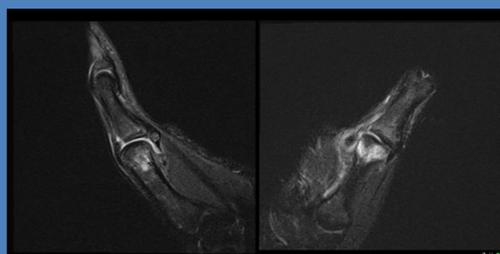


Introduction:

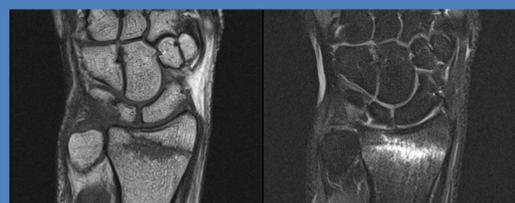
Trauma to the upper extremity is a common source of injury during winter sports activities. Winter sports related injuries are frequently seen in snowboarders and skiers as they are two very popular winter sports. Among skiers, injuries to the lower extremity are more common than injuries to the upper extremity. Snowboarders are twice as likely as skiers to injure their upper extremity, accounting for approximately 50% of snowboarding injuries. Differences in equipment and stance between the two sports result in the different rates and patterns of injury. Snowboarding injuries are more common in the left upper extremity due to the usual stance with the left side forward. Conversely, skiers have an equal likelihood of injuring either upper extremity. Diagnosis of these injuries is important, as inappropriate treatment can lead to long term morbidity. In high-performance athletes, winter-sports related injuries are managed aggressively. Other winter sports can also result in injuries to the upper extremity, including ice skating and ice hockey.

Injuries of the Hand and Wrist:



28 year-old female presenting after a fall while skiing. Sagittal and Coronal STIR MR images centered at the 1st MCP joint demonstrate edema and a torn UCL.

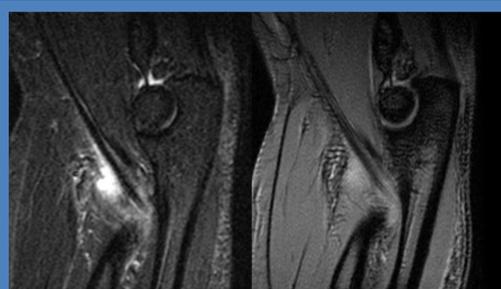
Injuries to the ulnar collateral ligament (UCL) of the thumb are common in skiers. Acute rupture of the UCL is referred to as “Skier’s Thumb” and 8-17 % of skiing accidents result in UCL injury. This injury is most often caused by a fall with a ski pole in hand. This results in forced abduction and extension at the first MCP joint and injury to the UCL. UCL injuries most commonly occur at the distal attachment site. These can be accompanied by a small avulsion fracture. UCL injuries can be classified as partial tears, nondisplaced complete tears, and displaced complete tears. A complete tear of the UCL with displacement of the ligament above the adductor pollicis aponeurosis is referred to as a Stener lesion. There is a high rate of Stener lesions among skiers with UCL injuries. Complete tears of the UCL can often be diagnosed clinically by valgus stress testing. Patients with Stener lesions often present with a small tender palpable lump at the base of the ulnar aspect of the thumb. Patients with symptoms and instability of the thumb benefit from surgery. Stener lesions do not heal well without surgical intervention. Skiers can attempt to reduce the rate of UCL injuries by not using wrist straps on their ski poles and dropping ski poles during a fall.



18 year-old male presenting with acute wrist pain after fall during snowboarding. Coronal T1 and T2 MR images demonstrate an acute distal radial fracture.

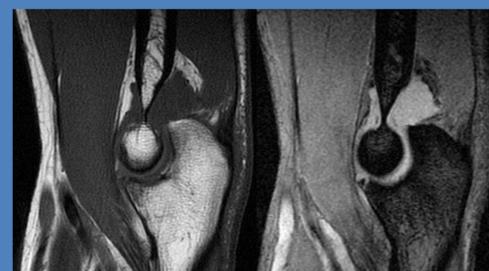
The wrist is the most commonly injured joint in snowboarders, involved in 23% of snowboarding injuries. These injuries are due to fall onto outstretched arms with hyperextended wrists. Novice snowboarders are much more likely to be injured and present with fractures of the distal radius, carpal bones and wrist sprains. More advanced snowboarders are at a higher risk for scaphoid fractures, radius fractures that involve the joint surface and lunate/perilunate dislocations due to high velocity injuries. Use of wrist guards in snowboarding can significantly reduce injuries.

Injuries of the Forearm and Elbow:



31 year-old male presenting after a snowboarding collision and acute pain and swelling. Sagittal STIR and GRE MR images demonstrate a high grade partial tear of the distal biceps tendon.

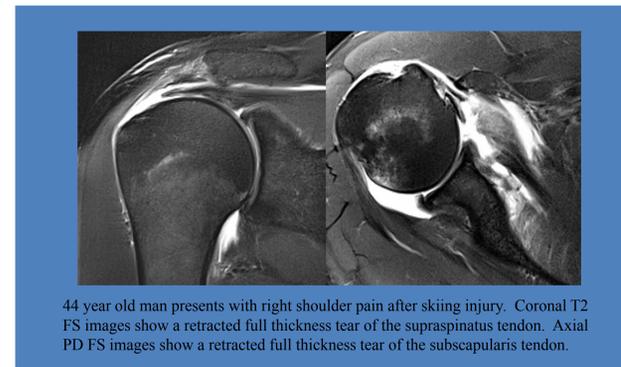
Injuries to the forearm, elbow and interosseous membrane (IOM) are more common in snowboarders than skiers. These are most often due to falls onto an outstretched hand. Falls with the forearm supinated often result in fracture of both the radius and ulna. Falls with the forearm in neutral position often result in isolated radial head fractures. Falls with the forearm pronated occur with maximum contact between the radial head and capitellum resulting in radial fractures with injury of the IOM and distal radio-ulnar joint. Disruption of IOM can result in chronic pain and weakness. Imaging findings in IOM disruption are often subtle, which can result in a delay in diagnosis.



43 year old man presenting after fall while sledding. Sagittal T1 and T2 MR images show a minimally displaced fracture of the coronoid process with a joint effusion.

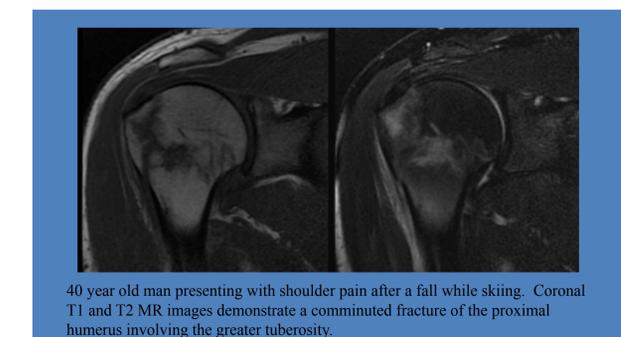
Injuries of the Shoulder:

Injuries to the shoulder account for 4-11% of all skiing injuries. These commonly include rotator cuff injuries, anterior glenohumeral dislocations, acromioclavicular separations and clavicle fractures. These are usually due axial loading from fall on an outstretched arm or excessive rotational forces on the shoulder joint from a fixed ski pole during a fall.



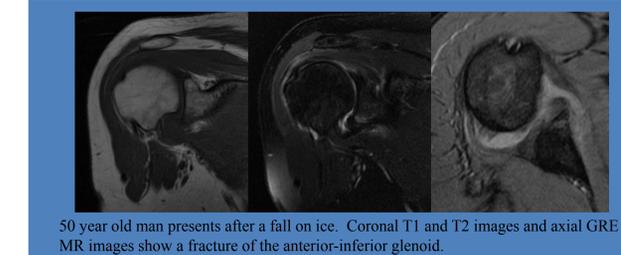
44 year old man presents with right shoulder pain after skiing injury. Coronal T2 FS images show a retracted full thickness tear of the supraspinatus tendon. Axial PD FS images show a retracted full thickness tear of the subscapularis tendon.

Anterior glenohumeral dislocations and rotator cuff strains are the most common shoulder injuries in skiing. In skiers over age 40 with a glenohumeral dislocation, there is a concurrent rotator cuff tear in up to 35% of cases. In younger skiers with a glenohumeral dislocation, particularly those under age 25, there is a high risk of future recurrence. As a result, although most cases of anterior dislocation are treated conservatively after reduction, there are some providers who advocate early arthroscopic stabilization in a young patient after his or her first dislocation. Skiers can attempt to reduce shoulder injuries by avoiding “pole-planting” and by not using poles with wrist straps.



40 year old man presenting with shoulder pain after a fall while skiing. Coronal T1 and T2 MR images demonstrate a comminuted fracture of the proximal humerus involving the greater tuberosity.

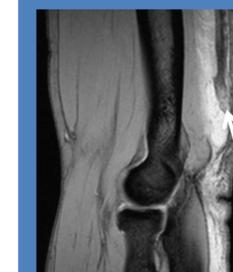
Shoulder injuries are also common in snowboarders, accounting for 8-16% of all snowboarding injuries. The most common snowboarding injuries in the shoulder are clavicle and proximal humerus fractures, acromioclavicular separations, and glenohumeral dislocations. Shoulder injuries in snowboarding are usually due to a forward fall. Glenohumeral dislocations occur more often during jumps and aerial maneuvers.



50 year old man presents after a fall on ice. Coronal T1 and T2 images and axial GRE MR images show a fracture of the anterior-inferior glenoid.

Imaging Findings and MRI Evaluation:

The imaging evaluation of winter sports related orthopedic injuries usually begins with plain film. Displaced fractures and dislocations are usually evident on X-ray. MRI is a more sensitive imaging modality for detection of occult fractures and soft tissue injuries. Nondisplaced fractures are easily visualized as abnormally increased T2 signal with decreased T1 signal. Trauma in the upper extremity often also involves ligamentous or tendon injuries, both of which appear as areas of increased T2 signal on fluid-sensitive MR sequences.



32 year-old female presenting with acute elbow pain after fall during ice skating. Sag GRE MR image demonstrates an acute triceps tendon tear. The torn triceps tendon appears retracted (white arrow).

In patients with suspected skiing-related UCL injuries, the UCL can be visualized with MRI. The normal UCL appears as a uniform band of low signal along the medial joint margin of the 1st MCP joint. Partial or complete tears can be seen as abnormal high signal traversing part or all of the ligament. Displaced tears can be seen with the ligament fibers folded away from the joint.

In the forearm, besides evaluation of ligamentous and tendon injuries, MRI is useful for diagnosis of injuries to the IOM. The normal interosseous membrane is a thin linear structure which appears hypointense on all sequences. Discontinuity of this on MRI is a sign of IOM disruption. Fat-suppressed T2 sequences of the middle-third of the forearm are the most helpful in evaluation of the IOM. Disruptions of the IOM can also be imaged with ultrasound.

In the shoulder, MRI is a useful modality for diagnosis of rotator cuff and labral tears. Fluid-sensitive sequences show increased T2 signal traversing the rotator cuff tendons in partial or complete tears. Labral tears are best assessed with MR arthrography. Although glenohumeral dislocations are usually apparent on X-ray, MRI provides evaluation of concomitant soft tissue injuries and associated fractures or osseous injuries which may be occult on plain film.



69 year old woman presents after fall on ice with anterior dislocation. Coronal T2 FS MR images show a Hill-Sachs lesion in the humeral head.

Conclusion:

MRI is an effective tool for evaluation of the upper extremity in winter sports related injuries. The rates of these injuries may be underestimated, as epidemiologic studies often use data from the ski patrol and on-site medical facilities, while many injuries are not reported until the injured person returns home. Recognition of common patterns of injury can aid the radiologist in diagnosis and help prevent morbidity from unrecognized orthopedic injuries.

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