Tibial accelerations during snowboarding jump landings

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Introduction
Snowboarding is a relatively safe popular winter activity and with an overall injury incidence rate of 4 per 1,000 runs. However when snowboarders attempt large jumps, the injury incidence rate increases to 14.2 injuries per 1,000 runs (Torjussen and Bahr, 2005). Ankle injuries are common in snowboarding with fractures estimated to make up 44% of all snowboard ankle injuries, with 1/3 to the lateral process of the talus (LPT). The injury is so unique that it is often times referred to as "snowboarder's ankle" (Kirkpatrick *et al*. 1998). It is believed that LPT fractures are the result of high axial loads combined with excessive dosiflexion and external rotation (Boon *et al*. 1999). It is also believed that the leading leg absorbs the largest proportion of impact force and it is thus involved in the majority of lower limb injuries (Bladin *et al*. 2004). However at this time it is not known how large the axial loads are in snowboarding jump landings.

Purpose of the study
The purpose of this pilot study was to investigate the magnitude of tibial axial loads during snowboarding jumps and to examine if the lead leg does in fact absorb more force.

Methods
Two healthy male snowboarders participated in the pilot portion of this study. Data were collected as each subject jumped and successfully landed ten times from a 9.1meter (30 foot) table-top jump which equated to roughly a 1.67 m (5 ft) vertical drop. Both subjects started their vertical decent to the jump at the same place on the mountain to better control takeoff velocity and they were instructed not to make any turns as they approached the jump.

Tibial axial acceleration data were collected on the front and back leg using two single axis accelerometers (3031 ICSensors, Durham Instruments) securely mounted to the antero-medial aspect of the tibia 20 cm above the medial maleolus of each leg to allow clearance from the top of the snowboard boot and lining. Accelerometry data were collected at 1000 Hz onto a portable data logger (BioRecorder, Biomedical Monitoring LTD). A low pass Butterworth filter was also applied with a cutoff frequency of 100 Hz. In addition, in- boot pressure insoles (Footscan, RSscan) were inserted into each boot to provide data on the distribution of force under the plantar surface of each foot.

Subjects were allowed to wear their own boots, use their own board and bindings, and use their preferred stance position for this pilot portion of the study although both subjects rode in a bilateral, externally-rotated "duck" stance. Statistical comparisons were made using a single factor ANOVA (alpha = 0.05).

Results

Average peak tibial accelerations were found to be quite variable during snowboard landings. Subject 1's peak accelerations were 17.5 ± 5.7 g's (range: 9.5 – 23.6 g) and 19.5 ± 11.2 g's (range: 3.4 – 36.4 g) for the front and back leg. Looking at the timing of the front and back leg impact peaks, subject 1 landed tail first 60% of the time followed by flat 20% and nose first 20%. For subject 2, average peaks were found to be 25.1 ± 12.2 g's (range: 10.5 – 41.9 g) and 26.9 ± 12.7 g's (range: 12.0 – 42.8 g) for the front and back leg respectively.

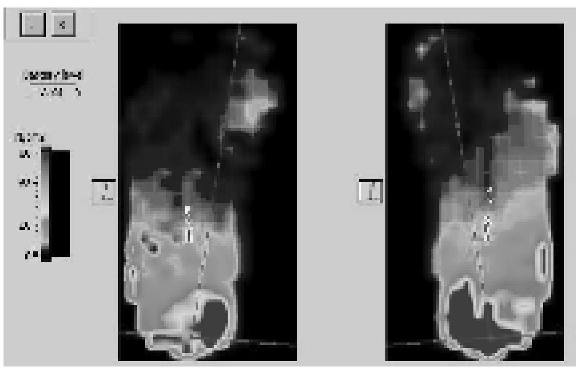

Figure 1. Representative pressure distribution during the moment of peak tibial acceleration.

Table 1. Average tibial acceleration of the front and back leg during snowboard jump landings. Acceleration reported in g's (SD).

Subject	Front Leg	Back Leg
1	17.5 (5.7)	19.5 (11.2)
2	25.1 (12.2)	26.9 (12.7)

Discussion and conclusion

Tibial accelerations during snowboard jump landings were found to be highly variable within each subject probably due to different landing orientations (i.e. tail, flat, nose), different landing points (i.e. flat top, knuckle, and landing ramp) on the jump, and slight differences in take off velocities and jump heights. The later three were not monitored in this study but should be monitored and recorded in future studies. It should also be noted that the jump our subjects used was relatively small in comparison to jumps more experienced and professional snowboarders would normally encounter. Top professionals execute jumps of 13.3 to 16.7 m (40 – 50 ft).

Further investigation into the impact landings incurred by riders could be useful to snowboard boot manufacturers in the form of cushioning devices inside the boots. Such devices could help reduce the impact shock to the tibia and potentially prevent LPT fractures from occurring.

References

Bladin, C. et al. (2004). Sports Med, **34 (2)**, 133-138.

Boon, A. et al. (2001). Am J Sports Med, **29(3)**, 333-338.

Kirkpatrick, D. P. et al. (1998). Am J Sports Med, 26 **(2)**, 271-277.

Torjussen, J. and Bahr, R. (2005). Am J Sports Med, 33 **(3)**, 370-376