IN-SHOE PRESSURE DISTRIBUTION ANALYSIS OF SOCCER SPECIFIC MOVEMENTS

Eils E¹, Streyl M¹, Linnenbecker S¹, Thorwesten L², Völker K² Rosenbaum D¹
¹Funktionsbereich Bewegungsanalytik (Movement Analysis Lab), Orthopaedic Department, University of Muenster, Germany;
²Institute of Sports Medicine, University of Muenster, Germany

Introduction
Overload injuries are a common problem in soccer (Knapp et al 1998). Although several investigations have described frequency and types of injuries (Inklaar 1994; Keller et al 1987; Tucker 1997) there is no quantitative information available concerning the foot loading characteristics in soccer specific movements. Therefore, the purpose of this investigation was to characterize and compare in-shoe pressure measurements during different soccer specific movements.

Methods
21 experienced male soccer players participated in the study. Their mean age, mass and height was 25.5±1.8 years, 78.7±5.4 kg and 182.9±5.7 cm, respectively. The Pedar Mobile system (Novel GmbH, Munich) was used to collect plantar pressure information. All subjects were fitted with new soccer shoes (with a typical 12-stud FG plate) and tested on an athletic field on red cinder. Four soccer specific movements were performed: a normal run at 4.1 m/s, a cutting maneuver at approximately 70% of maximum speed, a sprint and a goal shot. Peak pressures and relative loads were extracted for ten areas (medial and lateral heel (01, 02), medial and lateral midfoot (03, 04), medial, central and lateral forefoot (05, 06,07) and hallux, second toe and lateral toes (08, 09, 10), Fig. 1). A repeated measures Anova with the alpha-level set to 5% and the Scheffe test for post-hoc comparisons were used for statistical analysis.

Results
Different movements showed distinct pressure patterns (Fig. 2). Compared to the normal run, the cutting movement led to a significant load shift to the heel, midfoot, first metatarsal head and hallux (Fig. 3, left). In sprinting, the load shifted significantly to the medial and central forefoot and the toes (Fig. 3, center). Under the supporting leg in goal shot, significantly increased values on the lateral part of the heel and midfoot were found (Fig. 3, right).

For the four different movements, extreme loading of specific areas was found (table 1). In running, a typical pressure pattern was found with the main loading areas under the heel, metatarsal heads and hallux. In cutting, the heel, first and second metatarsal head and hallux were exposed to high pressures. Pressures under the heel were twice as high as in running. In sprinting, especially the first and
second ray were loaded and in kicking, highest pressures were found under the lateral part of the heel, midfoot and forefoot.

Fig. 3.: Shift of load in soccer specific movements. The gray areas indicate a significant increase of load compared to running.

<table>
<thead>
<tr>
<th>Peak Pressures [N/cm²]</th>
<th>01</th>
<th>02</th>
<th>03</th>
<th>04</th>
<th>05</th>
<th>06</th>
<th>07</th>
<th>08</th>
<th>09</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Run</td>
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<td>31±6</td>
<td>14±3</td>
<td>20±4</td>
<td>42±9</td>
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<td>20±7</td>
</tr>
<tr>
<td>Cut</td>
<td>61±14</td>
<td>46±9</td>
<td>23±8</td>
<td>19±6</td>
<td>62±13</td>
<td>30±6</td>
<td>14±3</td>
<td>47±9</td>
<td>22±7</td>
<td>17±5</td>
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<tr>
<td>Sprint</td>
<td>6±2</td>
<td>6±2</td>
<td>6±3</td>
<td>10±3</td>
<td>60±18</td>
<td>42±8</td>
<td>30±7</td>
<td>50±15</td>
<td>26±8</td>
<td>23±6</td>
</tr>
<tr>
<td>Shot</td>
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<td>72±14</td>
<td>26±10</td>
<td>36±9</td>
<td>31±11</td>
<td>32±9</td>
<td>40±9</td>
<td>38±10</td>
<td>26±8</td>
<td>27±8</td>
</tr>
</tbody>
</table>

Table 1: Peak pressures for all areas (see text above) during the four soccer specific movements.

Discussion and conclusion
The peak pressures for the normal run are higher compared to the values reported in the literature for running with similar speed and the same measuring system (Chen et al 1994), clearly indicating the strong influence of a typical soccer shoe design on pressure distribution. The different soccer movements show very specific loading characteristics. In cutting, the medial part of the foot, in sprinting, the first and second ray and in kicking, the lateral part of the foot are predominantly loaded. Despite the fact that the goal shot leads to extreme loading of the lateral anatomical structures of the foot, it should not be a main factor in developing overuse injuries because of the low frequency of occurrence during a soccer game. Instead, attention should be paid to the more frequent movements of sprinting and cutting in terms of overuse injuries and shoe or insole design.

References

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