VAIL SNOWBOARD INITIATIVE

Motion Capture on the Mountain

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There are over 60 million skier/snowboarding days per year in the US alone and many more if you count Europe and Asia.
The rate of injury in this population has changed over the years as have the patterns of injury.

- Equipment
- Style
- Accessibility to extreme terrain
The rate of knee injuries in elite snowboarding is similar to that of skiing.
The most frequent injuries among skiers were

- ACL tears
- knee sprains
- closed head injuries
- gastrocnemius tears
The most frequent injuries among snowboarders were:

- distal radius fractures
- wrist sprains
- closed head injuries
- acromioclavicular separations
These injuries were traditionally in the upper extremity, there are now more injuries occurring in the legs and specifically in the knee.
• The number one injury that caused time lost during a season was from injuries to the knee
• Ninety-one percent of the lower limb injuries were to the leading leg

• 91%! 
The Problem

- Elite snowboarders are suffering significant injuries, particularly knee injuries.
- Regardless of stance, knee injuries sustained by snowboarders predominantly involve the leading leg.
- Can we determine the injury mechanism and minimize the chance of injuries.
Sports Performance of Snowboarding

Pilot Study
Materials and Methods

• Recruited 3 professional riders
• Secured two days on Vail Mountain (April 17\textsuperscript{th} & 18\textsuperscript{th})
• Secured 16 camera motion analysis system (Raptor-E, Motion Analysis Corp., Santa Rosa, CA)
Materials and Methods

- Captured landings on a jump in the terrain park and in an 18’ half-pipe landing regular and switch
Materials and Methods

- Determined 3D knee kinematics of leading and trailing legs

![Diagram showing marker data, anatomical data, and joint rotation data.](image)
Kinematics Results: Half-Pipe

Leading leg flexion angle at impact smaller than trailing leg and in most isolated (‘at risk’) angle for ACL

Leading leg at impact demonstrates no adduction but still internal rotation impulse (not seen in trailing leg)

Knee joint angles (deg) of regular landing

![Graphs showing knee joint angles for regular landing](image-url)
Leading leg flexion angle at impact smaller than trailing leg and in most taut (‘at risk’) angle for ACL.

Leading leg at impact demonstrates adduction and internal rotation impulse not seen in trailing leg (suggesting valgus mechanism).
Kinematic results: Jump

Leading leg flexion angle at impact smaller than trailing leg and in most isolated ('at risk') angle for ACL

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Kinematic results: Jump

Switch landing results similar, but not as clear and more variable compared to regular landing

• Some rode switch into jump
• Others performed 180° in the air

Knee joint angles (deg) of switch landing
Discussion

• Kinematic analysis on mountain is feasible
• Obtained valuable experience with testing multiple riders

• Preliminary results suggest:
  – Leading leg more extended compared to trailing leg putting the leg at more vulnerable flexion angle for ACL rupture
  – Leading leg demonstrated adduction and consistent internal rotation impulse at time of landing suggestive of ‘valgus landing’ injury mechanism
  – Valgus landing characteristics not present in trailing leg regardless of landing type
Thank You!