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OUTSIDE WINTER INJURIES 1/9/2017 Volume 2, Issue 4

OUTSIDE WINTER INJURIES

Frostbite

By Kenneth Cicuto, MD

Frostbite is a localized cold thermal injury that results from tissue freezing. Frostbite injuries can have a substantial effect on long-term limb function and mobility if not promptly evaluated and treated. Overall, there are 4 degrees of frostbite (Fig. 1). The population at greatest risk includes military, homeless, outdoor adventurers or those with jobs in remote wilderness.

Fig. 1

1st Degree

This affects the surface of the skin. Skin develops white, red and yellow patches and becomes numb. There is typically no permanent damage. Long-term insensitivity to both heat and cold can occur.

2nd Degree

If the extent of superficial damage continues, injury usually blisters 1-2 days after becoming frozen. The blisters may become hard and blackened, but usually appear worse than they are. Most of the injuries heal in one month, but the area may become permanently insensitive to both heat and cold (Fig. 2).

3rd/4th Degree

If there is deeper freeze injury, the muscles, tendons, blood vessels, and nerves become damaged. The skin is hard, feels waxy, and use of the area is lost temporarily, and in severe cases permanently. The deep frostbite results in areas of purplish blisters which turn black and which are generally blood-filled. Nerve damage in the area can result in permanent paresthesia. This may result in amputation or gangrene. The extent of the damage done to the area by the freezing process of the frostbite may take several months to assess, and this often delays surgery to remove the dead tissue; "frostbite in January, amputate in July" (Fig. 3).

Pathophysiology

When the temperatures near zero degrees, the peripheral blood vessels constrict in order to preserve central core temperature. These temperatures cause loss of vascular tone and barrier leading to transendothelial plasma leak. Ice crystals form in the intra and extracellular space. There is both osmotic and ischemic cellular damage. In the final stage, there is impaired blood flow, increased blood viscosity, capillary thrombosis and arterial-venous shunting.

Imaging

X-rays demonstrate acute bony injury of late acro-osteolysis but are otherwise not particularly helpful.

The triple-phase bone scan is a useful indicator of tissue viability as early as 2 days after cold injury and appears to have a clinical role in the evaluation of frostbite injuries. The perfusion and blood pool images demonstrate the ischemic tissue at risk, while the delayed bone scan images demonstrate the extent of deep-tissue and bone infarction. There are 3 classic patterns:

1. Hyperemic blood flow with normal early blood pool and normal delayed bone images -> mild ischemia not typically requiring surgical intervention.
2. Absent blood flow and absent early blood pool, but depiction of bone in delayed images -> predicts superficial tissue infarction requiring minor debridement.
3. Absent perfusion, blood pool and bone uptake -> deep tissue injury requiring amputation (Fig. 4).

Fig. 2

Fig. 3

Fig. 4:

Frostbite Continued…

Treatment Options

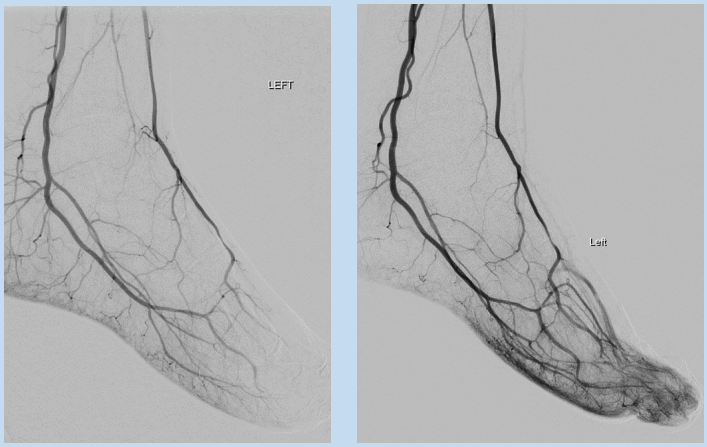
Passive rewarming involves using body heat and ambient temperature to slowly rewarm the affected area. Active rewarming is preferred as to limit the tissue damage from freeze injury. This is typically done in a water bath with temp 40-42 degrees C. Hyperbaric oxygen therapy is sometimes used as an adjunctive treatment to tissue salvage.

There is some data showing that IV or intra-arterial tPA (Fig. 5) is a safe and effective treatment which can reduce the need for amputation.

Remember never to thaw an affected area if there is risk of refreeze as this will exacerbate the damage. Only thaw once within a stable, warm environment. Additionally, excessive movement can worsen the crystal injury so always avoid rubbing, massaging, shaking or applying force to the frostbitten region. Stay safe out there in the Colorado winter weather!!

Kenneth Cicuto, M.D.

Fig. 5: 51 year old alcoholic who presented with severe left foot frostbite. Pre and post angiogram follow 24 hours of intra –arterial tPA infusion showing reconstitution of the vasculature of the distal foot.



Wrist Injuries for the Snowboarder: Scaphoid Fracture and MRI

By Jamie Colonnello, MD

There is snow falling in the high country. People are gearing up for an active season of skiing and snowboarding. Besides the traffic heading up I-70, injuries on the slopes can add frustration and delays to the wintertime fun. Skiing and snowboarding injuries frequently result in trips to physician offices or urgent care facilities. Undoubtedly, many of these patients will require imaging.

While many injuries between skiers and snowboarders overlap, there are clear injury patterns and injury percentages that differ between these activities. For example, with snowboarding, the upper extremity is injured nearly twice as often than skiing. Upper extremity injuries account for 59% of snowboarding injuries. The predominant explanation for this statistic is that with snowboarding, the feet are fixed to a single board with the arms used for balance. Forward and backward falls are typically "broken" by outstretched arms and hyperextended wrists (Fig. 1).

At the shoulder, there are resultant glenohumeral joint dislocations with associated impaction type fracture patterns and labral tears. Rotator cuff tears and humeral head fractures are also seen. The forces at hand may avoid the shoulder and instead cause clavicle fractures or AC joint separations. 20% of the upper extremity injuries directly involve the wrist and 50% of all fractures with snowboarding injuries are seen at the wrist.

Not surprising, nearly half (49%) of the wrist fractures seen with snowboarding effect beginning boarders, whom are more prone to falls. With beginners, most wrist injuries (73%) are encountered with backward falls onto the outstretched hands. Injuries at the wrist may be limited to soft tissue swelling but the other end of the spectrum includes complex fracture-dislocation patterns. The two most commonly encountered fractures at the wrist would include Colles fractures (distal radius fracture with dorsal angulation) and scaphoid fractures.

In general, scaphoid fractures are the second most common wrist injury and the most commonly fractured carpal bone. 65% of these fractures are seen in the mid portion of the scaphoid, or the scaphoid waist. The initial step in treatment requires recognition of the fracture. Nondisplaced or minimally displaced fractures may be radiographically occult. In the acute setting, radiographs can miss 5-20% of these factures. When there is a high clinical suspicion based on history and physical exam, an option would include mobilizsation with follow-up in two weeks. Alternatively, MRI may be performed at the time of presentation.

Fig. 1: Ouch. (snowrepublic.co.uk)

Wrist Injuries for the Snowboarder Continued…

Fig. 2A: Occult scaphoid fracture confirmed with MRI.

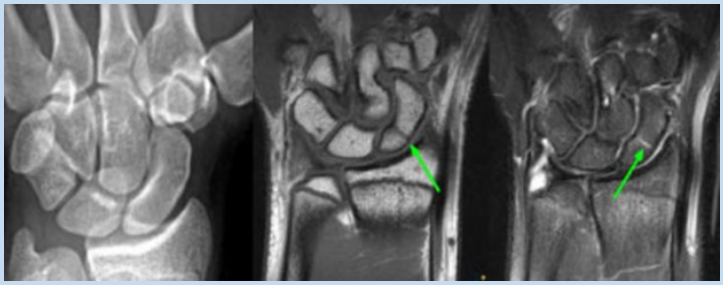
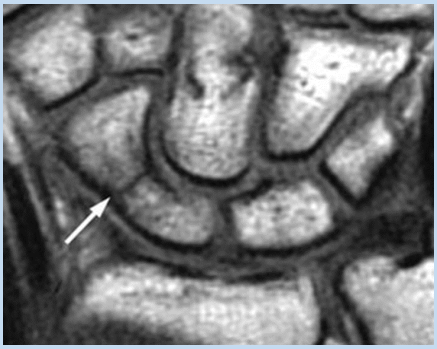


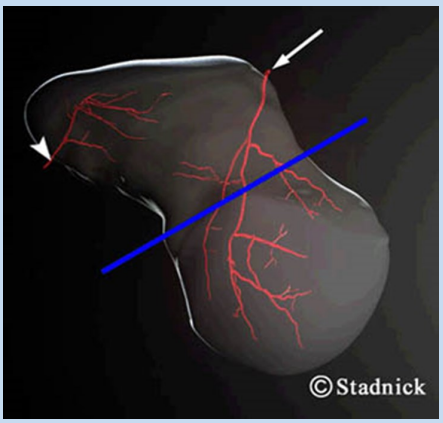
Fig. 2B: Occult scaphoid fracture line with surrounding marrow edema. (T1 sequence)



MRI is the most sensitive modality for trabecular fractures without cortical involvement. This type of fracture would not be seen with plain films or computed tomography. Classic appearance with MRI is marrow centered edema as evidenced by bright T2 signal. On T1 sequences low signal is seen in the marrow space with a dark, linear fracture line (Fig. 2A and 2B)

MRI would be able to diagnose additional injuries such as bone contusions, capsular injuries or ligament/tendon injuries.

Fig. 3: Scaphoid blood supply. Blue line represents waist fracture plane which can jeopardize blood supply to proximal pole.



The blood supply of the scaphoid is unique in that a dominant dorsal vessel enters the bone in the waist and has branches that supply the proximal pole. In other words, blood supply extends from distal to proximal (Fig. 3). When the scaphoid waist fractures, the blood supply to the proximal pole may be jeopardized which can ultimately lead to avascular necrosis (AVN). Altered blood supply directly impacts fracture healing.

Incomplete scaphoid waist or complete, non-displaced fractures are treated with immobilization. Operative repair is usually reserved for complex, displaced fractures or fractures with associated ligament injuries. Up to 15% of fractures will demonstrate delayed union or non-union. Intact vascularity of the proximal pole dramatically improves outcome of those fractures requiring surgery. In cases of delayed fracture healing, AVN may be present as increased sclerosis in the proximal pole. This finding can be seen with plain films and CT. Again, MRI has a role in imaging of the scaphoid. Classically, AVN will be seen as dark T1 and dark T2 signal (Fig. 4A and 4B). There may be evidence of bone collapse at the articular surface. This diagnostic information is crucial in fracture management.

Snowboarding continues to grow in popularity. In addition to helmets, many advocate the use of wrist guards for injury prevention. This may be particularly beneficial for the beginner snowboarder. Finally, understanding the mechanism of injury and patterns of injury allows for better patient care. MRI is an invaluable tool in those cases where conventional imaging is normal yet there remains a high clinical suspicion of injury.

Fig. 4A: Proximal pole AVN

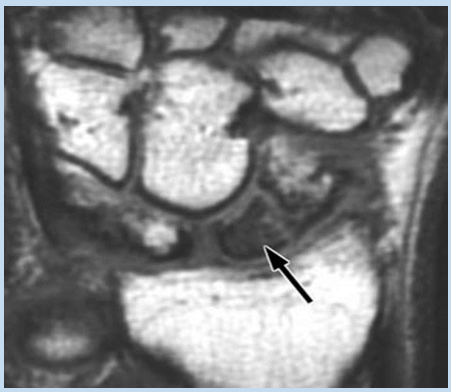
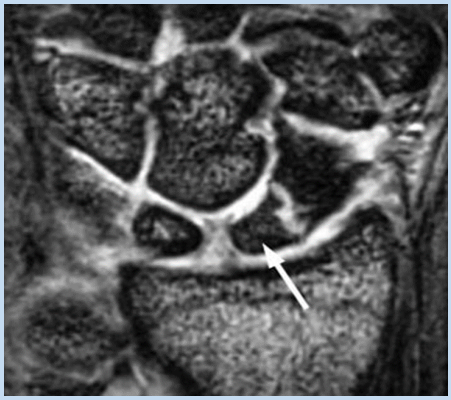


Fig. 4B: T2: Proximal Pole AVN



Enjoy the ski/snowboard season!

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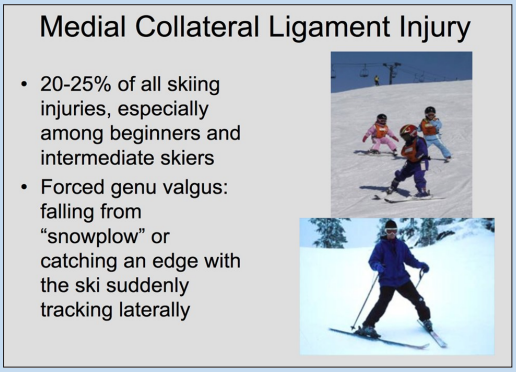
Common Ski and Snowboarding Injuries

By Michael Rogan, MD

Skiing in Colorado is part of the fabric of Winter. According to Vail Resorts, the total number of skier visits in Colorado in 2013-14 was 12.6 million, with 9% of residents of Colorado skiing. With an injury rate of around 3 per 1000 skier days, skiing is a risky sport (1). In this article, I will describe common knee injuries in skiing and ankle injuries in snowboarding, with a focus on the mechanism of injury and the imaging findings.

With the advent of modern ski boots and binding systems that are designed to reduce the incidence of ankle injuries, there has been an increase in the number of significant knee injuries occurring in skiers (1). Most experts agree that injury to the medial collateral ligament (MCL) is the most common knee injury in skiers, accounting for 20% to 25% of all injuries. ACL injuries are also common injuries.

Fig. 1 (3) :



The mechanism of injury is one skiers will recognize: a skier catches the inside edge of the front of the ski, resulting in external rotation of the tibia, the length of the ski significantly magnifies the torque acting on the knee, and the MCL is injured (Fig. 1).

An MRI is the imaging modality of choice that will demonstrate the ligament damage (Fig. 2).

There are several skiing mechanisms that cause ACL tears. Each causes twisting of the knee and anterior force in the tibia. One mechanism is when a skier lands a jump. The skier is off-balance in the air, and lands too far back. The tail of the skis land first, levering the tibia anteriorly via force transmitted through the top of the boot and creating an anterior drawer effect (Fig. 3). Another mechanism is when a skier catches the edge of his leading or downhill ski, and falls over it (Fig. 4). Other mechanisms include catching the inside edge and falling forward over the ski, and falling backward between the skis (Fig. 5 and Fig. 6). MRI imaging is

Fig. 2: Coronal FSE PD left knee in a 20 y/o skier. Extensive thickening and complete discontinuity of medical collateral ligament compatible with tear (black arrows). ACL yellow star) and PCL (white asterisk) are also torn.

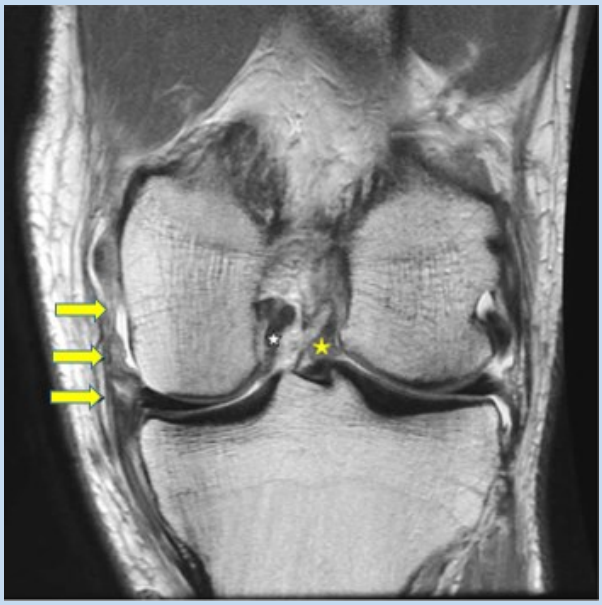


Fig. 3: ACL injury mechanisms (3)

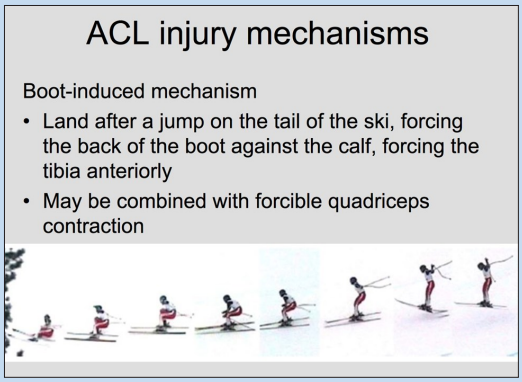


Fig. 4:

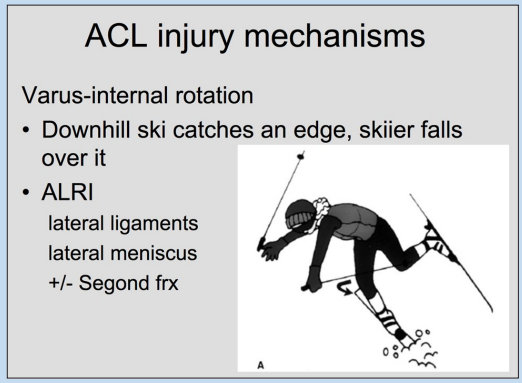


Fig. 5:

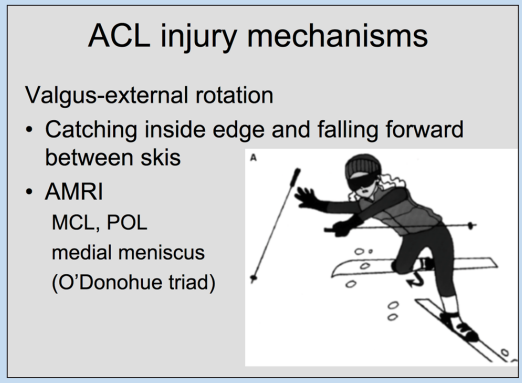
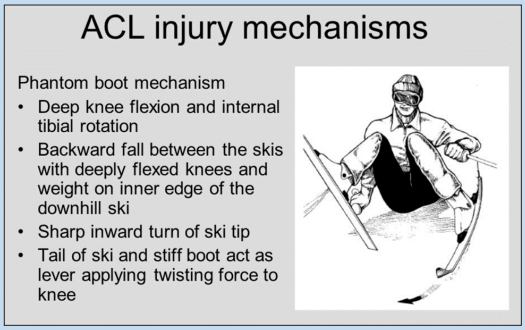


Fig. 6:

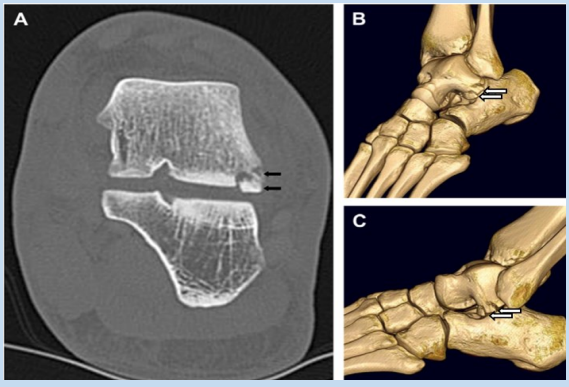


Common Skiing Continued…

Fig. 7: Sagital MRI image demonstrates a normal ALC on the left, and a torn ACL on the right.

Fig. 9: LPT plain film. Arrow points to fracture (3)

Fig. 10: (A) Coronal CT reconstruction on the left talus. 25 y/o snowboarder with anterolateral ankle pain following dorsiflexion injury with a fracture through the lateral process of the talus (black arrows). (B) Same patient as in (A), 3D volume rendering demonstrates the fracture (white arrow). (C) White arrow demonstrates the fracture.



the modality of choice to diagnose a torn ACL (Fig. 7).

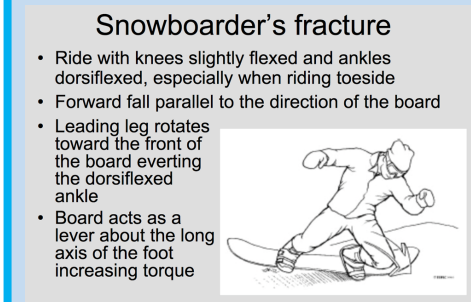
An unusual injury in the general public, but a common injury in snowboarders is a fracture of the lateral process of the talus (LPT). Before the popularity of snowboarding, fractures of the LPT were considered very rare, with few reported cases in the literature occurring usually as a result of motor vehicle accidents (2). These fractures only accounted for 0.86% of ankle fractures in the general public, but a whopping 32% of ankle fractures seen in snowboarders. Recognition of this fracture is important because they can masquerade as ankle ligamentous sprains and can lead to significant morbidity in a young and active patient population.

The mechanism of injury can be identified with snowboarding activities: high energy impacts with significant axial loading, with dorsiflexion and inversion or external rotation disrupting the talus-calcaneus alignment, concentrating stress on the LPT (Fig. 8, 9, 10). Jumping is more of an intrinsic element to snowboarding than skiing, with frequent aerial maneuvers with increasing skill levels, therefore the landings become more forceful.

It is very important for the technologist to communicate to the radiologist if the history for a plain ankle film is snowboarding injury, especially anterolateral ankle pain. The radiologist should have a very low threshold to request a CT of the ankle, even with a negative plain film because this type of injury is difficult to see due to the occult nature of these fractures.

As you can see, because of the unique speed and force that skiing and snowboarding activities have, there are several unique injuries that can occur. With improved equipment, the forces acting on knees and ankles have changed. New equipment also helps participants increase speed and create more difficult and creative aerial tricks. As radiology technologists and radiologists see patients during the winter months, it is helpful to understand the mechanism of injury to most accurately diagnose a skier or snowboarder's injury. The injuries presented in this article, knee MCL and ACL tears, and lateral process talar fractures will give the reader increased confidence to spot these injuries.

Fig. 8: Mechanism for LPT fracture (3)



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Michael Rogan, M.D.

Plain Film Evaluation of Winter Injuries

By Amy Hayes, MD

With the advent winter and ice and snow comes an increase in the number of patients seen in the emergency room for fractures. In a retrospective review of patients seen in an urban emergency room after an ice storm, for a fall on ice, the most common fractures were of the ankle (24.7%), wrist (19.4%) and hip (14.0%).

Ankle

The most common ankle fracture is a lateral malleolus (fibular) fracture alone. If the fracture is within 4 cm of the tip of the fibula it is considered stable and generally does not require surgical intervention (Fig. 1 and 2).

Fig. 1: Stable distal fibular fracture. Fracture is within 4 cm of the tip of the fibula.

Fig. 2: Unstable fracture, more than 4 cm above the tip. Ankle mortise is wide medi-

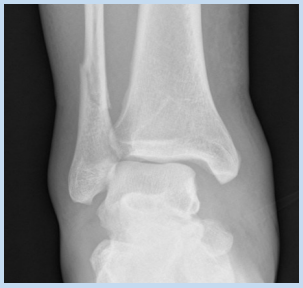


Fig. 4: Subcapital fracture. Risk of AVN is 50%.

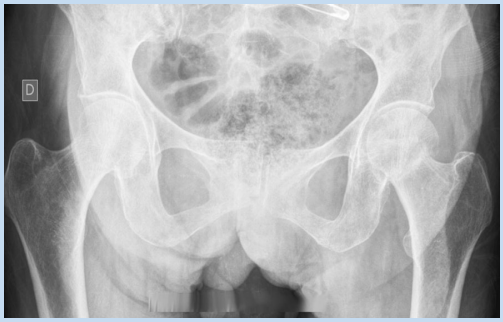
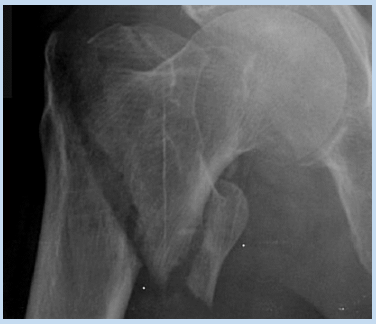


Fig. 5: Intertrochanteric fracture. Risk of AVN is 10%.



Wrist

The most common fracture of the wrist is a Colles fracture and is a typical FOOSH (fall on outstretched hand) injury. Colles fracture is a distal radial metaphyseal fracture with dorsal angulation and impaction without involvement of the articular surface (Fig. 3).

Hip

The most common types of hip fractures are femoral neck fractures and intertrochanteric fractures which occur about in equal numbers. A femoral neck fracture may interrupt the blood supply to the femoral head and may be more difficult to fix. An intertrochanteric fracture usually does not interrupt the blood supply (Fig. 4 and 5).

Fig. 6: Skier's Thumb

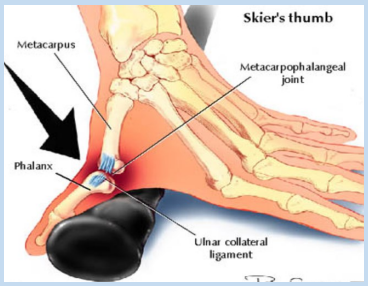


Fig. 7: Boot Top Fracture

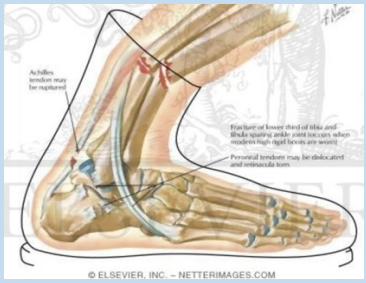


Fig. 3: Colles Fracture

Skiing and snowboarding can also cause injuries.

Skiers thumb occurs when there is forcible abduction of the thumb during a fall or aggressive pole plant. This results in acute rupture of the ulnar collateral ligament of the metacarpalphalangeal joint and avulsion of the base of the proximal phalanx along its ulnar aspect (Fig. 6).

Boot top fractures can occur when there is rapid deceleration of the ski and the binding does not release. The tibia and fibula can fracture just above the boot top if enough force is applied (Fig. 7).

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