Comparison of Muscle Activity During Weight-bearing Exercises on Stable & Unstable Surfaces

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PURPOSE
To compare lower extremity muscle activity during forward lunge, single leg stance, and double limb squat using the STEPRIGHT™ Stability System, BOSU training system, and standard shoe.

METHODS
• 18 recreationally active subjects, 9 males and 9 females, aged 18-25 years old
• Muscle activity was measured using a SEMG system on 8 muscles of the dominant limb
• Subjects performed three functional tasks on three surface types
• Surface type and functional task order were randomized
• Metronome was used to standardize cadence

HYPOTHESIS
1. Unstable devices would cause greater muscle activation than a firm surface
2. The most difficult combination of task and surface type would be:
   a. STEPRIGHT™ single leg stance
   b. BOSU forward lunge
   c. STEPRIGHT™ forward lunge

RESULTS & ANALYSIS

Table 1: Muscle Activation Levels During Forward Lunge Across Three Surfaces

<table>
<thead>
<tr>
<th>Activation Level</th>
<th>STEPRIGHT™ Lunge</th>
<th>BOSU Lunge</th>
<th>Flat Lunge</th>
</tr>
</thead>
<tbody>
<tr>
<td>“High” (&gt;40% MVIC)</td>
<td>Rectus Fem</td>
<td>VMO</td>
<td>VMO</td>
</tr>
<tr>
<td>“Moderate” (20-40% MVIC)</td>
<td>Bicep Fem, Fib Long, Add Long</td>
<td>Rectus Fem, Bicep Fem, Fib Long, Add Long</td>
<td>Rectus Fem, Bicep Fem, Add Long</td>
</tr>
</tbody>
</table>

Table 2: Comparison of %MVIC Across Tasks with p<.05

<table>
<thead>
<tr>
<th>MUSCLES</th>
<th>BOSU &amp; STEPRIGHT™</th>
<th>STEPRIGHT™ ONLY</th>
<th>BOSU ONLY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rectus Fem</td>
<td>Lunge &gt; SLS</td>
<td>Lunge &gt; Squat</td>
<td>Squat &gt; SLS</td>
</tr>
<tr>
<td>VMO</td>
<td>Squat &amp; Lunge &gt; SLS</td>
<td>Lunge &gt; Squat</td>
<td></td>
</tr>
<tr>
<td>Glute Med, Bicep Fem</td>
<td>Lunge &gt; SLS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bicep Fem, Tib Ant</td>
<td>Lunge &gt; SLS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Add Long</td>
<td></td>
<td>Lunge &gt; Squat &amp; SLS</td>
<td></td>
</tr>
<tr>
<td>Fib Long</td>
<td>Lunge &amp; SLS &gt; Squat</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lat Gastroc</td>
<td></td>
<td></td>
<td>Lunge &amp; SLS &gt; Squat</td>
</tr>
</tbody>
</table>

CLINICAL IMPLICATIONS
• Healthy collegiate-aged participants had similar %MVIC responses on the STEPRIGHT™ and BOSU devices on dominant lower limb
• When comparing across surfaces during SLS the STEPRIGHT™ elicited higher %MVIC at the ankle than a flat surface.
• The STEPRIGHT™ lunge elicited higher %MVIC than STEPRIGHT™ squat at the hip and ankle muscles
• Since the BOSU and STEPRIGHT™ devices are similar in cost, physical therapists may opt to choose the STEPRIGHT™ since it can be worn over the shoe for more mobile tasks compared to other unstable devices.

LIMITATIONS
• Population chosen was healthy, recreationally active, collegiate-aged individuals
• Neuromuscular balance factors not measured
• Electrode placement, manual muscle testing, and task performance were subject to variability
• Metronome and standardized task procedures may have altered body mechanics typically used during functional tasks

FUTURE RESEARCH
• Assess whether fatigue or endurance training affects %MVIC across unstable surfaces
• Same procedures performed on clinically relevant populations (i.e. patients with chronic ankle instability, patients with balance deficits)
• Comparison of balance training program using STEPRIGHT™ compared to other unstable surfaces