GROUND REACTION FORCE OF DROP LANDING ON SYNTHETIC TURF AND SHOCKPADS

Qu, H1, Zhang, SN2, Sorochan, J3, Weinhandl, J2
1Motion Analysis Lab, Department of Human Physiology, University of Oregon, Eugene, OR USA
2Biomechanics and Sports Medicine Lab, Department of Kinesiology, Recreation and Sport Studies, The University of Tennessee, Knoxville, TN, USA
3Department of Plant Science, The University of Tennessee, Knoxville, TN, USA
email: hqu@uoregon.edu, web: https://choulab.uoregon.edu/

INTRODUCTION
Turf has been widely utilized in sports since 1964. Discrepancies, however, in injury incidence on synthetic turf and natural grass have been reported throughout studies [1]. Adding a shock pad under synthetic turf carpet is claimed to aid in energy absorption and decrease impact loading. Although some studies have conducted materials tests and compared mechanical characteristics of synthetic turf with different shock pads, no studies have examined biomechanical characteristics of impact related human movements on an infilled synthetic turf system with different underlying shock pads.

The purpose of this research was to investigate effects of an infilled synthetic turf with three shock pads of different energy absorption characteristics on vertical ground reaction force (vGRF) drop landing. We hypothesized that turf and turf systems would result in lower peak vGRFs and their loading rates compared to the regular surface.

METHODS
Wearing running shoes, twelve active and healthy recreational male athletes performed five trials of drop landing from 60 cm with a controlled landing style (maximum knee flexion) on five surface conditions: a regular surface (force platform), an infilled synthetic turf, turf plus foam shock pad (SP1), turf plus a lower-density shock pad (SP2), and turf plus a high-density shock pad (SP3). Two force platforms were utilized to collect GRF data.

All GRF variables were processed and computed in Visual3D biomechanics software suite (5.0, C-Motion, Inc., Germantown, MD). GRFs were normalized to body weight (BW). The dependent variables included 1st and 2nd vGRF peaks and loading rates.

A one-way (Surface) repeated measures analysis of variance (ANOVA) was performed to determine effects of five surface conditions on the variables of interest for each of the two movements separately (23, IBM SPSS Statistics, Chicago, IL). An alpha level was set at 0.05 a priori. Post hoc comparisons using a paired-sample t-test with Bonferroni adjustments were conducted to determine differences across surface conditions when a significance of main effect occurred.

Table 1: Peak vertical ground reaction forces and related loading rates: mean ± SD

<table>
<thead>
<tr>
<th>Surfaces</th>
<th>Regular surface</th>
<th>Infilled turf</th>
<th>Infilled turf + SP1</th>
<th>Infilled turf + SP2</th>
<th>Infilled turf + SP3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st peak vGRF (BW)</td>
<td>1.58 ± 0.30</td>
<td>1.44 ± 0.24</td>
<td>1.37 ± 0.25a</td>
<td>1.37 ± 0.27a</td>
<td>1.38 ± 0.27a</td>
</tr>
<tr>
<td>Loading rate_1st peak vGRF (BW/s)</td>
<td>146.4 ± 34.9</td>
<td>116.4 ± 28.1a</td>
<td>116.5 ± 26.9a</td>
<td>109.2 ± 22.4a</td>
<td>115.5 ± 23.5a</td>
</tr>
</tbody>
</table>

a: Significantly different from regular surface.

RESULTS AND DISCUSSION
The 1st peak vGRF was higher on regular surface compared with the conditions of turf plus SP1 (p=0.003), turf plus SP2 shock pad (p=0.002), and turf plus SP3 (p=0.022). Previous studies documented that, by comparing landing on a soft and a stiff mat, surface stiffness was not a crucial factor related to the 1st peak vGRF [2, 3].

The loading rate for 1st peak GRF was higher in regular surface compared to the conditions of turf only (p=0.004, Table 1), turf plus SP1 (p=0.001), turf plus SP2 (p=0.001), and turf plus SP3 (p=0.002, Table 1). Lower loading rate could decrease the risks of injury. Due to the time to 1st peak vGRF occurred only about 11 ms after the initial ground contact, human body was not quick enough to be actively involved in impact dissipation. These results indicate that adding shock pad to a synthetic turf system had effects on attenuating more impact forces.

No differences were found in 2nd GRF and its loading rate across the surface conditions. Since we have controlled the landing stiffness (strategy) by limiting the maximum knee flexion to fall within (100 ± 9°), the landing height may play an important role in affecting the peak vGRFs’ results. The results suggest that the turf systems may be “bottomed out” and insufficient to attenuate the heel contact impact force during 60 cm landing.

CONCLUSIONS
Overall, the turf plus shock pad systems seem to provide improved impact attenuation for landing activities from heights of 60 cm or lower.

REFERENCES

ACKNOWLEDGEMENTS
Adidas and Astro Turf are acknowledged for donating the running shoes, turf carpet, and shock pads.