

# Tibial Accelerations during Snowboarding Jump Landings: A pilot study

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## Introduction

Snowboarding is a popular winter activity with an overall injury incidence rate of 4 per 1,000 runs. This is considered relatively safe compared to other sports and is on par with alpine skiing. 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. Of these fractures, about 1/3<sup>rd</sup> occur 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 dorsiflexion and external rotation (Boon et al., 1999). It is also believed that the leading leg absorbs the largest proportion of impact force and 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. Therefore the purpose of this pilot study was to investigate the magnitude of tibial loads during snowboarding jumps and to examine if the lead leg does in fact absorb more force.

## Methods

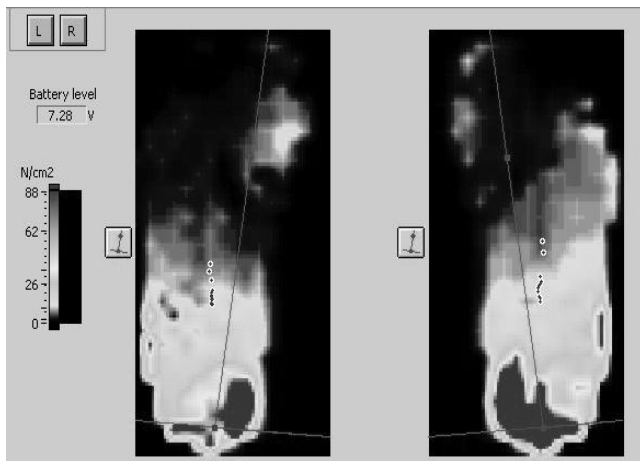
Two healthy male snowboarders participated in the pilot portion of this study. Data were collected as each subject jumped and successfully landed ten times from a 9.1 meter (30 foot) “table-top” jump which equated to roughly a 1.67 m (5 ft) vertical drop. Both subjects started their vertical descent 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 malleolus of each leg to allow clearance from the top of the snowboard boot and lining. Accelerometry data were collected at 1,000 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 ( $\alpha = 0.05$ ).

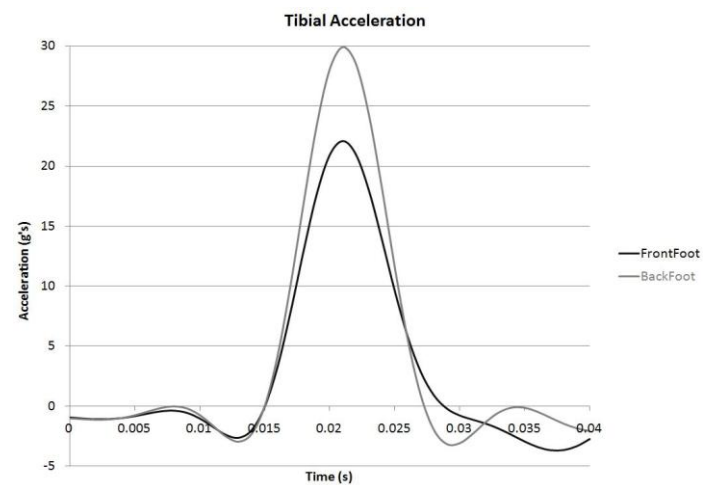
## Results

Average peak tibial accelerations were found to be quite variable during snowboard landings. Subject 1’s peak accelerations were  $17.5 \pm 5.7$  g’s (range: 9.5 – 23.6 g) and  $19.5 \pm 11.2$  g’s (range: 3.4 – 36.4 g) for the front and back leg. Looking at the timing of the 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  $25.1 \pm 12.2$  g’s (range: 10.5 – 41.9 g) and  $26.9 \pm 12.7$  g’s (range: 12.0 – 42.8 g) for the front and back leg respectively. Subject 2 landed flat 50% of the time followed by nose first 30% and tail first 20%.

Both subjects had similar average air times (time between take off and landing) of  $801 \pm 76$  ms. In-boot pressure data revealed most of the pressure was localized underneath the medial portion of the calcaneal bone during the moment of peak tibial acceleration.



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



**Figure 2.** Representative tibial acceleration data from subject 2 for the front (black) and back (grey) leg.

### Discussion and Conclusions

Tibial accelerations during snowboard jump landings were found to be highly variable within each subject. This is probably due to different landing orientations (i.e. tail, flat, nose) of the board, different landing points (i.e. deck, 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). For both subjects, less impact shock occurred during tail first landings as opposed to flat and nose first landings; this is consistent with prior literature. However there was no significant difference between tibial accelerations for the front and back leg as previously reported; although this could be due to our small sample size. The focus of these peak loads in the calcaneal region suggests a potential mechanism for LPT fractures. If the center of pressure was shifted anteriorly just a few centimeters, due to landing error, the mechanical leverage from the board could potentially cause significantly higher stresses on the LPT and eventually lead to a fracture.

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

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