CONTINUING EDUCATION

THE TALOCALCANEAL UNIT: PICTORIAL REVIEW OF ANATOMY AND PATHOLOGIC CONDITIONS ON MULTI DETECTOR CT

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Normal anatomy of the subtalar joints is illustrated in cadaveric specimens. Variations of the subtalar joints include three facets, fused middle and anterior facet, and missing anterior facet. Patients were studied by means of Multi Detector Computed Tomography (MDCT) to provide clinical examples of subtalar pathology including traumatic and non traumatic disorders.

Key-word: Foot, CT.

Our knowledge with regard to histology, anatomy and pathology of the talocalcaneal joints and sinus tarsi remains limited, despite advances in imaging of this region. The purpose of this article is to illustrate bony and soft tissue anatomy of the subtalar joint, to demonstrate variations in bony anatomy of the subtalar joint, and to show pathological findings as imaged with MDCT.

Technical considerations

For this study we used 9 pairs of bone specimens (talus-calcaneus), and obtained anatomical slices in 2 fresh cadaver specimens. Photographs of dissection available at the anatomy department were also studied. MDCT images were obtained in 120 patients with a suspicion of talocalcaneal and ankle pathology. A Siemens imaging system was employed (Siemens Somatom Plus, Erlangen, Germany). Scan parameters were as follows: collimation, 0.75; mAs, 130;kV, 120; feed/rotation, 6.8 mm. Reconstructions were performed as follows: slice thickness, 0.75; kernel, sharp; bone window; reconstruction increment, 0.5 mm.

MR can also demonstrate subtalar joint anatomy and is more accurate in demonstrating the ligamentous structures. Also fractures that are subtle and occult may be apparent on MRI as well as delicate subchondral changes in the absence of frank erosions.

Fig. 1. — A. Sagittal MDCT image shows middle subtalar joint (white arrow). Note small subchondral geode (long black arrow) and osteochondral lesion of talus (arrowheads). B. Sagittal MDCT image shows posterior (thick arrow) and anterior (thin arrow) subtalar joints. Note sinus tarsi (curved arrow). C. Sagittal MDCT shows middle (thick arrow) and posterior (thin arrow) subtalar joints, and tarsal canal (curved arrow).

Fig. 2. — Lateral radiograph in specimen. Note posterior (thin arrows), and middle (thick arrows) subtalar joints.

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Bony anatomy

The subtalar joint represents the articulation between the talus and calcaneus. While variations exist, typically the subtalar joint is described as consisting of three facets: anterior, middle, and posterior (Figs. 1, 2) (1, 2). The anterior facet is concave in shape and articulates with the head of the talus. It can be congruent with the middle facet. The middle facet is also slightly concave and is situated on the sustentaculum tali. The posterior facet is the largest facet and is convex. Three variations of the bony anatomy of the subtalar joints exist: three joint facets, missing anterior joint facet, and fused anterior and middle joint facets (Fig. 3). It is unknown whether certain types predispose to subtalar injury, or are associated with differences in subtalar ligament anatomy.

The anterior and middle facet are separated from the posterior facet by the tarsal sinus and tarsal canal. The position of the joint facets gives the tarsal sinus its trumpet shape with a wide opening at the lateral aspect, and a narrower opening at the medial aspect of the hindfoot (Figs. 4, 5). The medial portion is also termed the tarsal canal.

Fig. 3.—A. Superior view of calcaneus. Three subtalar facets are seen, the anterior (A), middle (M), and posterior (P) facet. B. Superior view of calcaneus. Two facets are seen. The anterior and middle facet are fused (F). Note posterior facet (P). C. Superior view of calcaneus. The anterior facet is missing, and only a middle (M), and posterior (P) facet are seen.

Fig. 4.—Photograph of calcaneus and talus. The sinus tarsi (S) is seen. Also note middle (thick arrow) and posterior (thin arrow) subtalar joints.

Fig. 5.—Drawing of funnel shaped appearance of sinus tarsi (arrows). Note anterior (A), middle (M), and posterior (P) facets.
Extrinsic stabilizers of the subtalar joints include medial and lateral ankle tendons and the various extrinsic ligaments connecting the bones of hind- and midfoot. The sinus tarsi contains fat, nerves, vessels, capsular reinforcements, and ligaments (3, 4). The soft tissue variations of the sinus tarsi and function of the various ligaments are incompletely understood. Ligaments in the sinus tarsi are extracapsular and include (from medial to lateral) a ligament in the canalis tarsi, capsular reinforcements, the interosseous ligament, the cervical ligament, and a fiber bundle connecting to the extensor retinaculum (Fig. 6). The cervical ligament extends from the inferolateral talar neck to the dorsal calcaneus. The primary function of the cervical ligament is thought to be limiting hindfoot inversion. The interosseous ligament extends obliquely between the talus and calcaneus. Although smaller than the cervical ligament, the interosseous ligament is also felt to play a role in hindfoot stability by limiting inversion (Figs 7-9). At the lateral aspect of the sinus tarsi, the inferior extensor retinaculum is anchored to the talus and calcaneus by roots that are located in the sinus tarsi. Tears of the sinus tarsi ligaments are often associated with ankle distortion. 

Fig. 6. — A. Sagittal anatomical slice through sinus tarsi (S). Note posterior subtalar joint (arrow). B. Sagittal anatomical slice through tarsal canal (white arrow). Note middle (thin arrow) and posterior (thick arrow) subtalar facets. C. Sagittal anatomical slice through sustentaculum tali (white arrow). Note flexor hallucis longus tendon (black arrows).

Fig. 7. — Coronal anatomical slice. Centrally interosseous ligament is seen (thick black arrows). Also note tarsal canal extension (white arrow), and medial and lateral tendon groups (thin black arrows).
CT may show soft tissue prominence, fiber interruptions and bony avulsions. The clinical and prognostic significance of these findings remains obscure, however.

Subtalar joint pathology

The subtalar joint is frequently involved in traumatic injuries to the hindfoot, namely fractures of the calcaneus and talus (Fig. 10) (5). Given the complex anatomy of the subtalar joint facets, radiographs are often limited in both the detection and characterization of these injuries.

MDCT is useful in establishing the presence of fractures, in detecting additional fractures not visible on radiography, and in the assessment of joint involvement, joint incongruity, and fracture comminution. These are important factors in both the treatment and prognosis for these injuries and therefore MDCT plays a vital role in the clinical evaluation of these patients. The subtalar joint can also be involved in a variety of arthritides, including degenerative, inflammatory, infectious, and crystalline processes. As for traumatic injuries, MDCT is invaluable in the detection and characterization of these entities.

Traumatic conditions

The calcaneus is the most frequently fractured tarsal bone with calcaneal fractures accounting for about 60% of all major tarsal injuries. The majority of fractures are intraarticular with subtalar joint involvement (Figs. 11-13) (6, 7). Calcaneal fractures result when axial forces applied to the foot cause the calcaneus to be driven into the lateral process of the talus. The result is a
primary fracture line oriented in an anteromedial to posterolateral fashion. Secondary fracture lines commonly occur. Also there are varying degrees of comminution. The management of intraarticular calcaneal fractures remains controversial. Decision making regarding treatment depends heavily on imaging findings. Extra-articular fractures are generally treated in a closed manner. Intraarticular fractures may also be treated closed but are usually treated with open reduction, osteotomy, internal fixation and arthrodesis. The goal of the radiologist is to accurately describe the fracture pattern such that the surgeon can match the fracture anatomy with the appropriate surgical approach.

The integrity of the talus is also critical to the normal function of the subtalar joint. Talus fractures are relatively uncommon injuries (Figs. 14-16) (7). Talar neck fractures account for approximately 50% of all talus fractures. Osteonecrosis is a common complication of talar neck fractures and is a major determinant of outcome. Fractures of the talar body, although less common than talar neck fractures, involve the posterior facet of the subtalar joint and may be associated with a subtalar dislocation (Fig. 17). Lateral process fractures are a subgroup of talar body fractures that are rare and often overlooked (8). The mechanism of these fractures is dorsiflexion and...
inversion and they often occur during snowboarding. A loss of talar blood supply may lead to osteonecrosis, which is a serious complication. The risk of AVN can be estimated by the Hawkins sign. Normally a subtle subchondral lucent line develops at the talar dome. Areas that remain sclerotic are at risk for AVN. If the fracture fragments are not displaced a closed treatment may suffice. If the fragments are displaced, a fixation with screws or pins is indicated.

Non traumatic conditions

Tarsal coalition is a frequent cause of painful flatfoot (9). Talocalcaneal and calcaneonavicular coalition are the most common types (Figs. 18, 19). While calcaneonavicular coalitions are usually well seen on conventional radiography, a coalition between the talus and calcaneus may be difficult to detect. On radiography the C sign may be demonstrated, but often CT or MR is necessary for accurate diagnosis (10). Coalitions can be osseous, cartilaginous or fibrous. Although a talocalcaneal coalition may occur at any of the three facets, the majority of osseous fusions involve the middle facet. Osseous coalitions are characterized by complete cortical bridging between the calcaneus and talus. Non osseous coalitions are characterized by joint space narrowing and irregularity sometimes accompanied by cortical hypertrophy and sclerosis.
The subtalar joint can be involved with a variety of degenerative, inflammatory, and crystalline arthritides. Involvement of the subtalar joints is likely underestimated due to limited visualization on radiography. Degenerative changes may be idiopathic or more commonly secondary to trauma and malformation (Figs. 20-22). Manifestations of osteoarthritis are the same as in any joint and include asymmetric...
joint space narrowing, sclerosis, and subchondral cysts. Rheumatoid and inflammatory disorders may involve the subtalar joints (Fig. 23) (11,12). Neuropathic arthropathy may occur in the diabetic foot, although the midfoot is more commonly affected. Gout may involve the mid- and hindfoot, in addition to the first metatarsophalangeal joint. Erosions are seen often with an overhanging edge and may be accompanied by soft tissue masses. Infection may occur in diabetics with infected soft tissues, and in a postoperative setting. The joint surfaces appear narrowed and eroded. Fragmentation may occur.

In conclusion, we described the normal anatomical variations of the bony anatomy of the subtalar joint. Pathological conditions of the subtalar joint may be imaged with MDCT, allowing for a more accurate diagnosis than radiography.

References