INTRODUCTION:

The structure of the foot arch, which acts as a shock attenuator, is known to vary widely from person to person [1]. Different foot types appear to predispose people to certain injuries [2] [3]. However, there is little information regarding the function of the arch during dynamic conditions.

In recent years, using videofluoroscopy to perform motion analysis [4], as well as to evaluate the biomechanics of the connective tissues during gait [5] has received increased attention in foot biomechanics literature. However, no research is available that demonstrates the impact-absorbing function of the arch by analyzing the change in the kinematics of the arch during landing from a jump. Furthermore until recently, motion analysis of the foot was limited to the medial arch, therefore very little research is available that includes the lateral longitudinal arch.

The purpose of this study is to determine the sagittal plane motion of the medial and lateral longitudinal arch during landing, as well as to determine the effect of landing technique on the displacements of the bones.

METHODS:

Ten healthy male subjects participated in this study. IRB approved informed consent was obtained from all subjects. All subjects performed single leg landings from a 1cm platform using two techniques: with the knee extended and with the knee in deep flexion. Subjects were asked to stop and balance after landing. Each trial was recorded using videofluoroscopy (INTEGRIS BHS0000R1 PHILIPS). Images were obtained at rate of 60Hz using a radiation exposure equivalent to 200mA 1msec with an intensity of 50kV. Simultaneous ground reaction forces (GRF) were measured using a force plate (KISTLER).

Data were analyzed using a template method [6]. Sagittal motion was defined as the change in the angle of the arch between the times of toe contact and maximum arch angle after landing. A paired t-test was performed to determine differences due to the landing technique. Significance was set at p<0.05.

RESULTS:

Figure 1 is a typical result. After toe contact, the magnitude of the arch angle increased with time for 80msec in all subjects. No differences in medial/latera arch angle were detected at the time of toe contact (Table 1). When the subjects landed with their knee extended, the magnitude of the angle of the lateral longitudinal arch was significantly larger than that of the medial longitudinal arch (Figure 2).

Concerning landing techniques, the angular change of the lateral longitudinal arch when landing with the knee extended was significantly larger than that obtained while landing with the knee flexed. This result suggests that the lateral longitudinal arch also functions to absorb the impact. The lateral motion of the arch may contribute to preventing injury of the lower extremity.

The purpose of this study is to determine the sagittal plane motion of the arch during landing from a jump. Furthermore until recently, motion analysis of the arch was limited to the medial arch, therefore very little research is available that includes the lateral longitudinal arch.

Differences in the displacement of the bones as a result of the landing technique could increase the likelihood of lower extremity injuries including stress fractures.

REFERENCES:

KINEMATICS OF THE MEDIAL AND LATERAL LONGITUDINAL ARCH DURING LANDING: ANALYSIS USING VIDEOFLUOROSCOPY

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Table 1. Average and standard deviations of the arch angle between landing knee extended and knee flexed at the time of toe contact.

<table>
<thead>
<tr>
<th>Landing Technique</th>
<th>Mean(SD) Knee Extended</th>
<th>Mean(SD) Knee Flexed</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medial arch angle</td>
<td>126.9(3.7)</td>
<td>139.6(3.0)</td>
<td>n.s.</td>
</tr>
<tr>
<td>Lateral arch angle</td>
<td>125.9(3.2)</td>
<td>138.9(5.0)</td>
<td>n.s.</td>
</tr>
</tbody>
</table>

*<p<0.05 n.s.: not significant

DISCUSSION:

The medial arch is thought to play a major role in the impact-absorbing ability of the foot arch [7]. Results from this study show that the magnitude of the lateral longitudinal arch was significantly larger than that of the medial longitudinal arch when landing with the knee extended. This result suggests that the lateral longitudinal arch also functions to absorb the impact. The lateral motion of the arch may contribute to preventing injury of the lower extremity.

The magnitude of the angle of the lateral arch during landings with the knee flexed was less than that with the knee extended. This illustrates that the landing technique has an influence on the displacement of the bones. Furthermore when landing with the knee flexed, the ground reaction force was 70–85% of that when landing with the knee extended. Therefore, it is suggested that the displacement of the lateral arch is related to the ground reaction force, i.e., increased ground reaction force increases the angle of the lateral arch.

Differences in the displacement of the bones as a result of the landing technique could increase the likelihood of lower extremity injuries including stress fractures.

Figure 2. Average angular change of the medial and lateral arch. (*<p<0.05)

Figure 3. Average and standard deviations of the peak vertical ground reaction force between landing knee extended and knee flexed. (*<p<0.05)

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