THE EFFECT OF DIFFERENT PLACEMENT OF HEEL ROCKERS ON KINEMATICS OF LOWER LIMB JOINTS IN HEALTHY SUBJECTS

Safaeepour, Z.1, Nabavi, H.2, Farzadi, M.3, Bagherzadeh, M.2, Gharaei, M.H.1, Geil, M.D.1
1 Georgia State University, Atlanta, Georgia, USA, 2 University of Social Welfare and Rehabilitation Sciences, Tehran, Iran, 3 Iran University of Medical Sciences, Tehran, Iran

INTRODUCTION

Rocker-sole shoes have been commonly prescribed for both healthy and pathological populations aimed at decreasing stresses on lower limbs (Long et al 2009). Typically a heel-to-toe rocker sole is rigid and rounded off at the bottom to facilitate the roll-over of the foot during gait (Hutchins et al. 2009).

An optimal design of a rocker shoe must consider both toe and heel rockers; however, most studies have focused on the toe rocker’s position. Therefore, the aim of this study was to assess the effect of different placements of heel rockers on the kinematics of lower limb joints.

METHOD

Eighteen healthy female volunteers with an average age of 24 ± 4.75 years, height of 159.1 ± 3.27 cm and body mass of 54.6 ± 6.48 kg participated in this study. The participants provided written informed consent. Three pairs of rocker shoes with different of heel rocker apex positions and one pair of unaltered flat shoes were constructed. The rocker shoes were characterized by a heel-to-toe rocker sole with the toe apex positioned 63% of the foot length and angled at 25º and the heel rocker apex was angled at 15º and placed on three different positions: anterior to the medial malleolus in shoe A, on medial malleolus in shoe B and posterior to the medial malleolus in shoe C. The flat shoe (D) was unaltered (Figure 1). 3D kinematic data were recorded using 6 infrared Vicon cameras. All participants walked at self-selected speed 3 times with each shoe type while kinematic and kinetic data were recorded. Afterward, each gait cycle was divided into four distinct intervals including Initial Contact (IC), Single Limb Support (SLS), Terminal Double Stance (TDS) and Swing (SW). Finally, desired variables were computed in each interval. Statistical analyses were conducted using SPSS software.

RESULTS

Cadence was greater with shoe A than shoe D (P = 0.02). When walking with shoe A, stride length increased compared to the other shoe conditions (P < 0.05). Sagittal knee and hip joint motion was the same across all shoes. However, there was a significant difference between shoe B and C in ankle range of motion during IC (P = 0.04) (Table 1). During SLS, ankle ROM increased with shoe A vs. C (P = 0.02), but decreased with shoe B and C compared to shoe D (P = 0.04, P = 0.01).

DISCUSSION

Our analysis demonstrated that backward/forward shifting of heel rocker axis affects the ankle ROM. In agreement with previous studies that showed rocker profiles have minimal effect on kinematics and kinetics of more proximal joint of lower limb, the ROM of hip and knee joint in sagittal plane was the same between all shoes.

CONCLUSION

Variable placement of the heel rocker in a rocker-bottom shoe affects gait kinematics, even when toe placement is kept constant. The effect is most prevalent in ankle range of motion earlier in stance, and knee and hip range of motion are not affected.

CLINICAL APPLICATIONS

Although most research addresses toe rocker position, the placement of heel rocker in a rocker-bottom shoe can be manipulated to produce desired ankle range of motion.

REFERENCES


<table>
<thead>
<tr>
<th>Shoe</th>
<th>IC</th>
<th>SLS</th>
<th>TDS</th>
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<tr>
<td>A</td>
<td>11.59 ± 5.64</td>
<td>23.20 ± 8.99&lt;sup&gt;b&lt;/sup&gt;</td>
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<tr>
<td>B</td>
<td>11.38 ± 5.25&lt;sup&gt;a&lt;/sup&gt;</td>
<td>21.30 ± 7.91&lt;sup&gt;c&lt;/sup&gt;</td>
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<tr>
<td>C</td>
<td>12.85 ± 4.73&lt;sup&gt;b&lt;/sup&gt;</td>
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<td>30.46 ± 5.79</td>
</tr>
<tr>
<td>D</td>
<td>12.00 ± 4.58</td>
<td>19.52 ± 5.13&lt;sup&gt;d&lt;/sup&gt;</td>
<td>30.11 ± 6.73</td>
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Table 1: Ankle ROM during stance. Bold superscripts indicate statistical significance.