PLANTAR PRESSURE DISTRIBUTION IN TRIPLE JUMP

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INTRODUCTION

The plantar pressure distribution measurements have recently been utilized widely in gait biomechanics (e.g. Schaff & Cavanagh, 1990; Perttunen and Komi, 1995). However, only a few studies have been published where the foot pressures have been measured in extremely high loading conditions such as a triple jump. Milani and Hennig (1992) suggested that high incidence of lower leg injuries may be due to high peak pressures in various region of the foot during the hop and step. The purpose of the present study was to describe the plantar pressure distribution and relate their peak values to the performance in the triple jump.

METHODS

Nine experienced triple jumpers (5 male 4 females) volunteered to perform 3 - 6 trials. Three best jumps were selected for further analysis. The athletes walked also at their preferred walking speed along a 20 m track three times. A portable, in-shoe pressure data-acquisition system (Paromed-System®, total mass 1.9 kg) with 16 high resolution microsensors in both insoles was used for measuring the pressure distribution under the feet. The sampling frequency for the plantar pressure was 200 Hz. The data collection was initiated by remote control and was synchronized with the ground reaction force. The collected triple jump recording was divided into hop, step and jump phases for the analysis.

Contact times were divided into braking and push-off phases according to the direction of the horizontal ground reaction force. Bilateral maximal plantar pressures of all sensors were analyzed and contour curves were drawn (Fig. 1).

Figure 1. An example of the foot pressure contours recorded 40 ms before the end of the take-off during the hop, step and jump.

RESULTS

The means (SD) of the three best jumps were 14.32 ± 0.45 m for males and 11.90 ± 0.28 m for females. For the total sample the durations of the braking phases were 0.079 ± 0.009s, 0.087 ± 0.009s and 0.113 ± 0.012s, respectively for the hop, step and jump. The respective push-off phases were 0.050 ± 0.007s, 0.070 ± 0.009s and 0.064 ± 0.012s. The highest peak pressures were obtained under the heel and forefoot areas while the lowest ones were found under the midfoot during both performances. In several cases the heel pressures (sensors 1 and 2, see Fig. 2) were so high in the triple jump that the signal exceeded the measuring range of the transducer. The observed peak pressures were more
than three times higher in the triple jump as compared to normal walking (Fig. 2).

A comparison of the maximal pressures revealed that the rearfoot area and big toe region differed significantly (p<0.05) between the hop, step and jump being the lowest during the hop. While the maximum peak pressures under the forefoot area may have been similar in all three phases of the triple jump, the pressure distribution patterns differed considerably as shown in the contours at 40 ms before release (Fig. 1). The pressures under the lateral forefoot (6, 9, 12) correlated positively with the length of the triple jump (r=0.62, r=0.66, r=0.80, p<0.001, respectively).

DISCUSSION

The high relationship between pressures under the lateral side of the forefoot and the length of the triple jump suggests that the body weight rolls powerfully over the lateral side of the foot. This creates good requirements for powerful force production with minimal decrease in the horizontal speed. These results suggest further that not only the peak pressure values are useful when describing the weight bearing models. Instead the entire pressure distribution expressed at certain time instants and/or drawn as contour curves for the entire contact phase may be more relevant to characterize the foot loads during the triple jump.

REFERENCES