COMPRESSION APPAREL EFFECTS ON JUMP PERFORMANCE AND HIP JOINT MECHANICS DURING DROP JUMPS FROM THREE HEIGHTS

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INTRODUCTION
Compression apparel is normally made with elastic fabric that conforms to the body contour. This elastic element provides certain compression which is evenly applied to limbs, trunk, and other specific body areas (Gladfelter, 2007). In recent years, compression garments as commercial products have been proposed to play a positive role in improving strength, endurance, and recovery of athletes (Davies, et al., 2009; Houghton, et al., 2009). Changes in kinematics parameters are reckoned to be one of the mechanisms for such enhanced performance (Doan, et al., 2003). However, much of the other work in this area has focused on evaluating the superficial relationship between kinematic changes and performance, but has not further considered why these changes occur and what the underlying kinetics reveal. Therefore, the purpose of this study was to investigate the effect of compression shorts on jump performance (height), hip joint angle, hip joint moment, and hip joint stiffness during drop jumps from three different heights.

METHODS
Twelve male basketball players (age: 23.7 ± 2.7 yrs, height: 178.3 ± 2.5 cm, weight: 70.0 ± 4.6 kg, years played: 6 yrs above) were recruited for this experiment. All were requested to wear two types of shorts [nylon-elastane compression shorts (CS) vs. loose fitting shorts (as a control condition, CC)] to execute three trials of maximal effort drop jump from each of height (30, 45, and 60 cm) from a custom-made platform. A VICON motion analysis system (120 Hz) and two 60 × 90 cm force plates (Kistler, 1200 Hz) were used to collect kinematics and kinetics data simultaneously.

The jump height \((h_0)\) was determined by the vertical takeoff velocity of the center of gravity \((v_0)\) with the following equation:

\[
h_0 = \frac{v_0^2}{2g}.\]

Data analysis of kinematics and related kinetics were processed through Visual 3D software (C-motion Corporation, USA). Inverse dynamics technique was utilized to calculate the hip joint moment. Hip joint stiffness \((k_{\text{hip}})\) was defined as the change in joint moment \((\Delta M)\) divided by the change in joint angle \((\Delta \theta)\) during the first half of the ground-contact phase (Farley et al., 1998).

Other variables discussed in this study for hip joint mechanics were maximum & minimum hip joint angle \((\theta_{\text{max}} \& \theta_{\text{min}})\), hip joint range of motion \((\theta_{\text{ROM}})\), and maximum & minimum hip joint moment \((M_{\text{max}} \& M_{\text{min}})\) during the stance phase. A 2 × 3 (condition × height) repeated measures analysis of variance (ANOVA) was used to determine the effects of compression shorts and drop heights on jump performance, hip joint angle, moment, and stiffness. Tukey post hoc tests were used to determine individual significant differences. The significant level was set at \(\alpha = 0.05\).

RESULTS AND DISCUSSION
No significant differences of jump height were observed between compression shorts (CS) and control condition (CC) during jump drops from all three heights (Figure 1). For the hip joint angle, the \(\theta_{\text{max}}\) and the \(\theta_{\text{min}}\) were significant greater in the CS compared to CC from all drop heights (Table 1). The hip joint angle-time curve from touchdown (time % = 0) to take-off (time % = 100) during a drop jump from a 60 cm height was showed in Figure 2. There was an evident increase of joint angle in the CS condition. However, the \(\theta_{\text{ROM}}\) in CS condition was not significantly different from that in CC. For the hip joint moment, no compression effect was found on the \(M_{\text{max}}, M_{\text{min}}, \) and \(\Delta M\) during the drop jumps from 30 cm and 45 cm heights. However, during the drop jumps from 60 cm, the \(M_{\text{max}}\) and the \(M_{\text{min}}\) were greater in CS condition compared to CC (Table 1). Meanwhile, according to the representative hip joint moment-time curve, there was...
an average increase of 48.2% in joint moment in the CS condition (Figure 3).

There were no changes in hip joint stiffness between two shorts conditions during drop jumps from 30 and 45 cm heights (Figure 4). However, there was still a trend towards an 8.3% increase at 60 cm height ($p = 0.07$). In addition, there was a significant effect of a height change ($p < 0.05$) as expected.

CONCLUSIONS
The commercial compression shorts adopted in the present study did not improve jump height during drop jumps from three heights. However, the tight and compression fit results in a great change in hip joint kinematics and a considerable moment generated by the hip both in flexion and extension phases during 60 cm drop jumps. Future research is warranted to investigate this effect in jumping events (e.g., high jump and long jump) and further confirm the role of compression apparel on joint stiffness as well as performance benefits.

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REFERENCES

Table 1: Hip joint angle and hip joint moment between compression shorts (CS) and control condition (CC) during jump drops from three heights.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Hip Joint Angle (°)</th>
<th>Hip Joint Moment (Nm/kg)</th>
</tr>
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<tbody>
<tr>
<td>Height</td>
<td>$\theta_{\text{max}}$</td>
<td>$\theta_{\text{min}}$</td>
</tr>
<tr>
<td>30 cm</td>
<td>CS 166.5±6.8*</td>
<td>111.4±5.9*</td>
</tr>
<tr>
<td></td>
<td>CC 162.0±5.9</td>
<td>106.1±4.7</td>
</tr>
<tr>
<td>45 cm</td>
<td>CS 169.4±8.6*</td>
<td>112.0±6.0*</td>
</tr>
<tr>
<td></td>
<td>CC 163.2±5.5</td>
<td>103.1±9.5*</td>
</tr>
<tr>
<td>60 cm</td>
<td>CS 166.5±6.3*</td>
<td>108.1±7.0*</td>
</tr>
<tr>
<td></td>
<td>CC 163.3±6.0</td>
<td>101.3±6.8</td>
</tr>
</tbody>
</table>

* indicate a significant difference compared to the CC, $p < 0.05$. 

Figure 3: Comparison of shorts conditions on the hip joint moment during a drop jump from a 60 cm height.

Figure 4: Influence of compression shorts (CS) on the hip joint stiffness during drop jumps from three heights.