The Hindfoot Arch
What Role Does the Imager Play?

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KEYWORDS

• Flatfoot • Pes planus • Radiography • MR imaging • Medial longitudinal arch • Posterior tibial tendon • Spring ligament • Deltoid ligament

KEY POINTS

- Collapse of the hindfoot arch leads to a flatfoot deformity, which can be classified into flexible and fixed subtypes.
- Flatfoot deformity can be caused by both osseous deformities and injury to the soft tissue supporting structures, particularly the posterior tibial tendon and spring ligament.
- Imaging plays an important role in the assessment of flatfoot deformity, with radiographs and computed tomography useful in characterizing the degree of osseous deformity and magnetic resonance imaging and ultrasonography most useful in the evaluation of the supporting soft tissue structures.
- The role of the imager is to identify the structural causes of the flatfoot deformity and delineate the anatomy for treatment.
- Effective treatment of flatfoot deformity depends on attempting to restore normal foot biomechanics and alignment through strengthening exercises, orthotics, and surgery.

INTRODUCTION

Flatfoot deformity is a common disorder of the foot and ankle that occurs with loss of the hindfoot arch.[1] Although the condition can be asymptomatic, certain subtypes can lead to pain and debilitating loss of function.[1–3] Understanding the various conditions that affect the hindfoot arch leading to flatfeet can be a daunting process for radiologists and clinicians if they are not familiar with the anatomy and the various imaging criteria used to assess injury to the supporting structures. The longitudinal arch of the foot has medial and lateral components that provide structural support to the body. Abnormalities of mainly the medial longitudinal arch (MLA) lead to flatfeet; however, both arches have important bony and soft tissue components that maintain the hindfoot arch, and injury or congenital deformities of these structures can lead to a painful flatfoot.[4–7] This article discusses the anatomy of the hindfoot longitudinal arch and the biomechanical consequences of injury to the medial hindfoot supporting structures. Next, it discusses the various imaging modalities used to evaluate injury of these structures. In addition, the surgical and nonsurgical treatments available for the treatment of flatfoot deformity are discussed.

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CLASSIFICATION OF FLATFEET

Flatfoot deformity, or pes planus, can be classified as flexible versus fixed, or congenital versus acquired.[1–3,8] In flexible flatfeet, there is loss of the MLA with weight bearing, which corrects with heel rise. Flexible flatfeet is a normal finding in infants and children and is caused by a normal prominence of fat underneath the midfoot (**Fig. 1**).[3] With growth and progressive weight bearing, a normal arch should form by 8 years of age.[3] Flexible flatfeet can persist into adulthood, with most cases being asymptomatic and requiring no treatment.[1] However, symptomatic flexible flatfeet can require treatment with orthotics, strengthening and stretching exercises, and surgery.[2,3,9,10] Fixed flatfeet can have a variety of causes (**Box 1**),[3] with the most common cause being tarsal coalitions (**Fig. 2**).[11] In these cases, normal joint alignment and motion are altered because of congenital bridging between bones.

Both pediatric flexible flatfoot and tarsal coalitions can be classified as congenital flatfoot disorders. In acquired flatfoot, the MLA is initially normal but subsequently fails because of injury of the supporting structures of the MLA.[2,4] The most common cause of acquired flatfoot is progressive tendinopathy of the posterior tibialis tendon (PTT).[2,4,12–14] This failure can lead to a cascade of additional injuries caused by imbalance of the biomechanical forces that maintain the hindfoot arch.[4,9,15] Deformities secondary to trauma, arthritic processes, and neuropathic arthropathy (**Fig. 3**) are other causes of acquired flatfoot deformity.

ANATOMIC CONSIDERATIONS IN FLATFEET

The longitudinal arch of the foot has medial and lateral components. The higher and more important MLA is formed by the calcaneus, talus, cuneiforms, and first and second metatarsals. The most superior aspect of the MLA is the talar head, whereas the calcaneus and first and second metatarsal heads form the proximal and distal aspects of the arch, respectively.[6,7] Elasticity of the MLA is important in order to provide cushioning and support of the body during motion and is a result of several supporting tendinous and ligamentous structures.[6,7,16–18] These include the PTT, spring ligament, deltoid ligament complex, and other midfoot capsular structures.[4,9,19–21] The lateral longitudinal arch is formed by the calcaneus, cuboid, and fourth and fifth metatarsals; its main supporting soft tissue structures are the peroneus brevis (which opposes the effects of the posterior tibialis), the long plantar ligament, plantar calcaneocuboid ligament, extensor tendons, and intrinsic muscles to the fifth toe.[6,7] Integrity and stabilization of the hindfoot rely on an interaction between these bones, muscles, tendons, ligaments, and fascia.

The PTT is arguably the most important dynamic stabilizer of MLA and hindfoot.[22,23] With PTT tear or tendinopathy, the unopposed peroneus brevis abducts the forefoot into pronation, the calcaneus into valgus (eversion), and the talus into plantarflexion.[2,24] As the hindfoot arch collapse progresses, increasing stress shifts to secondary supporting structures, which include the spring ligament, deltoid ligament complex, plantar fascia,

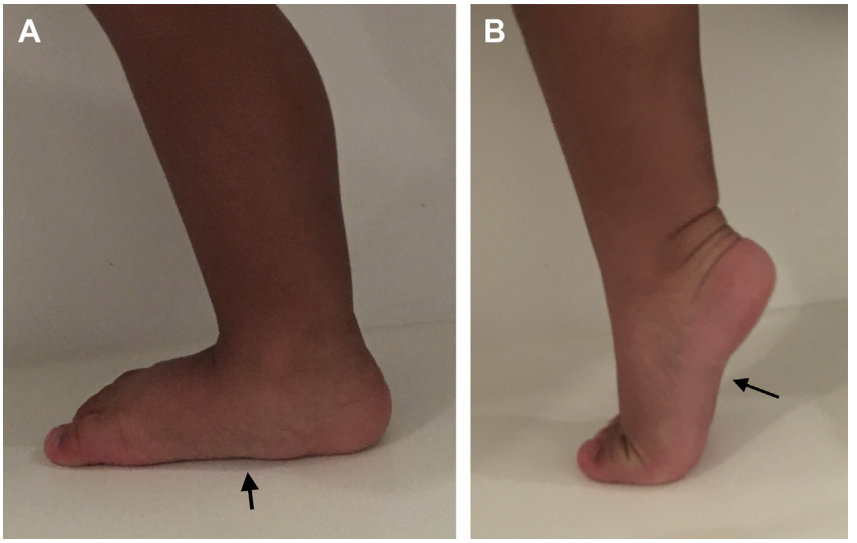

Fig. 1. Flexible flatfoot in a 2-year-old boy. Loss of the hindfoot arch (*arrow*) with standing (*A*), which returns to normal with heel rise (*B*).