Centennial, CO)
• 6 T-Series Vicon Cameras
• 2 Kistler Force Plates (Type 9286BA)

MAIN OUTCOME MEASURES:

• Hip, knee and ankle joint kinematics
• Peak knee joint forces and moments
• Peak ground reaction forces (GRF)

STUDY SAMPLE:

• A total of 66 Air Force Special Tactics personnel participated (age = 27.7 ± 5.0 years; weight = 83.1 ± 9.1 kg; height = 176.5 ± 5.7 cm) in this study

RESULTS

• Peak vertical ground reaction force (GRF) (180.1 – 504.0% body weight, p<0.001, Figure 2) and peak knee flexion angle (58.4 – 101.9 degrees, p<0.001, Figure 4) were significantly different between all tasks
• Single-leg landings generated higher vertical GRF (504.0 vs. 342.0% body weight and 271.6 vs. 180.1% body weight, p<0.001) and lower peak knee flexion (68.1° vs. 91.4° and 74.4° vs. 101.9°, p<0.001). FJSL had the lowest peak knee flexion (58.4°) and the second highest peak vertical GRF (435.1% body weight)
• SLDL generated the highest GRFs (504.0 and 50.2% body weight, respectively, p<0.001, Figures 2 & 3)
• Peak valgus moment was significantly higher during DDL (0.83Nm, p<0.001)

SUMMARY AND CONCLUSIONS

• A distinct within subject pattern of similarity between two tasks was not discernable and it does not appear to be one task that is best for eliciting a wide range of biomechanical risk factors of ACL injuries
• Multiple tasks should be considered, as certain tasks may be better suited for evaluating specific strategies as demonstrated by stop-jumps eliciting higher knee valgus angles but drop-landings eliciting higher valgus knee moments and ground reaction forces
• Researchers need to be cautious when comparing results between tasks. Athletic trainers and other clinicians need to consider these findings during evaluation of landing mechanics during assessments or rehabilitation

Figure 1. Landing Tasks

(A) (B) (C) (D) (E)

Table 1. Comparison of Landing Characteristics by Task

<table>
<thead>
<tr>
<th>Quantity</th>
<th>DDL</th>
<th>SLSJ</th>
<th>SLDDL</th>
<th>FJSL</th>
<th>ANOVA Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak HAD (deg)*</td>
<td>57.8 ± 7.3</td>
<td>57.5 ± 7.4</td>
<td>57.4 ± 7.3</td>
<td>57.2 ± 7.2</td>
<td>0.051 ± 0.010</td>
</tr>
<tr>
<td>Peak vertical GRF</td>
<td>504.0 ± 22.7</td>
<td>504.0 ± 22.7</td>
<td>271.6 ± 12.3</td>
<td>180.1 ± 10.5</td>
<td>0.001 ± 0.001</td>
</tr>
<tr>
<td>Peak GRF (mean)</td>
<td>180.1 ± 10.5</td>
<td>504.0 ± 22.7</td>
<td>271.6 ± 12.3</td>
<td>180.1 ± 10.5</td>
<td>0.001 ± 0.001</td>
</tr>
<tr>
<td>Peak GRF (median)</td>
<td>180.1 ± 10.5</td>
<td>504.0 ± 22.7</td>
<td>271.6 ± 12.3</td>
<td>180.1 ± 10.5</td>
<td>0.001 ± 0.001</td>
</tr>
<tr>
<td>Peak GRF (min)</td>
<td>180.1 ± 10.5</td>
<td>504.0 ± 22.7</td>
<td>271.6 ± 12.3</td>
<td>180.1 ± 10.5</td>
<td>0.001 ± 0.001</td>
</tr>
<tr>
<td>Peak GRF (max)</td>
<td>504.0 ± 22.7</td>
<td>504.0 ± 22.7</td>
<td>271.6 ± 12.3</td>
<td>180.1 ± 10.5</td>
<td>0.001 ± 0.001</td>
</tr>
</tbody>
</table>

1. T-statistics reported for normally distributed analyses and Chi-square from the Friedman were reported for non-normally distributed analyses

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