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Subtalar Arthroereisis for the Correction of the Adult Acquired Flatfoot



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Introduction

Adult acquired flatfoot is defined as a progressive deformity of the foot typically presents with flattening of the medial longitudinal arch leading to insufficiency of the medial ankle and hindfoot structures commonly associated with posterior tibial tendon dysfunction. Due to the complexity of the anatomical structures involved in the adult acquired flatfoot is necessary to

classify the different variants or stages of this deformity. Johnson and Strom [1] described 3 stages of posterior tibial tendon dysfunction and Myerson [2] adding an additional stage IV. Stage II has been subclassified in a, b, and c substages according the forefoot supination, forefoot abduction, and medial column instability [3] (Table 1):

Table 1: The Stages of Adult Acquired Flatfoot Deformity.

Stages	Deformity	Radiographs	
		Anteroposterior	Lateral
I	Pain and swelling along PTT; no deformity	No findings	May see some preexisting flatfoot
IIa	Mild flatfoot deformity, heel valgus <5 degrees, inverts past the midline, able to perform single-heel raise, minimal forefoot abduction	< 25% talar head uncoverage	< 10 degrees of collapse of the talar-first metatarsal angle
IIb	Moderate flatfoot deformity, heel valgus <15 degrees, may demonstrate inability to invert heel past the midline, difficulty with single limb heel raise	Talar head uncoverage of between 25% and 40%	10-20 degrees of collapse at the talar-first metatarsal angle
IIc	Severe flatfoot but remains flexible, heel valgus >15, inability to invert past midline, inability to perform a single limb-heel raise, lateral subtibular impingement, severe abduction deformity	Talar head uncoverage >40%	> 20 degrees of collapse at the talar-first metatarsal angle
III	Fixed flatfoot deformity; may be able to reduce heel valgus but residual forefoot varus uncorrectable	Arthritic changes at the talonavicular and calcaneo cuboid joints may be seen; deformity typically as described for the stage IIc	Arthritic changes noted at triple hindfoot joints will be variable; deformity typically as described for the stage IIc

IVa	Flexible ankle valgus with underlying flatfoot foot deformity	Evaluate ankle film for severity of deformity and note minimal arthritic change; may utilize fluoroscopy to evaluate flexibility of the deformity	No significant ankle arthritis noted
IVb	Fixed ankle valgus deformity with flatfoot deformity	Evaluate ankle for severity of deformity and arthritis	Evaluate ankle for subluxation, joint space narrowing, osteophytes

In early stages conservative treatment [4,5] should be considered and several modalities have been used such as, nonsteroidal anti-inflammatory drugs, cast, orthoses, and ankle braces [6,7].

Surgery is indicated in more advanced stages or when conservative treatment has failed, and pain and deformity is present. Various modalities of surgical techniques can be grouped into four categories [8,9]:

- i. Soft tissue procedures including primary repair of the tendon, debridement, tenosynovectomy and soft tissue transfer.
- ii. Arthrodesis or osteotomies to correct and stabilize joints.
- iii. Osteotomies or limited arthrodesis combined with dynamic tendon transfer.
- iv. Arthroereisis: Operation that limits the movement of the subtalar joint without fusion (arthrodesis) in order to improve its position.

Arthroereisis has been used predominantly to treat flatfeet in the pediatric population [10]. Viladot et al. [11] reported their experience treating posterior tibial tendon dysfunction stage II with arthroereisis.

Subtalar Arthroereisis for Adult Acquired Flatfoot

An excessive range of motion of the subtalar joint resulting in adult acquired flatfoot and subtalar arthroereisis procedure is designed to limit hyperpronation. There are numerous clinical studies [12-14] demonstrating satisfactory results after arthroereisis of the subtalar joint for treatment of flexible flatfoot, initially in the pediatric population and later to treat the adult acquired flatfoot due posterior tibial tendon dysfunction. Different modalities have been developed to perform arthroereisis among which are mentioned subtalar temporary staple, sinus tarsi implant, sinus tarsi polyethylene screw, cup silicone implant, and conical implants [15]. Based on their biomechanical properties, sinus tarsi implants are classified into 3 types: Self-locking wedge, axis-altering implant, and impact-blocking device [16]. The majority of sinus tarsi implants are self-locking wedges.

Indications

Subtalar arthroereisis is useful for correcting valgus in adult acquired flatfoot stage IIa. Stages IIb and IIc (forefoot abduction

and medial column stability respectively) will not be corrected with sinus tarsi implant. Tenosynovectomy is not recommended for stage II disease [16].

Discussion

Acquired flexible flatfoot in adults is a common condition that requires surgery in more advanced stages or when conservative treatment has failed, and pain and deformity is present. The operative procedure most frequently used to treat adult flatfoot secondary to stage II posterior tibial tendon dysfunction consists of medial displacement calcaneal osteotomy and flexor digitorum longus transfer. This technique has proven to be effective for this condition, although calcaneal osteotomies are not free from complications. Subtalar arthroereisis is a method that provides good results in flat foot correction in children [17]. It is an alternative to calcaneal osteotomy in the treatment of stage II of posterior tibial tendon dysfunction, particularly in stage IIa, where valgus hindfoot is the main deformity [11,18,19]. In the early stage IIa, pain and swelling are noted over the medial ankle, and the patient performs a single-limb heel raise (Figure 1a). The heel is in valgus position when the Rearfoot Angle (RFA) is $\geq 5^\circ$ valgus representing a pronated foot type and some forefoot abduction is evident by the appearance of the too-many-toes sign (Figure 1b). With the patient in the seated position, the hindfoot valgus can be corrected to neutral and the forefoot abduction usually corrects quite easily. There is minimal compensatory forefoot varus. Radiographs show < 25% talar head uncoverage (AP view) (Figure 2a) and < 10 degrees of collapse of the talar-first metatarsal angle (lateral view) (Figure 2b).

Subtalar arthroereisis has a greater potential of hindfoot valgus correction than calcaneal osteotomy providing a 3-dimensional correction of the flatfoot deformity by repositioning the talus in its physiologic position [20] (Figure 3). Compared with medial displacement calcaneal osteotomy [21], subtalar arthroereisis (Figure 4) it is easy, quick to perform, and less invasive procedure with no risk of nonunion or malunion, no risk of damaging medial neurovascular structures, and it requires less immobilization time and shorter recovery time. There are also disadvantages among which we can mention: limits subtalar joint mobility, the sinus tarsi level pain rate is relatively high (10%-40% of patients) which may require implant removal [22]. Calcaneal osteotomy and subtalar arthroereisis can be performed combined on the same patient to gain more heel valgus correction [19].

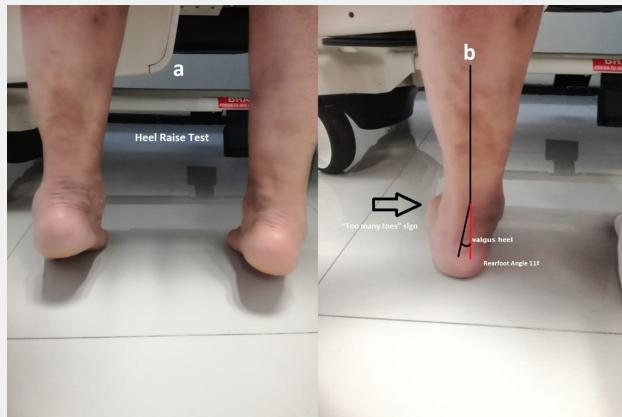


Figure 1:

- a. Single heel rise sign.
- b. "Too many toes" sign: When the feet are examined from behind a patient with flatfoot deformity, more toes may be visible laterally (arrow) indicating forefoot abduction. Heel valgus: Rearfoot Angle (RFA) $\geq 5^\circ$ valgus represents a pronated foot type, 4° valgus to 4° varus a neutral foot and $\geq 5^\circ$ varus a supinated foot.



Figure 2:

- a. Normal talonavicular coverage angle. The angle between the articular surfaces of the talus and the navicular is less than 7 degrees. Talonavicular uncoverage indicating adult acquired flatfoot stage IIa.
- b. Normal lateral talar - 1st metatarsal angle (Meary's angle). The long axis of the talus is angled plantar ward in relation to the first metatarsal, consistent with adult acquired flatfoot stage IIa



Figure 3: Correction of the deformity is observed after surgery.



Figure 4: Postoperative anteroposterior and lateral radiographs of a patient with stage IIa flatfoot deformity who underwent subtalar arthroereisis.

Conclusion

Subtalar arthroereisis is an alternative to calcaneal medializing osteotomy to treat adult acquired flatfoot stage IIa. Pain in the sinus tarsi is the most common complication that usually disappears after removal of implant.

Declaration of conflicting Interests

The author declared no potential conflicts of interest.

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