The case:

A 14-year-old boy presented with foot pain, which had increased over the past several months.

Figure: Lateral radiograph of the right foot.

Your diagnosis?

For answer see page 450
**Diagnosis:**

**Talocalcaneal Coalition**

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A coalition is a congenital bridge or bar between adjacent bones. The classification of coalition is defined by both coalition location and type. Coalitions occur most commonly within the tarsal bones of the foot in 1% to 2% of the population, followed by coalition of the carpal bones and elbow.\(^1\) Ninety percent of tarsal coalitions involve the talocalcaneal and calcaneonavicular joints. Other foot coalitions can occur, but are rare. Coalitions are also classified based on the type of intervening tissue and include osseous, cartilaginous, or fibrous types.

A coalition is usually an isolated abnormality, present bilaterally in approximately 50% of patients, and believed to follow an autosomal dominant inheritance pattern with variable penetrance.\(^2,3\) Although this abnormality is congenital and present at birth, coalition most often presents in adolescence, with insidious or acute onset of midfoot or hindfoot pain.

Talocalcaneal coalition is one of the most common and most frequently symptomatic coalitions of tarsal bones. Talocalcaneal coalition is difficult to visualize on standard views of the foot, secondary to the anatomic complexity of this joint. On routine imaging of the foot, secondary signs of subtalar coalition can be seen and, when present, may increase the suspicion of coalition. The majority of patients with suspected coalition undergo advanced imaging with either computed tomography (CT) or magnetic resonance imaging (MRI) to evaluate the location and type of coalition. Patients may be treated conservatively or operatively, with the therapeutic goal of decreasing pain, improving function, and avoiding degenerative disease.

**Etiology**

Tarsal coalition represents a congenital segmentation failure during development of the tarsal bones. The mesenchymal anlage fails to complete its normal separation, resulting in the lack of normal tarsal joint formation. The subtalar joint is composed of anterior, middle, and posterior facets. Subtalar fusion almost invariably involves the middle facet between the talus and the sustentaculum tali.

**Clinical Findings**

Although coalition is a congenital anomaly, the condition is asymptomatic in early childhood. The coalition bar prevents normal joint motion.
As ossification of the tarsal bones progresses, the bridging bar also ossifies, becoming less flexible. This natural progression causes hindfoot coalition to become symptomatic in the second decade of life, usually between 12 and 16 years, with heavy or more active patients presenting at an earlier age. Tarsal coalition is a common cause of the clinical entity, “peroneal spastic flatfoot.” Patients with peroneal spastic flatfoot present with chronic or sudden onset of hindfoot or tarsal pain and stiffness, usually associated with activity. On examination, the patient is often found harboring a rigid flatfoot with decreased hindfoot motion, pes planus, and calcaneus valgus. With an attempted hindfoot inversion maneuver, the patient reports pain in the sinus tarsi region.

**DIAGNOSTIC IMAGING**

Weight-bearing radiography of the foot is the first-line imaging procedure in patients presenting with pain suspicious of talocalcaneal coalition. Due to the complexity of the hindfoot anatomy and the presence of overlapping structures, the coalition itself is not well evaluated on standard imaging. The diagnosis of subtalar fusion has been described using the Harris or axial calcaneal view of the foot. Since patient’s symptoms may be nonspecific and given that the Harris view is not a routinely used imaging position, the diagnosis may be missed on initial imaging. Therefore, it is important to recognize the secondary signs of subtalar coalition identifiable on the routine lateral view. These include narrowing of the subtalar joint, overgrowth of the lateral process of the talus, failure of visualization of the middle subtalar joint, the “C sign,” “talar beak,” and “ball and socket” configuration of the ankle joint.

The C sign is caused by bridging, overgrowth, and continuity between the inferomedial talus and sustentaculum tali (Figure 1A). On the lateral view of the foot, the “C” is formed by the normal talus dome and the inferior surface of this region of overgrowth. This nonspecific finding can be seen in cases of flatfoot without coalition. A talar beak is caused by abnormal subtalar joint mechanics, but is not indicative of arthrosis. The ball and socket configuration is believed to represent an adaptation of the ankle joint to provide motion lost in subtalar fusion (Figure 1B). The ankle joint adapts to provide inversion and eversion in addition to the usual dorsiflexion and plantarflexion. This finding is usually seen in more severe cases of coalition or when additional abnormalities of the foot and ankle are present. An excrescence, or beak, is formed at the talar head, immediately adjacent to the talonavicular joint resulting from dorsal subluxation of the navicular and lifting of the associated periosteum (Figure 1C).

Patients with suspected subtalar coalition often undergo advanced imaging using either CT or MRI. These modalities can assist in surgical planning by providing precise characterization of the location, type, and size of the abnormality, as well as arthrosis evaluation involving the adjacent joints.

Computed tomography and MRI provide similar anatomic coalition delineation. In osseous fusion, a bony bridge is identified between the talus and the sustentaculum at the middle facet. In fibrous or cartilaginous coalition, the middle facet joint is abnormally oriented, narrowed, and undulating, with reactive cystic and hypertrophic changes of the underlying bone. While either imaging modality can reliably diagnose subtalar coalition, MRI can contribute additional information about marrow edema-like signal changes and tendon pathology, and may differentiate fibrous and cartilaginous coalitions.

Magnetic resonance imaging is also reported to have increased sensitivity for non-osseous fusions. For ease of positioning on CT, and given the frequency of bilateral coalition, both feet can be imaged simultaneously. Multidetector CT acquisition in the axial plane with 2D coronal and sagittal reconstructions is commonly obtained, with the coronal plane considered most useful for diagnosis. Fibrous or cartilaginous coalitions cannot be differentiated by CT. In both types, the joint appears narrowed and irregular with cystic and sclerotic changes at the joint margin, but the intervening tissue type is indistinguishable (Figure 2A). In cases of osseous coalition, continuity of the cortex and trabecular pattern between the talus and calcaneus can be demonstrated by CT (Figures 2B, 2C).

Magnetic resonance imaging of coalition usually includes axial, coronal, and sagittal imaging planes and various sequences, including T1- and T2-weighted, short tau inversion recovery, and proton density sequences. It may be possible to differentiate fibrous from cartilaginous coalitions with MRI: intermediate to low signal intensity within the joint on both T1- and T2-weighted imaging may indicate a fibrous coalition. If the joint demonstrates signal intensity similar to fluid or cartilage, a cartilaginous coalition is likely present (Figure 3A).

In cases of osseous coalition, cortical and marrow signal is continuous across the bridging talus and calcaneus (Figures 3B, 3C, 3D). Eighty-six percent of patients with subtalar coalition also demonstrate edema-like signal changes in the subchondral bone adjacent to the site of coalition. For patients in whom this entity is an unsuspected diagnosis, such a finding may be useful to direct attention to the site of the coalition. Abnormal biomechanics may also produce tenosynovitis of the peroneal or flexor tendons, which can be identified by MRI.

**MANAGEMENT**

Symptomatic patients are initially treated conservatively through activity modification and/or use of a medial heel wedge, arch supports, and orthosis. Foot immobilization via
casting may be attempted next if these initial treatment modalities fail. If all conservative approaches prove ineffective at relieving symptoms, surgical management may be indicated.

Controversy exists as to the optimal operative approach to the treatment of subtalar coalition, and the choice of operative procedure may be influenced by multiple factors. In symptomatic patients without hindfoot arthritis, surgical intervention aims at decreasing pain and improving motion, and, therefore, coalition resection is the preferred procedure.

Although coalition resection may include the interposition of bone wax, fat graft, or flexor hallucis longus tendon, 89% of resection patients are satisfied with the reduction in symptoms postoperatively, regardless of interposition graft use. Recent reports have advocated combining resection with flatfoot reconstruction to improve clinical outcome. In patients with associated degenerative disease, or in cases of failed resection, triple arthrodesis is usually performed.

REFERENCES

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