

MEASUREMENT OF PLANTAR PRESSURE DURING HIGH IMPACT-SHORT CONTACT TIME SPORTS ACTIVITIES

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INTRODUCTION

Force measurement plays an integral role in biomechanical research. Plantar force measurement has important functions in analysis of performance, equipment development, as well as understanding and preventing injuries. Traditionally the most reliable force measurement systems had to be built into the ground, usually in a laboratory. The fact that these platforms cannot be easily moved severely limits their application in sport movement analyses. The purpose of this study was to evaluate the use of soft pressure sensors (PAROTECH, Rosenheim, Germany) inside the shoe as a means of portable and reliable force measurement during high force short contact time jumping movements.

METHODS

The subjects ($n=14$) performed a series of 'depth jump' similar exercises simulated by a falling pendulum (Fig.1). The chosen weights of the pendulum were body weight (bw), **bw-10kg**, and **bw-20 kilograms**. For each trial, the pendulum was raised to a defined height and then released. The subjects were instructed to 'jump' as hard and fast as possible to repel the pendulum. Force curves were generated with the use of 4 soft Parotech force sensors which were held to the underside of the right fore-foot (Hallux, Metatarsals 1, 3 and 5) using tape. To further stabilize the sensors the subjects wore gymnastic shoes over the sensors during the experiments. Force data were **simultaneously** collected using piezo-resistive force sensors (KISTLER, Winterthur, Switzerland) built into the contact surface of the pendulum. These were used as control in evaluating the accuracy of the Parotech sensors. All analog data were sampled at 1000 Hz. The following temporal aspects of the force curves were compared: the total contact time (CT), the time from landing to the first peak (T1), and the time from landing to the second peak (T2). Further parameters were the force at the first peak (F1), the force at the saddle between the first and second peaks (FS), and maximum force (F2).

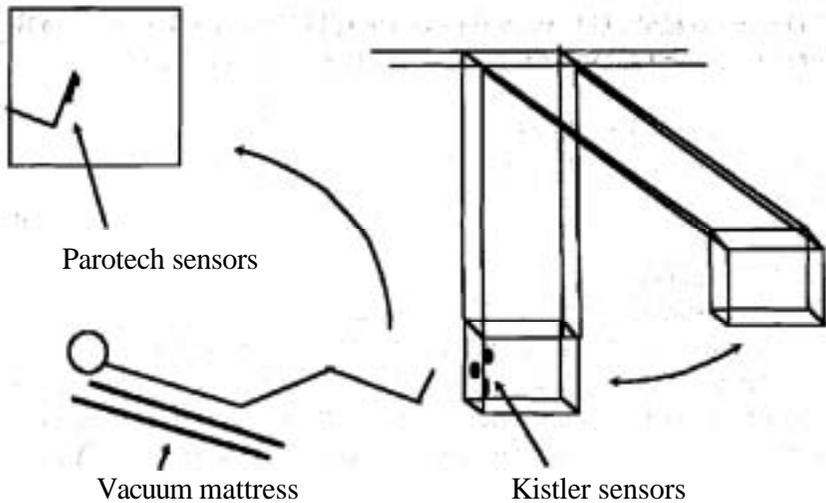


Figure 1. Experimental Set Up

RESULTS / DISCUSSION

A total of 580 jumps were measured with total contact times ranging from 128 - 338ms. Analysis of the force curves revealed that the T1 and T2 values were consistently (approx 70%) identical (± 0 ms) for the two systems, although a variance of 1 ms in either direction was seen in approximately 30% of the trials for both values. Although the time of initial contact was also consistently recorded the same by both systems the comparison of CT values was not usually possible because of indistinct take-off times recorded by the Parotech sensors. More specifically, the Parotech force curve showed variations in the baseline values before landing and after take-off. This may have been caused by residual pressure between the foot and the gymnastic shoes after take-off. This irregularity varied between the subjects and was calculated to be 1 - 3%. As expected, the Parotech sensors measured considerably less of the total force than the Kistler sensors. In the early phases of this study the force values measured with the Parotech sensors were 48%, 47% and 32% of that measured with the Kistler sensors, respectively, for the parameters FS, F1 and F2. In the later stages of this experiment, the Parotech sensor placement was altered for improved force values of 70%, 66% and 62% of the respective Kistler values. Greater discrepancies were seen at higher force values.

A comparison of the force curves generated by the two systems can be seen in Fig.2. The two curves have the same basic form characteristics. On the downward slope of the Kistler curve, a slight irregularity can be seen. This is due to pendulum vibration.

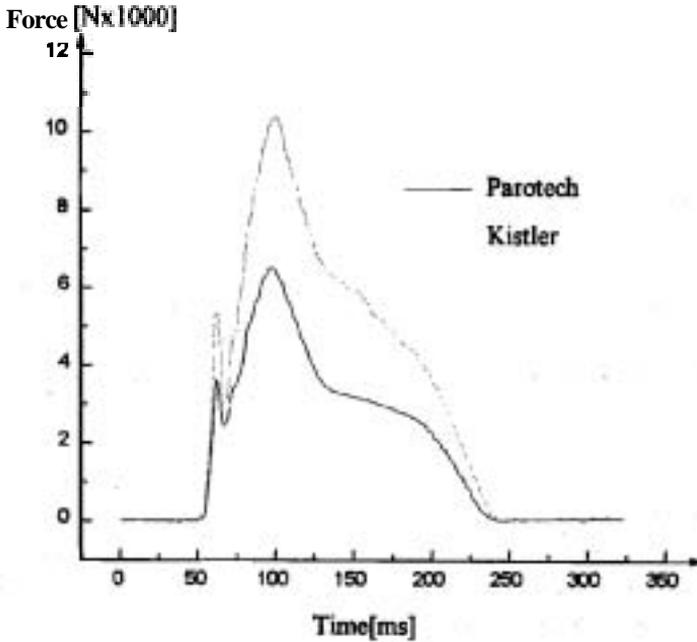


Figure 2 A comparison of force curves produced during a drop jump similar exercise. The curves were measured using a Kistler system (dotted line) and Parotech force sensors (solid line).

CONCLUSIONS

The comparison of the force curves in this study indicate that Parotech sensors, as used in the above described configuration for high impact-short contact time movements, are accurate in measuring important force parameters. The accuracy was best for the various temporal measurements. The Parotech sensors also seem to be capable of reliably measuring force. However, because of the high possible variability of the force measurement due to sensor placement, extreme care should be taken in this placement.