QUANTITATIVE ANALYSIS OF PLANTAR PRESSURE DISTRIBUTION: CHARACTERISTIC OF PLANTAR LOAD PATTERNS DURING VERTICAL AND BROAD JUMPS

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INTRODUCTION

As one of the quantitative methods to evaluate the gait movements, plantar load distribution has been used in the fields of clinical and biomechanical researches [1]. However, quantification of plantar load distribution has various problems such as definitions of sub-area boundary. The purposes of this study were to examine an integrated system consisted with a pressure plate (Footscan), 3D motion capture system (Vicon) and a force platform (Force plate) in order to quantify the plantar load distribution based on foot anatomical measurement points and to describe the characteristics of plantar load patterns during vertical and broad jumps (VJ, BJ).

METHODS

In order to define sub-areas from foot anatomical measurement points, Foot scan (Rs scan international, Balance 2nd Generation 7.7, 0.5m plate, with 4096 resistive sensors, 200Hz), Vicon MX20×8(Oxford Metric Inc. 100Hz) and Force plate (Kistler Inc. 0.6m×0.9m, 1KHz) were systematically synchronized as to acquire the data (Fig.1). Each foot sub-area was determined using methods of J.A.Stebbins,et al.,(2005) [2] including 5 sub-area(MF: medial forefoot, LF: lateral forefoot, MiF: midfoot, MH: medial heel, LH: lateral heel). Plantar load matrix data were exported every 10ms into each worksheet. In order to examine the accuracy and validity of pressure application force and the position of center of pressure (COP) were compared with those obtained from Force plate and Vicon coordinate system. The accuracy and the validity of weight was also examined by lading the weight of 25-125kg and actual human jumping. The accuracy of COP position was investigated load to 39 point using original calibration stick. 32 subjects (age: 21.9±2.6yrs, BH: 170.6±4.9cm, BW: 69.0±6.4kg) performed a vertical and broad jumps on Foot scan and Force plates. Plantar load distribution during VJ and BJ were compared between good and poor jumpers.

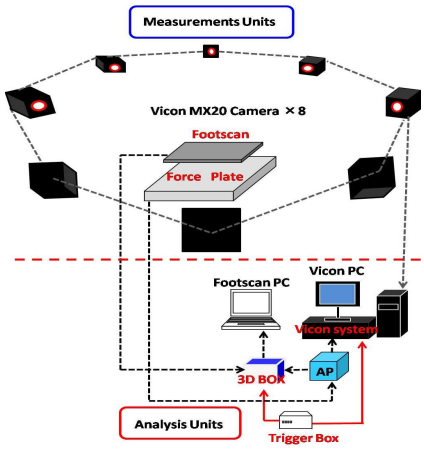

Figure 1 Diagram of experimental setup composed with three instruments; Vicon, Force plate and Foot scan.

RESULTS AND DISCUSSION

As for the accuracy and the validity of this integrated system, difference of load value between Force plate and Foot scan were less than－1%. The error of load of Foot scan and Force plate showed the tendency that became greater in the phase of decreased load. On the other hand, difference of COP position was －2.1% between Foot scan vs Force plate and －2.9% between Foot scan vs Vicon, respectively.

In VJ, major changes in plantar load distribution from lateral LF to MF were observed. On the other hand in BJ, heel foot, LF and MF were most remarkable areas which indicated major changes in plantar loads. Plantar load distribution only around the forefoot was observed in poor jumper, whereas good jumper was characterized as the plantar load distribution in all sub-area (Fig.2).

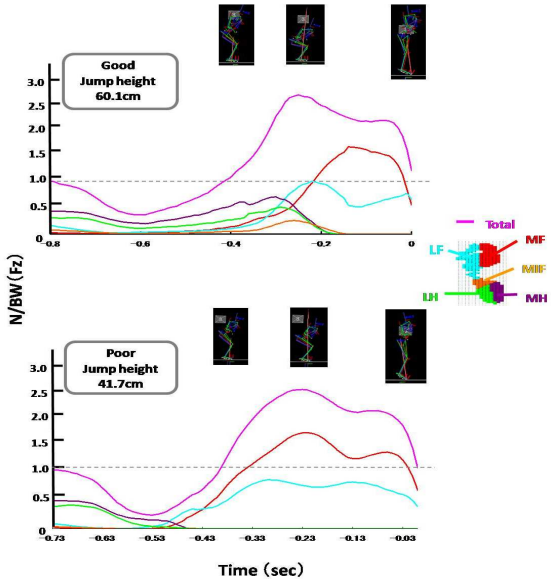

Figure 2 Temporal changes in plantar load distribution of sum of the right and left foot in 5 sub-area as well as the changes in kinematics and ground reaction force. (upper: good jumper, lower: poor jumper)

CONCLUSION

The plantar load distribution during jump movements was quantified using newly developed integrated system .The accuracy and the validity of this system were indicated. Pattern of plantar load determined by this system might be useful as one of the key factors for the assessment of skill in jump performance. Future applications for evaluating plantar load distribution quantitatively might be expected using this newly developed integrated system.

REFERENCES

1 Giacomozzi C. et al., *Med. Biol. Eng. Comput.*,38:157-163, 2000.
2 Stebbins J.A. et al., *Gait & Posture*,22: 372-376, 2005.