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Magnetic Resonance Imaging Findings of Snowboarding Osteochondral Injuries to the Middle Talocalcaneal Articulation

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This report presents 2 cases of subtle injuries to the subtalar joint, specifically, osteochondral defects of the middle facet of the talus and concomitant involvement of the middle talocalcaneal articulation sustained while snowboarding. The 3T magnetic resonance image revealed fracture of the lateral talar process with osteochondral lesions of the middle talocalcaneal articulation. This injury can lead to severe and chronic disability if undetected and could ultimately end athletic participation prematurely.

Keywords: Ankle, osteochondral lesion, middle facet of talus, MRI, snowboarding

Injuries to the ankle and peritalar joints are common in sports such as snowboarding, skiing, skateboarding, and surfing.[1,9,14,23] In most of these sports, the athlete is able to release foot constraints. However, in snowboarding, the feet are held in place with stiff boots. While the boots provide support to the heel and ankle, movement at the joints of the hindfoot is constrained; this often results in impaction of the sustentaculum tali and middle facet of the talus, while the other joints are deflected out of the line of force. This can result in osteochondral injury to the middle facets.[4,13] It is important to detect this injury to the sustentaculum tali and/or middle facet of the talus to avoid persistently painful ankles and long-term disability.[4] This injury may be overlooked in the presence of other injuries to the ankle (talocrural) joint or may be dismissed as the more common ankle sprain.[4]

There is little information regarding osteochondral injuries involving the middle facet of the talus and the middle talocalcaneal articulation due to the inaccessibility of this specific area for imaging examination.[1,4,9,14,23] However, advancements in magnetic resonance imaging (MRI), including increased resolution and better signal-to-noise ratios, facilitate the diagnosis of injuries to the sustentaculum tali and the middle talocalcaneal joint.[7]

INITIAL PRESENTATION

Two patients who both sustained osteochondral injuries while snowboarding underwent MRI on a 3T scanner (Siemens Magnetom Verio 3T, Erlangen, Germany) using a dedicated foot/ankle coil (standard ankle MRI protocol: axial T2-weighted turbo spin echo [TSE] and proton density fat-suppressed TSE sequences, followed by coronal and sagittal proton density TSE sequences with and without fat suppression—total of 6 sequences) (Table 1).

MRI Examination and Findings

The first patient was a 25-year-old male snowboarder injured 3 weeks prior to MRI examination. There was a substantial impact sustained after landing a jump and significant lateral pain initially, but he was able to continue snowboarding enough to leave the mountain. The initial medical examination, including radiographs interpreted as negative, led to a diagnosis of a sprain. Due to his level of pain and mechanism of injury, a computed tomography (CT) scan was obtained, which revealed fracture of the lateral process of the talus extending to the posterior aspect of the sinus tarsi (Figures 1a-1c).

MRI revealed scarring and sprain of the anterior talofibular and calcaneofibular ligaments and sprain and contusion of the deltoid ligament complex. A small talocrural effusion was seen with capsular sprain and scarring. Synovitis and debris in the anterior and posterior recesses were also present. Bone edema and impaction fracture of the plantar medial aspect of the talar neck and head were seen with extension into the middle facet and sustentacular articulation (Figure 2a). Chondral contusion with fissure and focal, full-thickness chondral

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Table 1. Details of 3T MRI parameters

Weighting and Planes	FOV	TR	TE	Sequence Used	Slice Thickness, mm	Gap, mm	Matrix Size
T2-weighted, axial	120	3730	108	TSE	3	0.3	640 × 512, interpolated values
Proton density–weighted, axial	120	3730	45	TSE, fat-suppressed	3	0.3	640 × 512, interpolated values
Proton density–weighted, coronal	110	5380	33	TSE	3	0.3	768 × 652, interpolated values
Proton density–weighted, coronal	110	4660	43	TSE, fat-suppressed	3	0.3	640 × 512, interpolated values
Proton density–weighted, sagittal	120	2660	35	TSE	3	0.3	768 × 652, interpolated values
Proton density–weighted, sagittal	120	2570	43	TSE, fat-suppressed	3	0.3	640 × 512, interpolated values

FOV, field of view; TSE, turbo spin echo; TR, repetition time; TE, echo time.

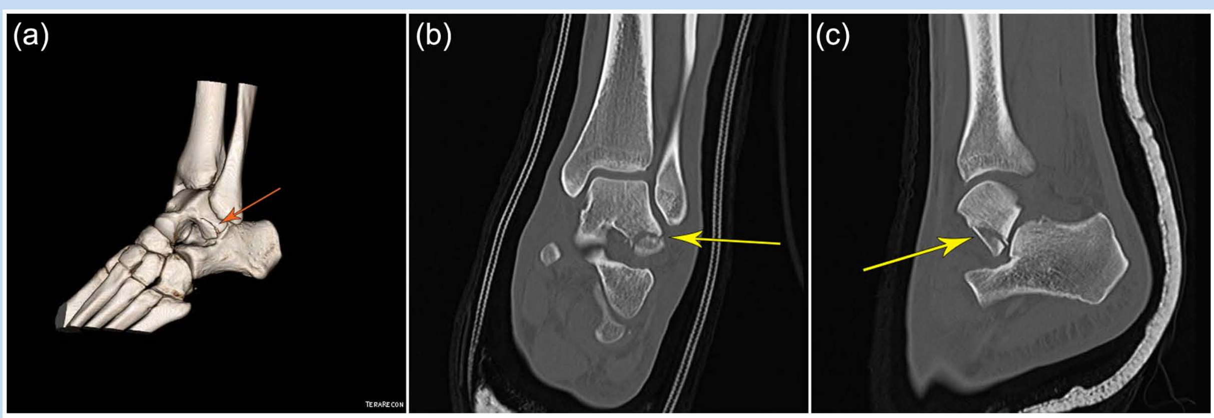

Figure 1. (a) Three-dimensional CT reconstruction depicting fracture through the lateral process of the talus. (b) Coronal and (c) sagittal images from a CT scan showing a fracture through the lateral process of the talus.

defects were present (Figure 2b), as were ligamentous injury and partial tearing of the talocalcaneal interosseous and cervical ligaments. Bone edema and impaction injury of the adjacent sustentaculum tali extending to the medial portion of the body of the calcaneus were also observed. Multiple chondral fragments were present adjacent to the sustentaculum tali (Figure 2c). Due to the patient's nondisplaced fracture, improving pain, and satisfactory range of motion, he was treated nonoperatively and resumed snowboarding professionally within 6 weeks.

The second patient was a 26-year-old male snowboarder with a similar mechanism of injury who had a lateral talar process

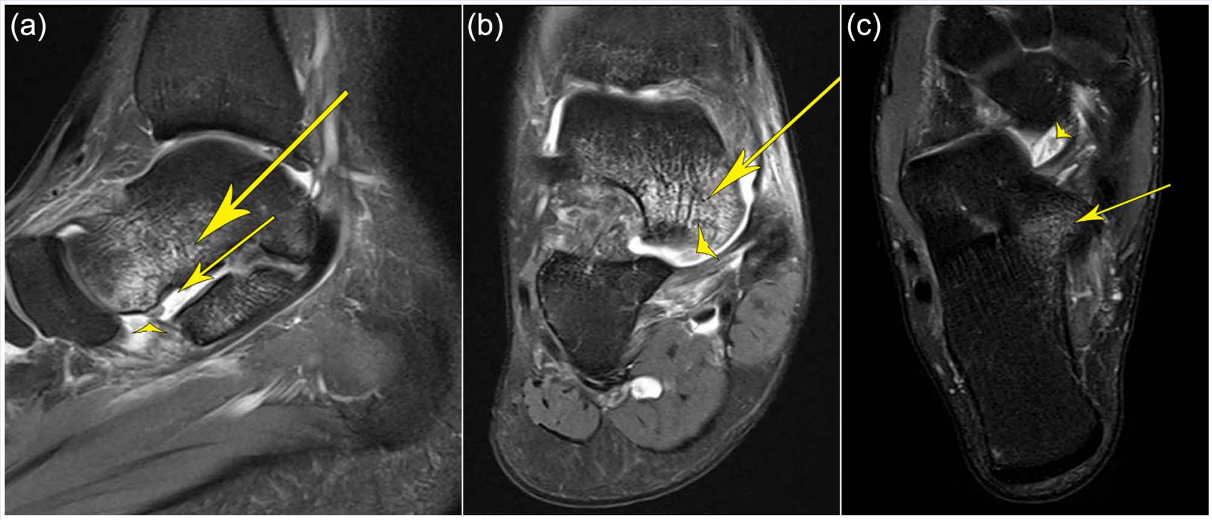

Figure 2. (a) Proton density–weighted turbo spin echo (TSE) fat-suppressed sagittal image through the ankle demonstrating the multiple components of this injury. Bone marrow edema shows the site of the impaction fracture of the middle facet of the talus (long arrow). A partial-thickness chondral defect is present over the middle facet on the inferior aspect of the talus (short arrow). Arrow head, chondral fragment. (b) Proton density–weighted TSE fat-suppressed coronal image through the ankle demonstrating bone marrow edema at the site of the impaction fracture of the middle facet of the talus (arrow). Arrow head, chondral fragment. (c) Proton density–weighted TSE fat-suppressed axial image through the ankle demonstrating bone marrow edema, which shows the site of the impaction fracture at the sustentaculum tali (arrow). Arrow head, chondral fragment.

fracture. MRI revealed mild impaction of the plantar aspect of the talar head with extension into the middle facet of the talus (Figure 3a); there was also a focal sharply marginated, full-thickness chondral defect (Figure 3b) with an adjacent chondral fragment (Figure 3c).

TREATMENT/SURGICAL TECHNIQUE

While nonoperative treatment was chosen in these 2 patients, intra-articular injury to the talocalcaneal joint is often treated, with exception of minor, nondisplaced fractures.[4,10] The articular surface of the posterior facet can be readily visualized with arthroscopy, and debris can be removed from the sinus tarsi intra-articularly. Lateral talar process fractures can be evaluated and at times treated with arthroscopically assisted percutaneous fixation using fluoroscopic guidance.[20]

REHABILITATION

Both individuals rested their ankles for a period of 6 weeks before resuming sports participation since both had nondisplaced injuries with minimal pain and minimal risk of further injury. Due to the intra-articular nature of the injury, it is essential to begin range of motion exercises early to avoid stiffness while avoiding impact loading in the early postinjury period. If surgery is necessary, it is desirable to keep the patient nonweightbearing for a minimum of 3 to 6 weeks.

DISCUSSION

Ankle injuries are the third most common injury in snowboarders (16%), in contrast to the tenth most common injury in skiers (6%). As snowboarding gains popularity and participation increases, more injuries specific to this sport may be seen.[1,9,14,23] In snowboarding, the mechanics and forces are vastly different than those seen in alpine skiing.[4] Thus, the prevalence, distribution, and patterns of injury vary a great deal. The stance of a snowboarder is very similar to skateboarders or surfers, with the rear foot at 90° to the long axis of the board and the front foot positioned between 45° and 90° to the long axis of the board. The snowboarder executes turns by shifting body weight to the front foot and forcing the tail of the board to swing out. Since poles are not used, the arms and hands are used to break a fall. The bindings, boot (stiff or soft), and stance position of the lead foot contribute to the injury pattern. These ankle injuries, torsional and impact, can cause talocalcaneal/subtalar injuries that may go undetected.[1,2,5,6,12,14-17,21-23] Significant chronic problems including posttraumatic arthritis may result. Prompt treatment may prevent osteoarthritis.[3,11,15,21]

The talus and the subtalar joints are part of the complicated biomechanical ankle-hindfoot complex, with multiple degrees of freedom. The talocrural joint acts in accord with the subtalar and transverse tarsal (talonavicular and calcaneocuboid) joints, providing significant complexity and multiaxial function.

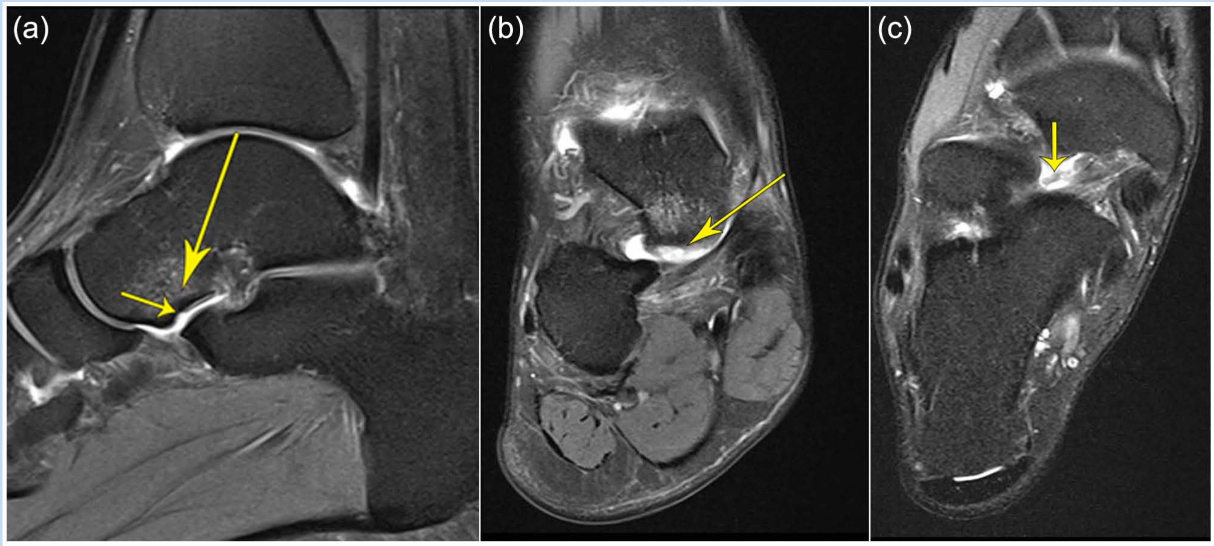

Figure 3. (a) Proton density–weighted turbo spin echo (TSE) fat-suppressed sagittal image through the ankle demonstrating bone marrow edema at the site of the impaction fracture of the middle facet of the talus (long arrow). A chondral defect can be noted in the articular cartilage of the middle facet on the inferior aspect of the talus (short arrow). (b) Proton density–weighted TSE fat-suppressed sagittal image through the ankle demonstrating a chondral defect in the articular cartilage of the middle facet on the inferior aspect of the talus (arrow). (c) Proton density–weighted TSE fat-suppressed axial image through the ankle demonstrating a single chondral fragment adjacent to the sustentaculum tali (arrow).

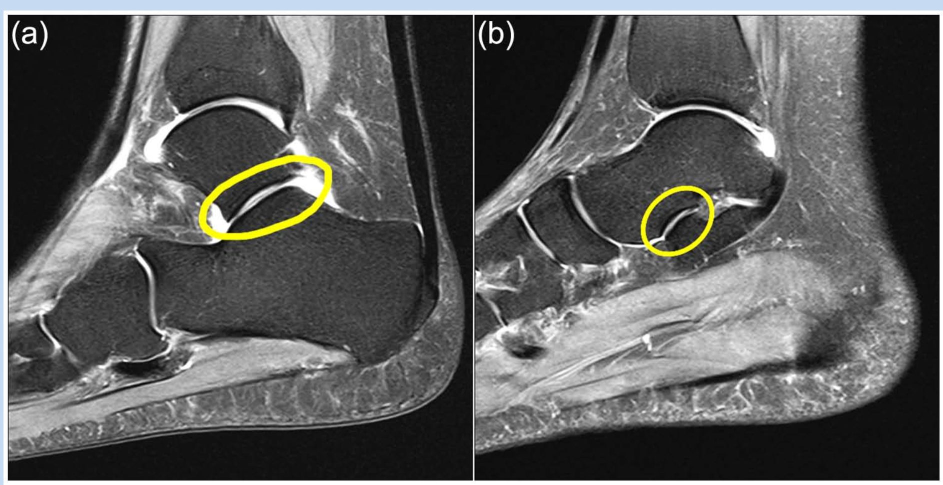

Figure 4. Proton density–weighted turbo spin echo (TSE) fat-suppressed sagittal images through the ankle highlighting the normal (a) posterior and (b) middle facets of the talocalcaneal joint.

These movements facilitate foot navigation on irregular and uneven terrain.[3,18] Patients presenting with ankle (talocrural) injuries must be carefully examined for subtalar injuries. The 3 talocalcaneal articulations can be visualized on standard planes on MRI (Figures 4a and 4b). However, subtle injuries with osteochondral fractures require greater attention to detail with higher resolution.

The lateral process of the talus projects off the inferior portion of the talus overhanging the subjacent calcaneus (Figure 5). This is a triangular bony structure, which becomes a part of the subtalar joint inferiorly and part of the lateral talomalleolar articulation laterally. The talocalcaneal ligament attaches to the tip of the lateral talar process, extending inferiorly, and inserts on the calcaneus. Generally, the talus,

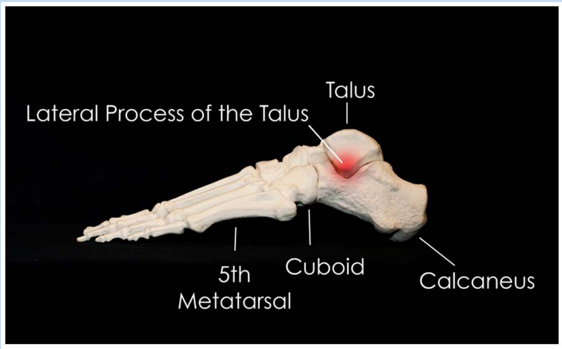

Figure 5. Bone model of the foot highlighting the lateral process of the talus and adjacent bones.

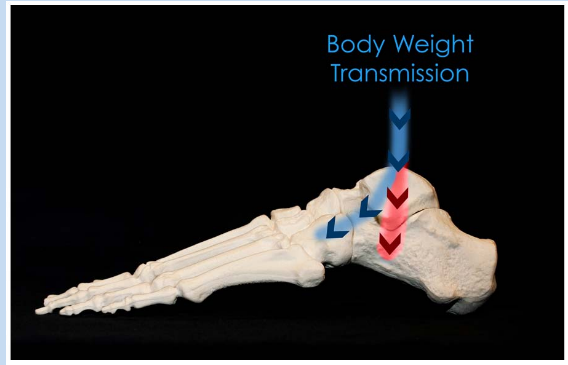

Figure 6. Bone model with a diagram of normal weight transmission forces through the ankle and hindfoot complex (blue) and altered weight transmission forces while heel is fixed in a rigid boot (red).

which bears the brunt of the body weight, transmits force to the acetabulum pedis and/or to the calcaneocuboid articulation and thence forward (Figure 6). However, during snowboarding, the grip on the heel from the boot and the restriction of permitted movement at the talonavicular joint contribute to the restriction of normal translation of force to the middle talocalcaneal joint. The talus, being shaped like a truncated cone, is wider anteriorly than posteriorly (Figure 7). With snowboarding injuries to the ankle, there is inversion at the ankle and simultaneous dorsiflexion. During dorsiflexion, the wider portion of the talus is introduced into the narrower, posterior portion of the mortise, which forces the fibula to translate laterally and rotate externally.[19] The stiff boot restricts the outward rotation of the fibula, consequently increasing the chance of injury to the talus. Force is transmitted to the lateral process of the talus, which then fractures, producing the classic snowboarder's fracture.[4,13]

Classically, patients who sustain this type of injury undergo conventional radiography and CT.[8] MRI provides several additional advantages, including visualization of areas extending beyond the subtalar joint and cartilaginous structures in the subtalar joints and a detailed evaluation of ligaments.[7] So, while there may be severe injury to the talocrural joint, talar and subtalar injury must also be evaluated carefully to ensure the successful treatment of the ankle-hindfoot complex.[3,11]

CONCLUSION

Osteochondral injury to the subtalar joint involving the middle facet of the talus and middle talocalcaneal articulation is a relatively uncommon ankle injury that has a higher frequency in snowboarders. If unrecognized, this injury can lead to severe and chronic disability and end athletic participation prematurely. MRI can identify subtalar injury, ensuring prompt and appropriate treatment.

Figure 7. Superior view of highlighting the articular surface of the talus and depicting the wider articular surface over the anterior aspect when compared to the posterior aspect.

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