KINEMATIC MEASUREMENTS OF SNOWBOARDERS' ANKLES

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INTRODUCTION

In 1989, there were 1.5 million snowboarders worldwide, 40% of which were in North America. In 2001, it was estimated that Snowboarders made up to 28.5% of those using the slopes. The incidence of trauma from snowboarding is 4 to 6 for every 1000 medical examinations, which is comparable to that of alpine skiing. Compared to injury patterns in alpine skiing, snowboarders are more prone to ankle injuries than alpine skiers (Bladin, 1993; Shealy, 1993). Also, snowboarders with soft boots have more ankle injuries than snowboarders with hard boots (Kirkpatrick, 1998; Pino, 1989). The goal of this project was to design an experimental protocol to measure the kinematics of the ankle during regular snowboard maneuvers.

METHODOLOGY

An electromagnetic motion tracking system (Fastrak, Polhemus, VT, USA), with four 6-degree-of-freedom position sensors, was converted into a fully portable system operating on two 12-volts batteries and connected to a laptop computer. The sensors were attached to the shanks (antero-medial surface of the tibia) and feet (posterior surface of the calcaneus) of the snowboarder. The electromagnetic source was mounted on the snowboard between the two bindings, thus defining the global coordinate system rigidly attached to the snowboard. The bindings were adjusted at 21° and 6° rotation for the forward and backward leg respectively. The motion tracking system control box, batteries and laptop computer were carried by the snowboarder in a 20-pound backpack.

An anatomical calibration procedure was performed to calculate the spatial relationship between each sensor and a coordinate system defined on its corresponding anatomical segment (Della Croce, 1999). Bony landmarks on the shank and foot were palpated and measured with a Fastrak stylus through strategically located holes in the boots.

The trials consisted in snowboarding down a course of 10 turns and performing a sideways stop, on an intermediate-level slope of groomed snow. Each snowboarder was asked to perform 3 trials on a freestyle board with strap bindings and soft boots. The trials were measured with the motion tracking system at 120 Hz (30 Hz per sensor).

The recorded motion signals were smoothed using a two-pass second-order Butterworth filter. The rotation of the ankle through time was expressed in Euler angles with the feet considered as fixed in space.

RESULTS AND DISCUSSION

The analysis of the preliminary data obtained with two subjects showed consistent ankle range of motion in the frontal and sagittal planes. The inversion of the forward ankle and the eversion and dorsiflexion of the backward ankle (Figure 1) allow the snowboarder to shift his weight towards the tail of the snowboard. Radically different ankle range of motions were observed in the transverse plane. One subject had his forward ankle adducted (Figure 1) while the other had it abducted. Since the same standard binding rotation was imposed to all subjects, one might interpret this rotation as a shift of the shanks towards a more natural feet orientation in the transverse plane, which may differ between subjects.

The experimental method has proven successful and will be used to measure the effect of different types of snowboard boots and bindings on the ankle range of motion.

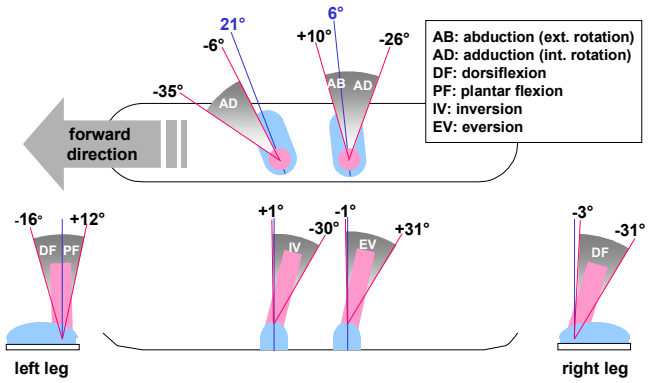

Figure 1: Range of motion of the ankle during snowboarding for one typical subject.

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ACKNOWLEDGEMENTS

This research was funded by FCAR and the Development Fund of the Faculty of Health Sciences of the University of Ottawa. The authors would like to thank Dany Lafontaine, Robert Joncas, Station de ski Bromont and Mont Tremblant for their collaboration.