Snow Skiing and Snowboarding Musculoskeletal Injuries

Matthew McNairy MD

5/22/2008

Incidence of Skiing Injuries

- 10,000 skiers in U.S. in 1935. 15 million in 2000 (200 million worldwide)
- Alpine skier injury rate 2-4.4 per 1000 skier days (down from 5-8/1000 before 1975)
- Injury rate in children 59% higher than in adults
- Beginners at greater risk for injury (skiers and snowboarders)

Boots

- Decreased injury rate related to decrease in ankle fractures (down 91%) and other injuries distal to the knee related to modern boots with high, rigid shell
- 1980s to 1990s adult ACL injury rate increased 280%, tibial plateau injury rate increased 485%

Medial Collateral Ligament Injury

- 20-25% of all skiing injuries, especially among beginners and intermediate skiers
- Forced genu valgus: falling from “snowplow” or catching an edge with the ski suddenly tracking laterally

Medial Collateral Ligament Injury

- MRI helpful to
  - Diagnose displaced tears
  - Identify associated injuries (ligamentous, meniscal or osteochondral injuries)
- MRI grading
  - I edema around ligament
  - II partial tear
  - III complete tear
- Treatment
  - Hinged knee brace for isolated injury
  - Associated injuries may require surgery

72 year old woman with skiing injury
Grade III MCL injury

Anterior Cruciate Ligament Injury

- 200,000 new ACL injuries/year in U.S.
- 20,000 related to skiing
- 13-19% of all skiing injuries

Anterior Cruciate Ligament

- Primary restraint to anterior displacement of the tibia (Anterior tibial displacement primary cause of isolated ACL injury)
- Secondary restraint to tibial rotation particularly internal rotation in full extension
- Minor secondary restraint to varus-valgus angulation in full extension

ACL injury mechanisms

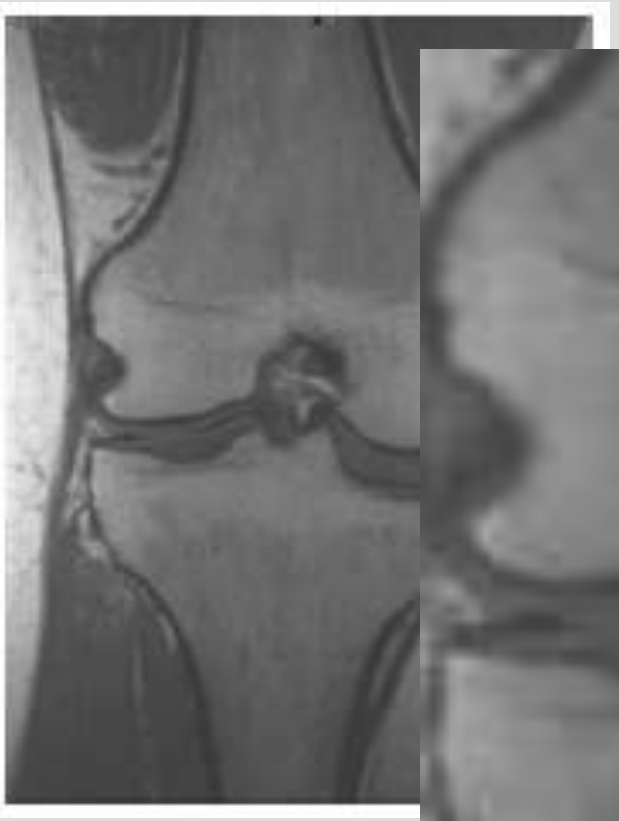
Phantom boot mechanism

- Deep knee flexion and internal tibial rotation
- Backward fall between the skis with deeply flexed knees and weight on inner edge of the downhill ski
- Sharp inward turn of ski tip
- Tail of ski and stiff boot act as lever applying twisting force to knee

ACL injury mechanisms

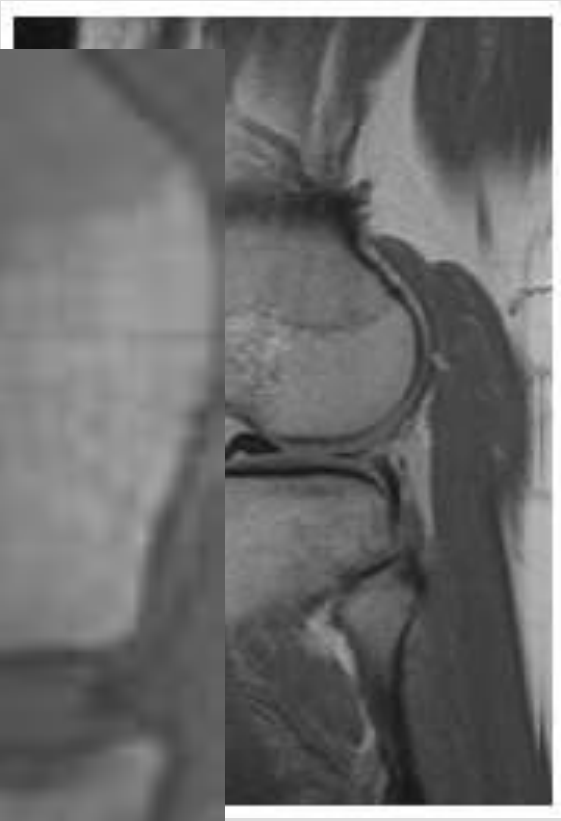
Boot-induced mechanism

- Land after a jump on the tail of the ski, forcing the back of the boot against the calf, forcing the tibia anteri
- May be co iceps contraction



ACL tear

Quadruple cruciate sign
"Jack and Jill lesion"



t handle tear
al meniscus
uble delta"

ACL injury mechanisms

Aggressive quadriceps contraction

- Produces anterior tibial translation through patellar tendon
- Experts with powerful quads
- “Falling back” position trying to regain control

ACL injury mechanisms

Valgus-external rotation

- Catching inside edge and falling forward between skis
- AMRI

  MCL, POL

  medial meniscus

  (O'Donohue triad)

ACL injury mechanisms

Valgus-external rotation

- Catching inside edge and falling forward between skis
- AMRI
  - MCL, POL
  - Medial meniscus
  - (O’Donohue triad)

ACL injury mechanisms

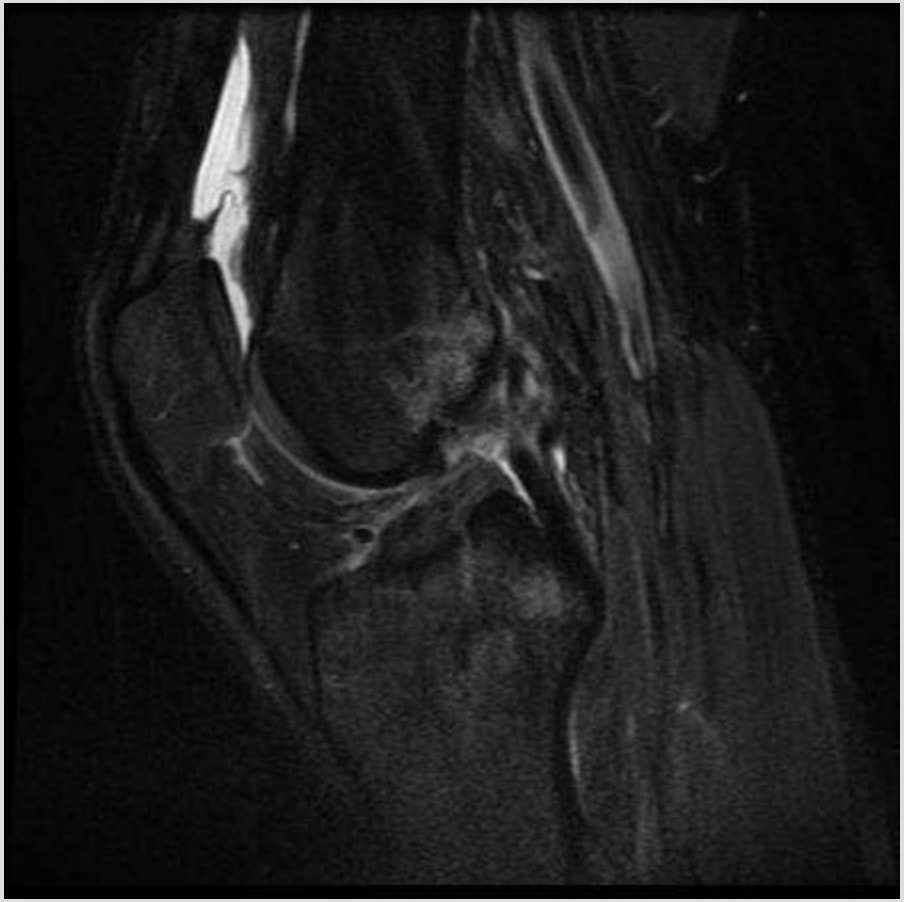
Varus-internal rotation

- Downhill ski catches an edge, skiier falls over it
- ALRI

  lateral ligaments

  lateral meniscus

  +/- Segond frx



ACL tear distribution

- Proximal 1/3 of ACL 80%
- Middle 1/3 17%
- Distal 1/3 3%

Anterior Cruciate Ligament Injury

- Physical exam
  - 62-100% sensitive
  - 56-100% specific
- MRI
  - 90-98% sensitive
  - 90-100% specific
  - Accuracy decreased for partial thickness or chronic tears
  - Helpful to identify displaced tears, associated injuries

Injuries associated with ACL tear

60 acute complete ACL tears in skiers

- 98% bone contusions
- 60% posterior soft tissue injuries (posterolateral capsule, popliteus)
- 50% MCL
- 35% medial meniscal tear
- 18% partial PCL tear
- 17% LCL
- 15% lateral meniscal tear
- 3% Segond fracture

72 year old woman with skiing injury

Injuries associated with ACL tear

328 acute ACL tears in skiers

- 23% meniscal tear (13% lateral, 10% medial)

Usual incidence of meniscal tear in acute ACL injury 60-70% (60% lateral, 40% medial)

ACL deficient knee

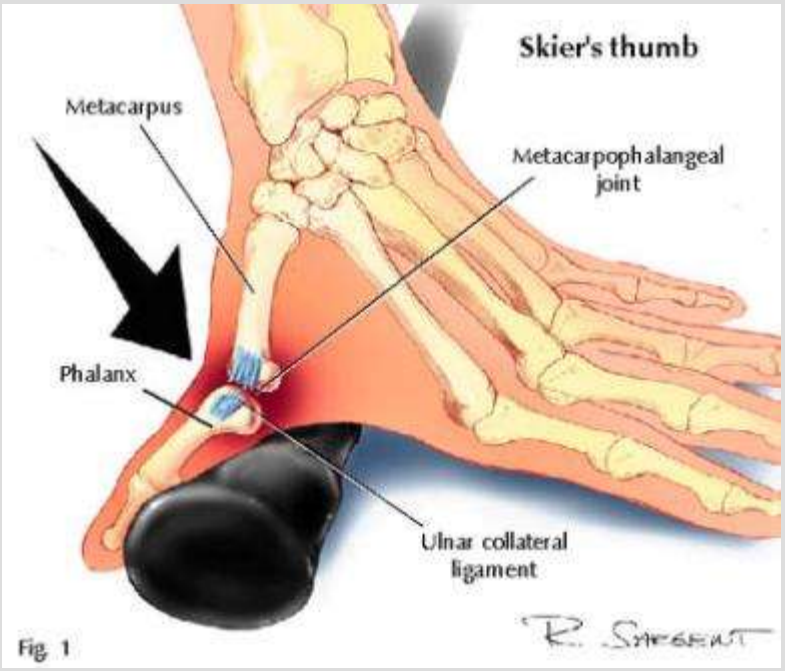
- 6 times more likely to have a recurrent skiing injury
- Recurrent skiing injury more severe

Skier's thumb

- Acute injury of the ulnar collateral ligament of the MCP joint of the thumb
- AKA gamekeeper's thumb
- Most common upper extremity injury in skiing
- 35-80% of upper extremity skiing injuries
- 8-17% of all skiing injuries

Skier’s thumb mechanism

- Fall with pole in outstretched hand
- Pole handle acts as a fulcrum at the base of the thumb, resulting in hyperabduction and extension
- Molded, strapless grips do not change frequency of injury
- Should ski without straps and release the pole during fall before hit ground

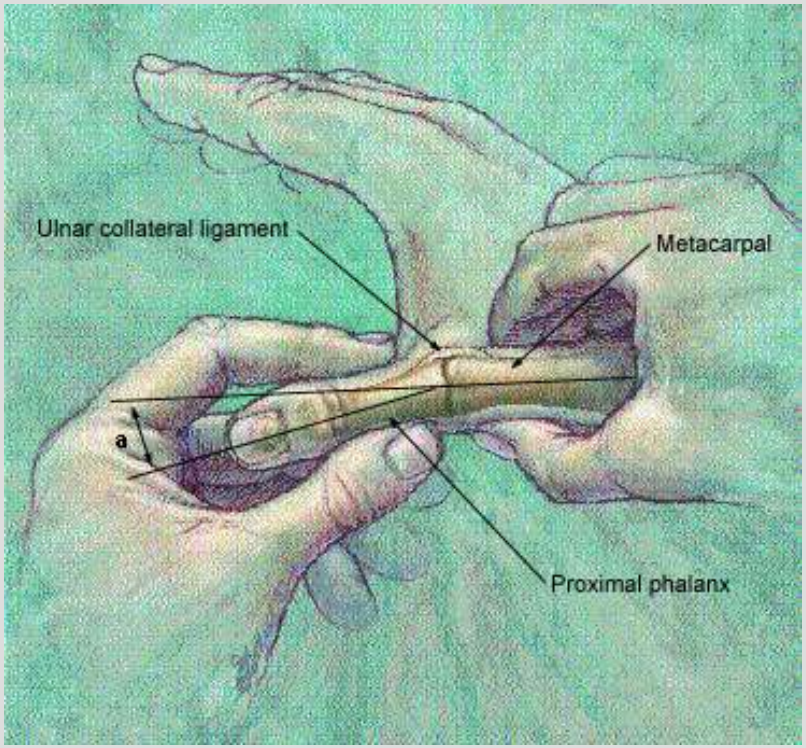


Skier's thumb

- Clinical presentation acute UCL injury – pain, swelling, ecchymosis
- Small, tender lump on ulnar aspect of MCP joint of thumb highly suggestive of Stener lesion, but lack of lump doesn't rule it out

Skier's thumb

- Normal radiographs versus small avulsion fracture
- Valgus stress radiographs (contraindicated if large intra-articular fracture, fracture of shaft of MC or proximal phalanx of thumb, ?small avulsion fracture)
- Complete rupture of UCL likely if radial deviation at the MCP joint > 30-35 degrees or 10 degrees > opposite side



Avulsion fractures

Cases courtesy of Tudor Hughes

Skier’s thumb

- Partial thickness, nondisplaced complete tear, or displaced complete tear (Stener lesion – in up to 80% of complete tears)
- Distal tear 5x > proximal tear > midsubstance tear

Stener Lesion

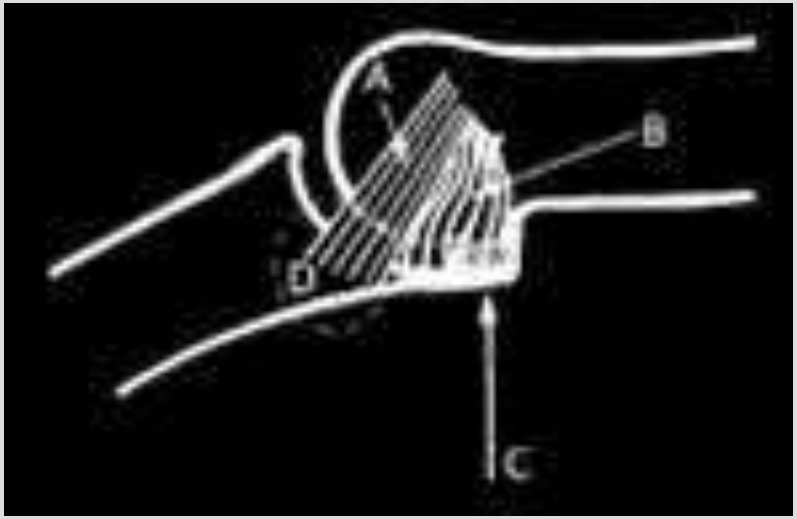
- Complete distal or midsubstance tear
- Torn UCL displaced superficial to the proximal adductor pollicus aponeurosis
- Displaced UCL will not heal effectively unless normal anatomy is restored
- Surgery helps to prevent complications of chronic UCL instability (pain with pinch and grasp maneuvers)
- ‘Yo-yo on a string’ = proximal margin of the adductor aponeurosis abutting the folded UCL

Ulnar collateral ligament anatomy

A Proper collateral ligament
- Metatarsal head to volar aspect of the phalanx
- Taut in flexion

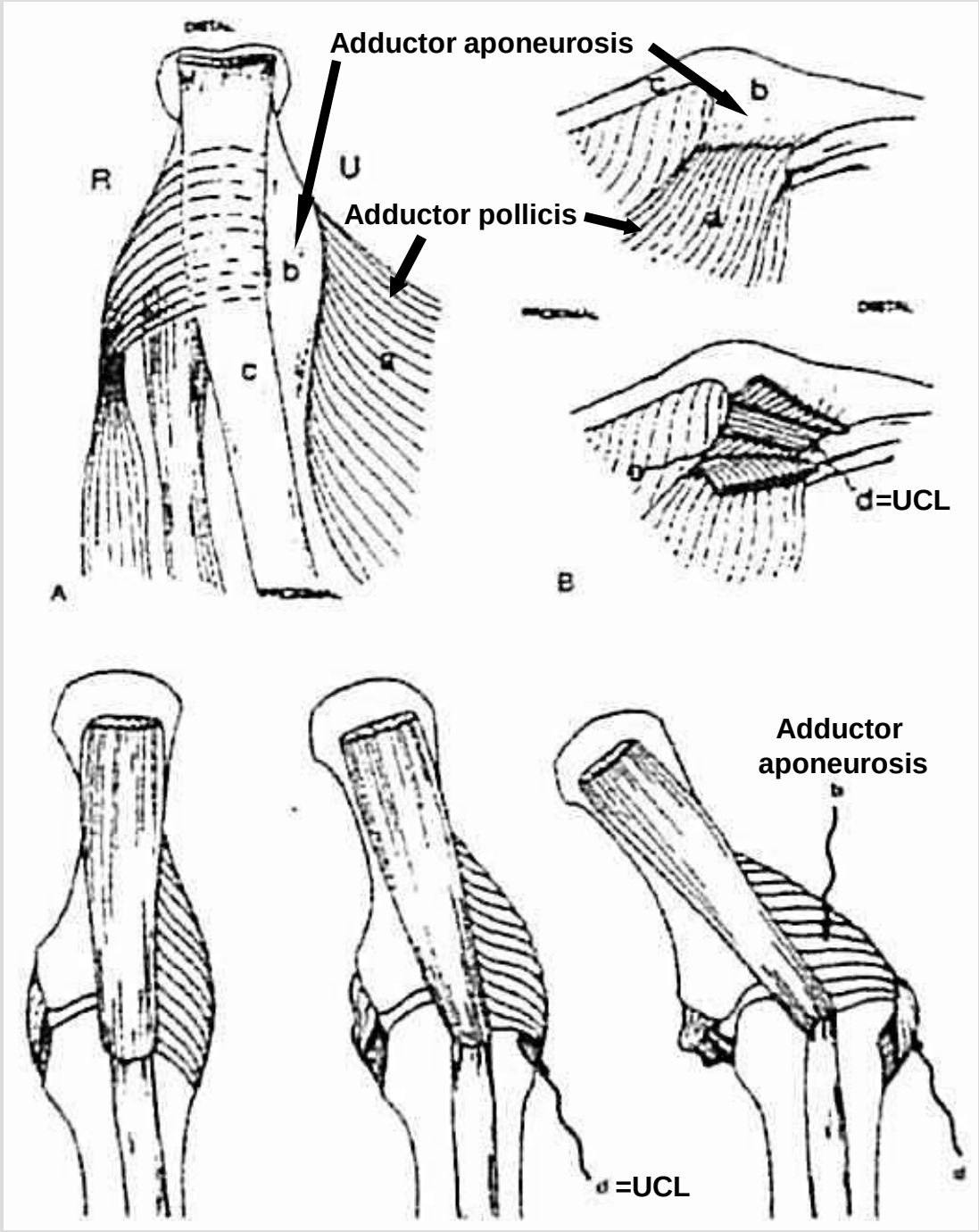
B Accessory collateral ligament
- Volar to proper ligament and attaches to the volar plate
- Lax in flexion

C Volar plate



On MRI UCL = band of low SI closely apposed to medial joint margin along its entire course

Adductor pollicis muscle



Partial tear proximal UCL

Complete distal UCL tear
Nondisplaced

Case courtesy of
Tudor Hughes

Stener lesion
“yo-yo on a string”

Case courtesy of
Tudor Hughes

Skier’s thumb treatment

- Primary indications for surgery: symptomatic patient with instability (>35 degrees of angulation with stress testing) and a displaced UCL tear or displaced avulsion fracture
- Displaced tear = torn fibers balled up, folded ulnarward away from joint, or gap >/= 3mm
- Surgery best within 3 weeks of injury
- After 1-2 months atrophy and fibrosis of UCL may preclude primary repair and require UCL reconstruction or MCP arthrodesis

Shoulder injuries

Skiing

4-11% of all injuries

#1 Rotator cuff injury (24%)

#2 Glenohumeral dislocation (22%)

#3 AC separation (20%)

#4 Clavicle fracture (11%)

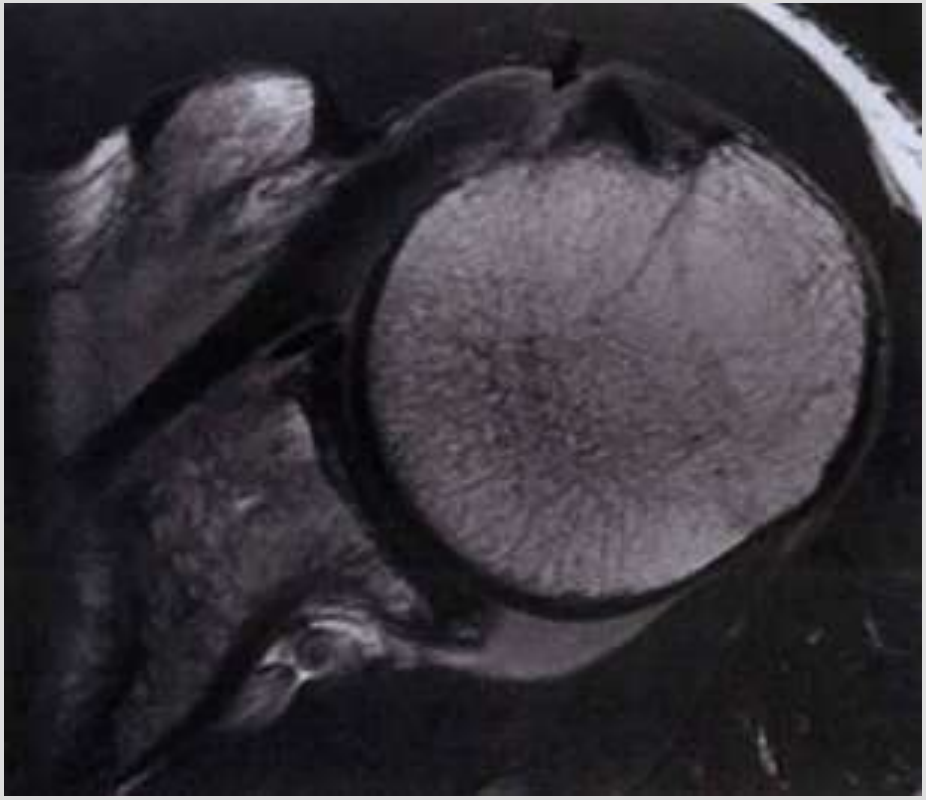
Snowboarding

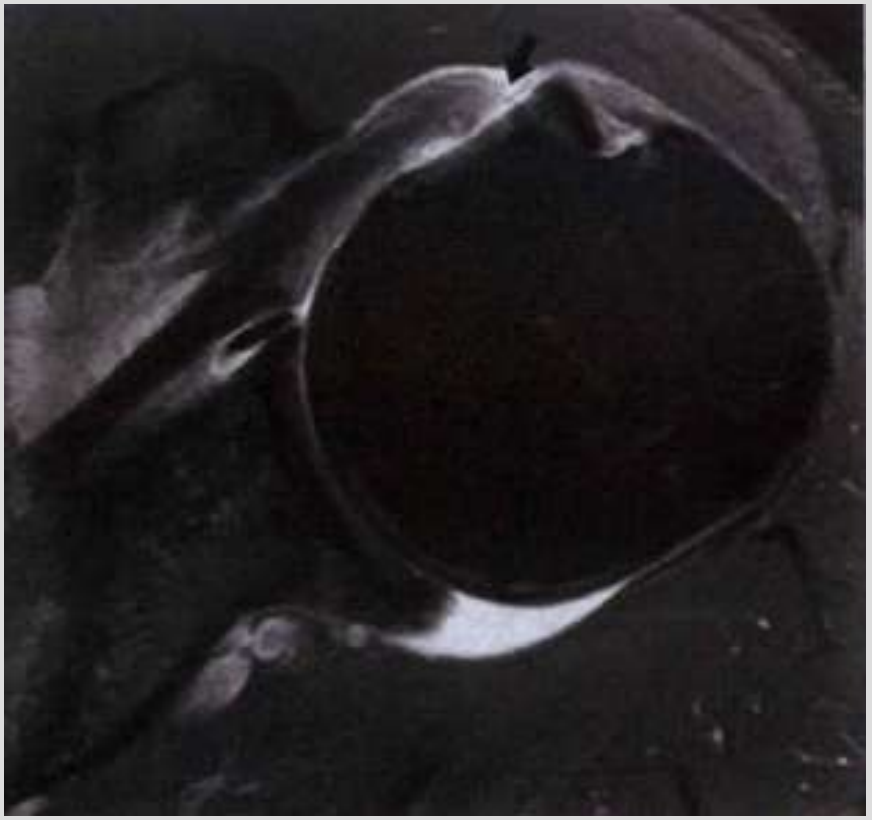
8-16% of all injuries

#1 AC separation (32%)

#2 Fracture (29%) clavicle most common

#3 Glenohumeral dislocation (20%)





65 year old skier
Subscapularis tendon tear

54 year old skier
HAGL
Greater tuberosity fracture

Snowboarding injuries

- Fastest growing winter sport in the U.S.
- 6.3 million active snowboarders

Snowboarding injuries

- Lower extremity
  - Both feet firmly attached to board (less twisting of legs/knees)
  - Snowboard shorter than skis (shorter lever arm)
  - Usually softer boots (less ankle protection, less force transmitted to knee)
  - Less ACL, more ankle injuries

Snowboarding injuries

- Upper extremity injuries
  - No poles
  - Feet perpendicular to direction of movement
  - Can’t stabilize by moving leg out
  - Fall backward (heel side) or forward (toe side) without poles to break fall
  - Wrist and shoulder injuries

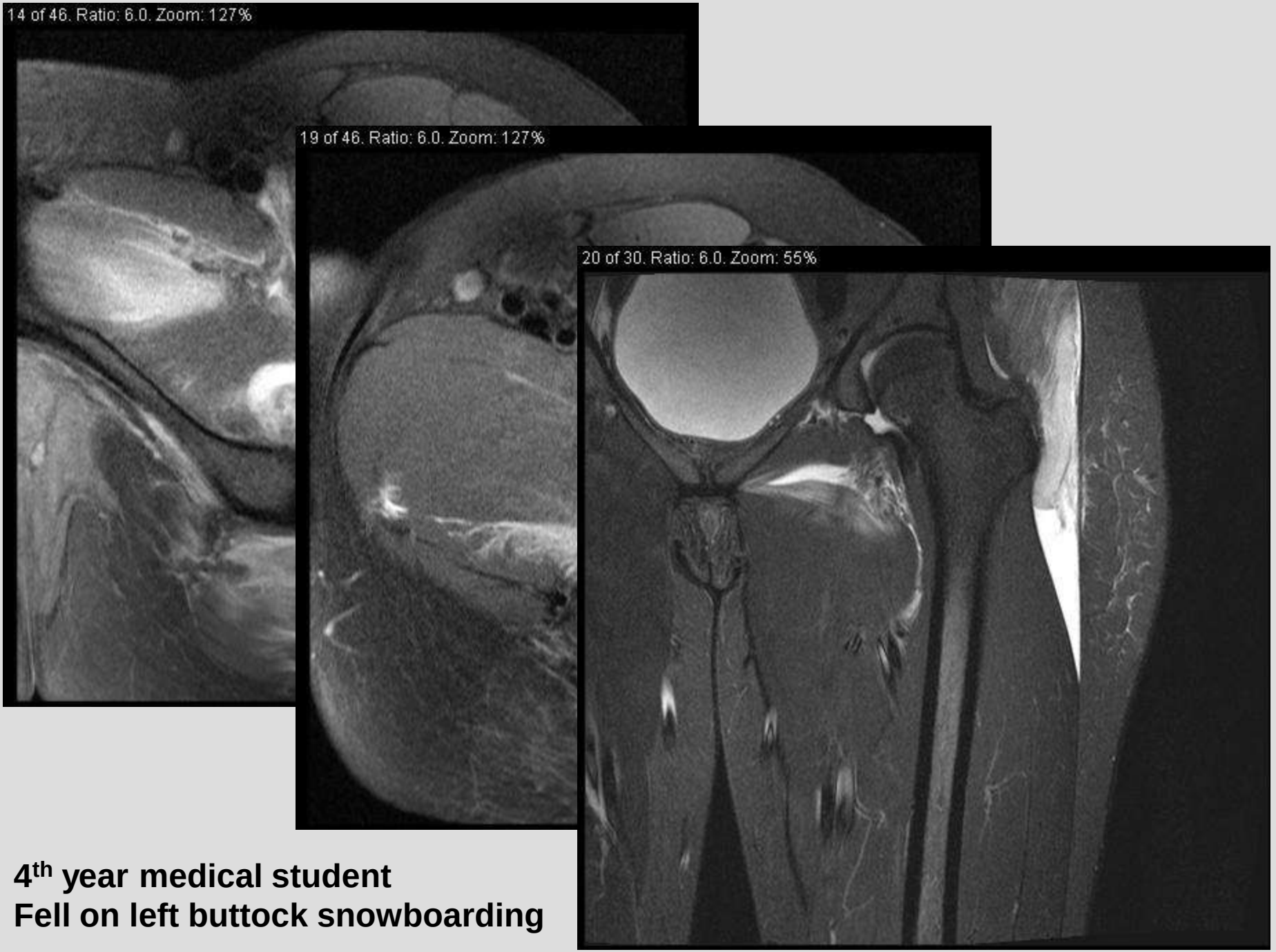
    instead of skier’s thumb

Regular or goofy?

- Regular foot = left foot forward
- Goofy foot = right foot forward
- Extremities toward front of board at highest risk of injury (LUE>LLE>RUE>RLE)
- No asymmetry with skiing injuries

Snowboarding injuries

- Almost ¼ of snowboarding injuries occur on the rider's first day
- Almost ½ occur during the rider's first season
- Beginners lose balance at low speed
- FOOSH with wrist/distal forearm injuries



4th year medical student
Fell on left buttock snowboarding

Snowboarding injuries

- Advanced snowboarders at higher risk for spine injury
- Higher speed, landing a jump

Snowboarding injuries

Most common sites of injury:

- 23% wrist
- 17% ankle
- 16% knee
- 9% head
- 8% shoulder
- 8% trunk
- 4% elbow
- 7% other

Upper extremity snowboarding injuries

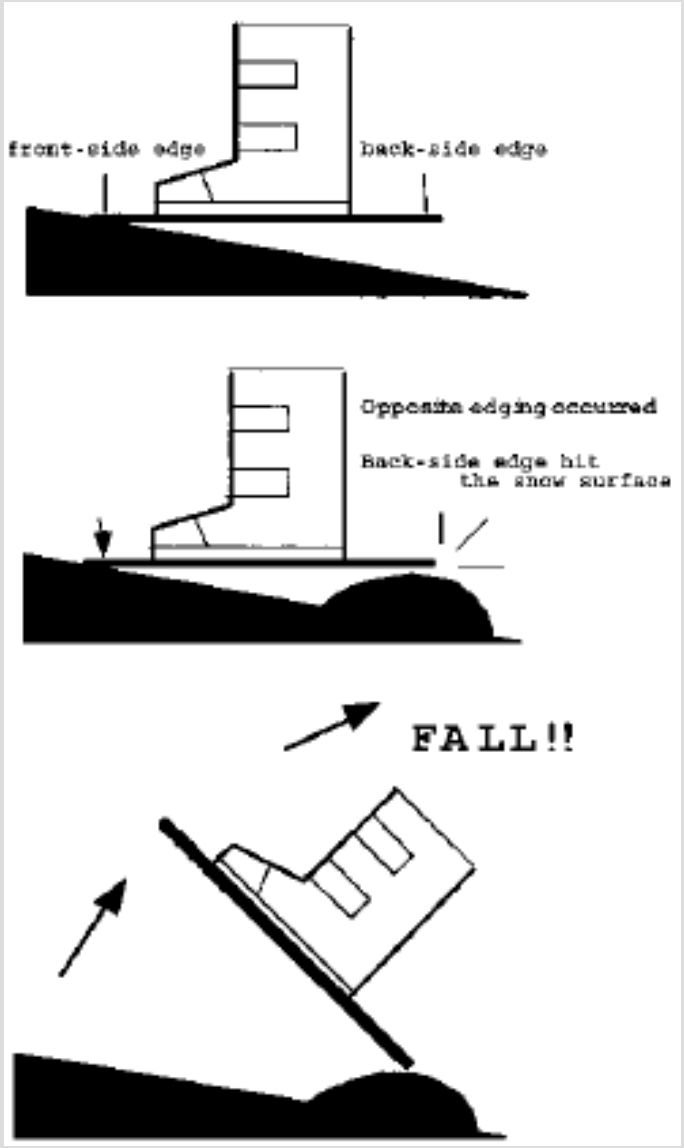
- Fractures (56%) > sprains (27%) > dislocations (10%) > contusions (6%)
- Fractures: radius (esp. distal) > carpal bones (esp. scaphoid) > clavicle > humerus > ulna
- Dislocations/subluxations: glenohumeral and acromioclavicular joints most common

Snowboarding wrist injuries

- Wrist injury more common with a backward (heel side) fall – 75% of wrist dislocations
- Shoulder injury more common with a forward (toe side) fall

Snowboarding wrist injuries

- Wrist injury more common with a backward (heel side) fall – 75% of wrist dislocations
- Shoulder injury more common with a forward (toe side) fall



12 year old snowboarder, FOOSH

Another 12 year old snowboarder

Snowboarding wrist injuries

Carpal injuries

- Beginners – contusions, simple fractures (except scaphoid), ligament sprains
- Intermediate and advanced riders – scaphoid fractures, dislocations including perilunate

Snowboarding wrist injuries

- Snowboarders with wrist guards ½ as likely to be seen for wrist injury
- Large proportion of snowboarders do not use any protective equipment
- In a survey, snowboarders ranked “getting stuck in the flats” the #1 negative aspect of the sport. Risk of injury was #9.

Snowboarding ankle injuries

- 2nd most commonly injured site
- 12-38% of snowboarding injuries vs. 5-6% of skiing injuries
- Leading leg (62-91%) > trailing leg
- Sprains 52%, fractures 44%

Snowboarder's fracture

- Fracture of the lateral process of the talus
- Rare injury before snowboarding:
  - <0.9% of ankle injuries
  - high energy trauma
- In snowboarding:
  - 2.3% of all injuries
  - 15% of ankle injuries
  - 34% of ankle fractures
  - 95% of talus fractures

Lateral process of the talus

- Superior surface forms part of the ankle joint
- Inferior surface forms part of the posterior subtalar joint
- Fractures are usually intra-articular

Snowboarder’s fracture

- Hawkins 1965 reported 13 cases of fractures of the lateral process of the talus
- MVA or fall from height
- Patients reported dorsiflexion and inversion at the time of injury

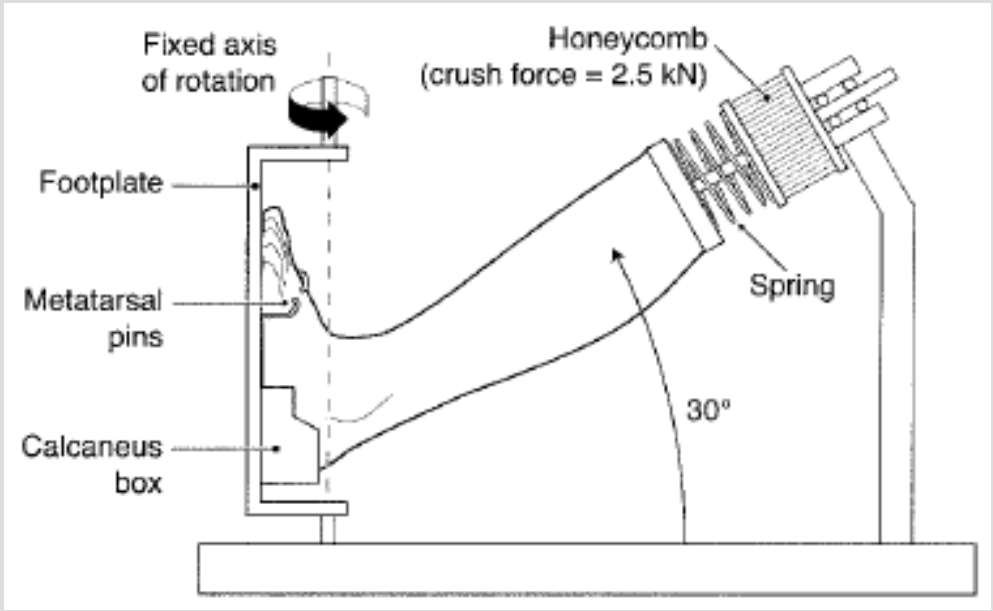
Snowboarder’s fracture

- Dorsiflexion and inversion has been the commonly accepted mechanism
- In snowboarding: landing after an aerial maneuver

Snowboarder's fracture

Biomechanical studies have suggested other mechanisms:

- Boon et al. 2001
  - Cadaveric leg specimens
  - Dorsiflexion, inversion + axial load = 0 LPT fractures
  - + External rotation = 6/8 LPT fractures



- Funk et al. 2003
  - 10 cadaveric leg specimens
  - Dorsiflexion, axial load + inversion = 0/3 LPT fractures
  - (osteochondral frxs, sustentaculum tali frxs, lateral ligament tears)
  - Dorsiflexion, axial load + eversion = 6/6 LPT fractures
  - (+medial ligament tears)

Snowboarder's fracture

- Ride with knees slightly flexed and ankles dorsiflexed, especially when riding toeside
- Forward fall parallel to the direction of the board
- Leading leg rotates toward the front of the board everting the dorsiflexed ankle
- Board acts as a lever about the long axis of the foot increasing torque

Snowboarder's fracture

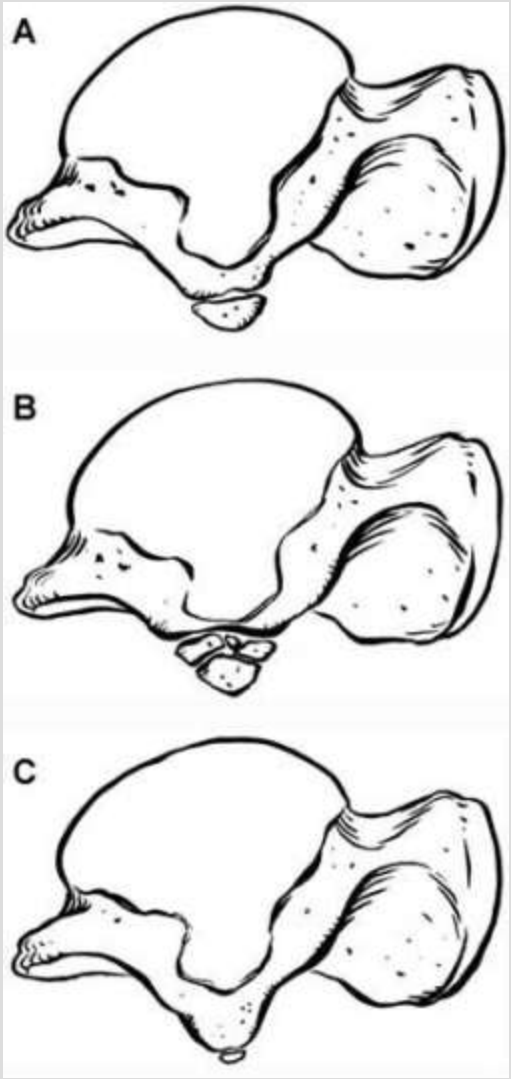
- Anterolateral ankle pain, similar to anterior talofibular ligament sprain
- Early diagnosis important to decrease the risk of persistent pain from nonunion, malunion or subtalar osteoarthritis
- Even with treatment, appoximately 25% have pain at follow up

Snowboarder's fracture

- May be occult or inconspicuous on radiographs
- 40% missed at initial presentation
- May be seen better with CT or MR
- CT best modality to evaluate size, displacement, comminution
- Surgery for large (>1cm) or displaced (>2mm) fragments or comminuted fractures

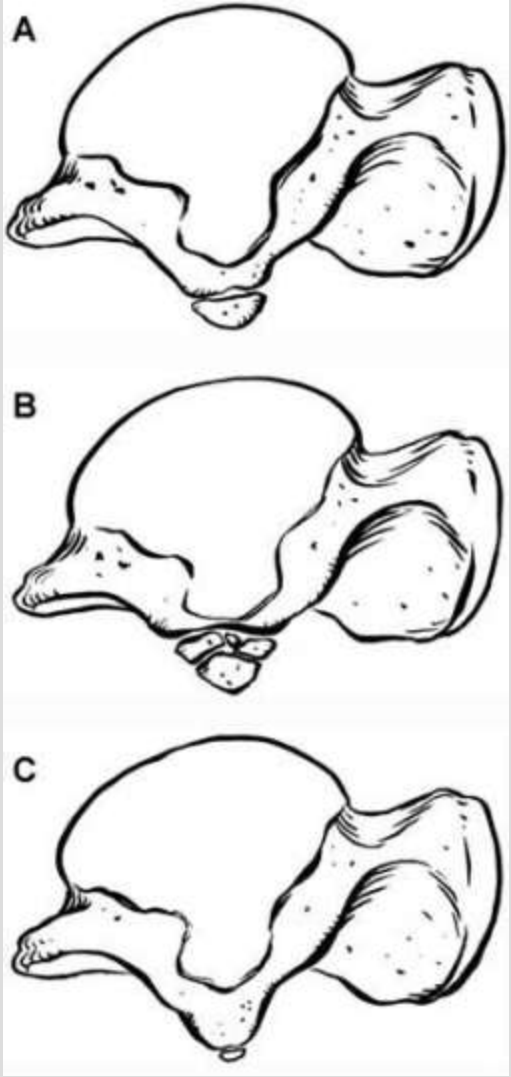
Snowboarder's fracture

- Hawkin's classification
  - I Simple fracture from talofibular surface to posterior subtalar articular surface
  - II Comminuted fracture involving both joints
  - III Chip fracture - anteroinferior without involvement of talofibular joint



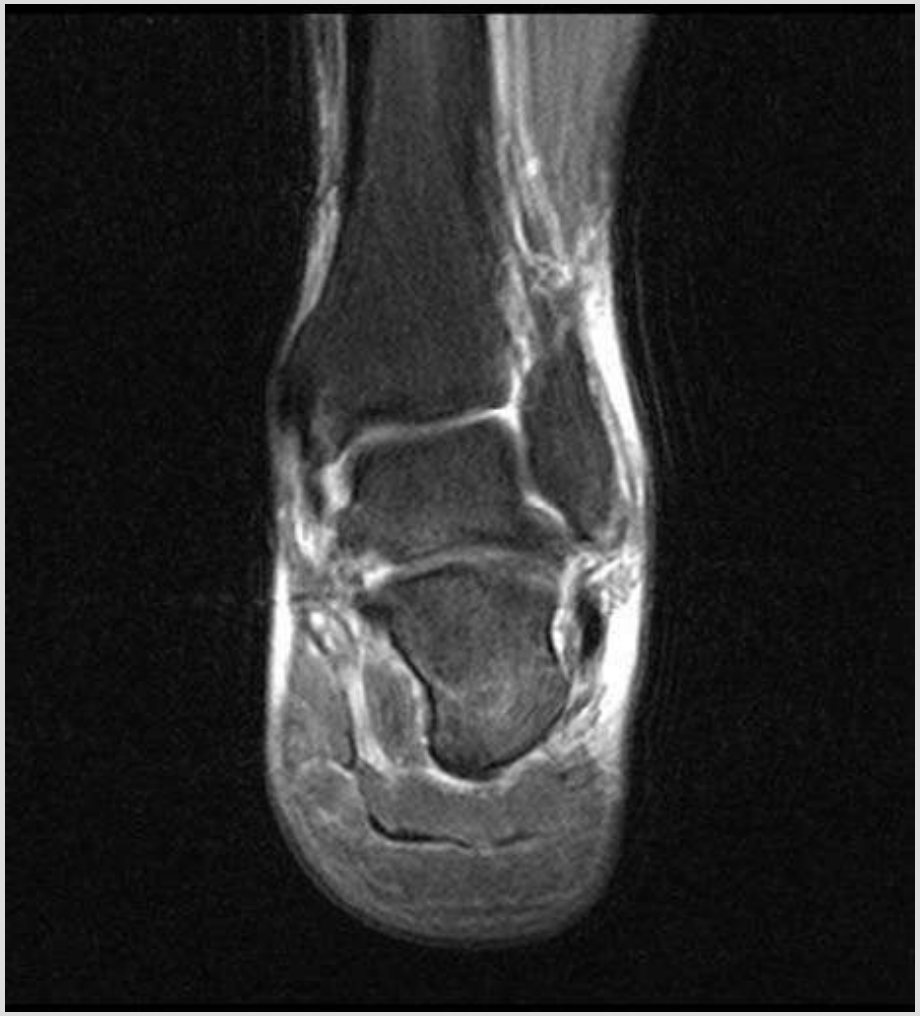
Snowboarder's fracture

- Alternate classification
  - I Chip fracture - anteroinferior without involvement of talofibular joint
  - II Simple fracture
    - A Involving talofibular joint
    - B Involving posterior subtalar joint
  - III Comminuted fracture involving both joints



Type II fracture
Positive “V” sign

Type III fracture



Type IIb fracture

Case courtesy of Tudor Hughes

Spinal injuries

- 1-13% of snowboarding and skiing injuries
  - 0.04/1000 days of snowboarding
  - 0.001-0.01/1000 days of skiing
- Mechanism
  - Jumping (77% of spine injuries in snowboarding versus 20% in skiing)
  - Fall related to loss of balance (59% of spinal injuries in skiing versus 18% in snowboarding)
  - Collisions (5-6% of spinal injuries in both)

Spinal injuries

- Study of serious spine injuries in 34 skiers, 22 snowboarders
  - Fracture at one level (82% of skiers, 73% of snowboarders)
  - Burst fracture > anterior compression fracture
  - Thoracolumbar most common, especially T12, L1
  - C7 most common cervical level
  - Sacral fractures only in snowboarders

Collisions

- 14% of skiing injuries are caused by collisions (with objects, skiers or snowboarders) versus 10% of snowboarding injuries
- 1% of injuries to skiers are caused by collisions with snowboarders versus 7% by collisions with other skiers

SABOTAGE STUPIDITY

THERE ARE STILL FOUR RESORTS IN NORTH AMERICA THAT DON'T ALLOW SNOWBOARDING

WE'RE THROWING DOWN A $5,000 CASH PURSE TO THE PERSON OR CREW

THAT SUBMITS THE BEST VIDEO DOCUMENTATION OF THEIR POACH EXPERIENCE FROM EACH RESORT.

- VIEW SUBMITTED VIDEOS
- POACHER NEWS & PHOTOS
- MISSION STATEMENT
- POACHING 10 COMMANDMENTS
- HOW TO ENTER

References

Boutin RD, Fritz RC. MRI of snow skiing and snowboarding injuries. *Seminars in Musculoskeletal Radiology* 2005;9(4)360-78.

Chan GM, Yoshida D. Fracture of the lateral process of the talus associated with snowboarding. *Annals of Emergency Medicine* 2003;41(6)854-858.

Chung CB, Lektrakul N, Resnick D. Straight and rotational instability patterns of the knee concepts and magnetic resonance imaging. *Radiol Clin N Am* 2002;40:203-216.

Davidson TM, Laliotis AT. Snowboarding injuries a four-year study with comparison with alpine ski injuries. *West J Med.* 1996;164:231-237.

Deibert MC, Aronsson DD, Johnson RJ, Ettlinger CF, Shealy JE. Skiing injuries in children, adolescents, and adults. *J Bone Joint Surg Am.* 1998;80:25-32.

References (continued)

Funk JR, Srinivasan SCM, Crandall JR. Snowboarder's talus fractures experimentally produced by eversion and dorsiflexion. *Am J Sports Med* 2003;31:921-928.

Hawkins LG. Fracture of the lateral process of the talus: a review of thirteen cases. *J Bone Joint Surg Am.* 1965;47:1170-1175.

Knoch F, Reckord U, Knoch M, Sommer C. Fracture of the lateral process of the talus in snowboarders. *Journal of Bone and Joint Surgery Br.* 2007;89B: 772-7.

Resnick *Internal Derangement of Joints* 2nd ed.

Tecklenburg K, Schoepf D, Hoser C, Fink C. Anterior cruciate ligament injury with simultaneous locked bucket-handle tears of both medial and lateral meniscus in a 19-year-old female professional ski racer: a case report. *Knee Surg Sports Traumatol Arthrosc.* 2007;15:1125-1129