CASE STUDY:
Adult Acquired Flatfoot

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Adult Acquired Flatfoot (AAF) is the result of a progressive result of the dynamic and static stabilizing structures of the medial arch of the foot. Once thought to be a condition of tendinitis or dysfunction of the posterior tibial tendon, the AAF is a more significant, complicated pathology that continues to challenge clinicians and researchers in the field of lower extremity biomechanics.

Historical Background

In the past 20 years, AAF has received a great deal of attention in the foot & ankle biomechanical literature. Early papers attributed the condition to a pathologic rupture of the posterior tibial tendon (PTT). An early classification system proposed by Johnson and Strom was based on: 1) the subjective evaluation of tendon function, and 2) the differentiation of a "flexible" vs. "rigid" deformity. Since this classification was proposed in 1986, our knowledge has expanded to include that:

- Individuals with obesity, diabetes and/or hypertension are more prone to pathologic rupture of the PTT. Females (> 60 years) appear more at risk than men of the same age.
- A pre-existing flatfoot is thought to be a primary risk factor
- There is recent evidence that shows that there is no role of ischemia in the rupture of the PTT.
- Mechanical overload leads to intra-substance degeneration of the PTT and this is the primary contributing factor in AAF
- The progression of the AAF deformity is due to sequential rupture of key ligaments in the ankle and hindfoot.
- The best surgical approach for the AAF deformity remains unclear. Most agree that the patient population is not a good surgical risk, and most procedures require immobilization with significant long term disability.

Clinical Findings

Most patients with AAF present with bilateral flatfoot deformity. However, the symptomatic foot will present with a visible sign of collapse and a recent onset of symptoms which are isolated to one foot. The symptomatic foot will exhibit pain and swelling along the PTT.

Radiographic analysis of AAF is difficult and both feet often show significant flatfoot deformity. Occasionally, the symptomatic foot will show degenerative changes in the joints of the ankle and hindfoot. The clinical findings will determine the diagnosis and will direct the treatment decisions. MRI analysis is usually not indicated, however, may be helpful when surgery is considered. It is of little use in directing conservative management. In later stages, the deformity will cause impingement in the lateral aspect of the subtalar joint with pain referred either to the sinus tarsi or to the lateral malleolus.

Stages of AAF

The Johnson and Strom staging system is still used today, despite being outdated by recent research. The staging system includes:

Stage I: Described as a simple "tendinitis" without visible collapse of the foot compared to the contralateral foot. Note: may not have any relevance to AAF.

Stage 2: Visible change or collapse of the foot occurs; originally thought to be due to attenuation of the PTT. Now, we know that such collapse can only be possible if key ankle and hindfoot ligaments become attenuated.

Stage 3: The deformity becomes rigid

Stage 4: Valgus deformity occurs at the talocrural joint.

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Selection of Treatment Options

Of primary focus is the Stage 2 category that includes a flexible, reducible deformity. This is the most common stage in patients with AAF presenting to the clinician. A Stage 2 deformity may be successfully treated with a functional foot orthoses, but may also fail with this intervention. A functional AFO (i.e. Richie Brace) will often be required to stabilize the ankle and hindfoot to allow soft tissue healing. The key for determining which treatment option to use is the presence or loss of ligament integrity in the hindfoot.

The progressive collapse and dysfunction of the AAF is the result of ligamentous rupture. It is well documented that the significant changes in ankle, subtalar and midtarsal joint alignment indicative of a Stage 2 AAF deformity occur secondary to the rupture of certain key ligaments. Most important, are the attenuation and eventual rupture of the superficial deltoid ligament, the spring ligament and the plantar aponeurosis that occur secondary to PTT rupture. This leads to a breakdown in coupling and movement transfer between the forefoot, the rearfoot and the leg. Foot orthoses rely on intact coupling mechanisms between the foot and the leg. Therefore, when the foot becomes disconnected from the leg in advanced AAF, an AFO may be needed to *re-connect* these structures.

Whether foot orthoses or ankle foot orthoses are used in the treatment of AAF, additional rehabilitation techniques should be utilized to assure restoration of ligament stability and muscle strength. Also, patients with AAF will present with significant balance deficits which pose serious threat for falls. Loss of balance and postural control in AAF is thought to be due to compromised proprioception in the subtalar and ankle joints which are positioned at end range of motion.

CASE PRESENTATION

A 61 year old female presents with a chief complaint of a painful swollen right ankle. The symptoms have been present for 3 months. The patient states that she has had "flat feet" all her life, but notes that recently there has been further collapse of her left foot.

Examination

The right medial ankle demonstrates swelling and erythema along the distal course of the posterior tibial tendon. Inversion strength of the right ankle demonstrates significant weakness compared to the left (Figure 1).

Figure 1: *Posterior Tibialis Strength Test*

Off weight bearing supination range of motion demonstrates a "lag" on the right, with inability to cross the midline (Figure 2).

Ankle joint dorsiflexion is restricted to 0 degrees with the legs extended but reaches 10 degrees with knee bent, bilateral. Subtalar range of motion demonstrates eversion of 20 degrees on the right, 10 degrees on the left. Forefoot to rearfoot relationship shows 4 degrees varus on the left, 15 degrees varus on the right. However, the varus deformity can be reduced on both feet indicating a forefoot supinatus rather than fixed varus.

In stance, the right foot shows "too many toes" and the flatfoot deformity can be reduced to a vertical hindfoot (Figure 3). In relaxed stance, the rearfoot is aligned in 12 degrees valgus on the left, and 3 degrees valgus on the left.

Figure 2: *Supination Lag Test*

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Figure 3: *Too Many Toes Sign (Left)*

The patient cannot perform a single foot heel rise on the right, but can easily do so on the left. From an anterior view, the right ankle mortise is noted to be markedly internally rotated, with visible anterior displacement of the fibula on the right, compared to the left.

In gait, the right foot is carried in significant abduction during swing. Heel strike on the right demonstrates an everted rearfoot alignment. Mid-stance alignment of the forefoot is severely abducted on the rearfoot with medial collapse of the talo-navicular joint. At heel rise, the rearfoot continues to evert with avoidance of full push off due to antalgic guarding.

Radiographic Exam

Anteroposterior X-ray reveals loss of coverage of the talus by the navicular with significant widening of the talo-calcaneal angle. Lateral X-ray shows significant increase of talus-first metatarsal angle (Meary's Angle) on the right.

Diagnosis

Adult Acquired Flatfoot, Stage 2

Treatment Plan

1. Custom functional ankle foot orthosis: Richie Brace. Full flexion hinge, 6 mm medial heel skive.
2. Footwear: Brooks Ariel
3. Physical therapy with specific strengthening of tibialis posterior (Figure 4) and balance/proprioceptive training.

Figure 4: *Posterior Tibialis Exercises*

Discussion

This patient demonstrates a classic stage 2 AAF deformity. It was elected to prescribe a Richie Brace rather than a functional foot orthosis. Based upon the evidence of ligament attenuation, an ankle foot orthosis can be expected to provide better control of transverse plane rotation, which dominates this deformity.

We have noted that transverse plane rotation of the tibia is a primary deforming force in the AAF deformity, and the orientation of the limb uprights of the Richie Brace are ideally suited to control rotation of this segment. In addition, the balanced functional orthotic footplate of the Richie Brace can provide control of both the subtalar and midtarsal joints.

With continuous use of the Richie Brace, approximately 30% of patients in Stage 2 deformity can recover strength and stability to be controlled by a standard foot orthosis. It appears that these patients re-establish ligament integrity just like patients who suffer ankle sprain.