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Treatment of Symptomatic Pediatric Flexible Flatfoot

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Abstract:

Background: Pediatric flexible flatfoot is a common musculoskeletal condition characterized by collapse of the medial longitudinal arch during weight-bearing, with restoration of the arch when the foot is unloaded or during tiptoe standing. In most children, flexible flatfoot is physiological, asymptomatic, and tends to improve spontaneously with growth and maturation. However, symptomatic cases may present with pain along the medial longitudinal arch or sinus tarsi, early fatigue, reduced endurance, gait abnormalities, heel-cord tightness, and limitations in daily or sports activities. Despite its high prevalence, the optimal management of symptomatic pediatric flexible flatfoot remains controversial because there is no universal agreement regarding the appropriate age to initiate treatment, the most reliable diagnostic methods, or the effectiveness of the available therapeutic options. Careful clinical assessment is essential to differentiate flexible from rigid flatfoot and symptomatic from asymptomatic cases. Conservative treatment represents the first-line approach and includes patient and parental education, activity modification, supportive footwear, foot orthoses, stretching and strengthening exercises, and nonsteroidal anti-inflammatory medications when inflammation or pain is present. Surgical intervention is reserved for children with persistent pain and functional impairment despite adequate nonsurgical treatment. Available surgical procedures include soft-tissue reconstruction, calcaneal osteotomies, arthrodesis, and subtalar arthroereisis. Treatment should be individualized according to the child's age, symptoms, severity of deformity, associated conditions, and response to conservative management.

Keywords: Pediatric flexible flatfoot; Pes planus; Conservative treatment; Foot orthoses; Calcaneal osteotomy; Subtalar arthroereisis.

Introduction:

Despite high prevalence of pediatric flatfoot, there is no universal agreement on proper treatment of this disorder. Multiple controversies exist regarding appropriate management such as age to start treatment, diagnostic procedures, the best intervention methods and effectiveness of each treatment measure. It is of great importance to first categorize the patients in two groups of flexible or rigid flatfoot. As mentioned earlier, rigid flatfoot is usually related to the complicated bony deformities and mandates investigation that is more detailed. Flexible flatfoot can be further divided into asymptomatic and symptomatic.(1)

The literature discussing the non-operative and operative treatment of symptomatic flexible flatfoot is confusing, contradictory, and even not reliable based on personal accounts rather than facts or research.

Recommendations range from aggressive surgical correction of severe flexible pes planus in children as young as two years of age to no treatment, avoiding even shoe modifications or inserts.(2)

Asymptomatic flexible flatfoot:

Most flexible flatfeet are physiologic, asymptomatic, and require no treatment. Children with asymptomatic flexible flatfoot should be monitored clinically for onset of symptoms and signs of progression. Continued progression requires reassessment to identify other underlying disease. As growth, related changes of

foot alignment and mobility will continue until approximately 8 years of age, it is anticipated that developmental problems resolve by this age. Therefore, persistence of flatfoot in children older than eight years necessitates further assessment, despite the lack of symptoms.(1)

Symptomatic flexible flatfoot:

Symptomatic forms result in subjective complaints, deteriorate function, and produce substantial objective findings. Pain along the medial part of the foot; pain in the sinus tarsi, leg, and knee, diminished endurance, gait disorders, prominent medial talar head, everted heels, and heel cord tightness are among these findings. (3)

Initial treatment options include activity modification, proper shoe and orthoses, stretching and strengthening exercises and nonsteroidal anti-inflammatory medications. Furthermore, comorbidities such as obesity, ligamentous laxity, hypotonia, and proximal limb problems (genu valgum), must be identified and managed. (3)

If there is a positive clinical response and symptoms are settled, follow-up observations are recommended. If clinical response is not acceptable, reassessment and additional work-ups are indicated. (4)

When all nonsurgical treatment options fail, surgery can be considered. A summary of algorithmic approach to pediatric flatfoot is shown in **figure 1**. (1)

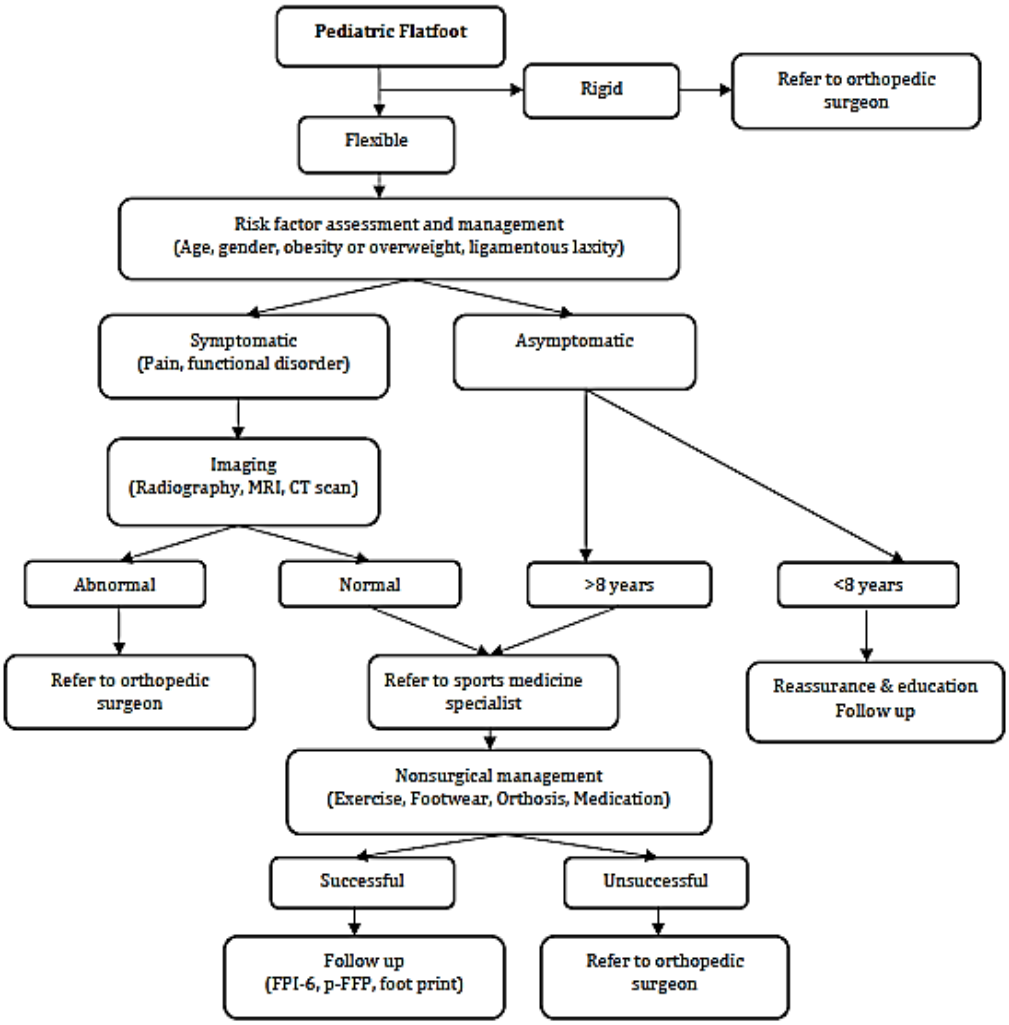


Figure (1): Algorithmic approach to pediatric flatfoot. (1)

Nonsurgical interventions:

There are many types of non-surgical treatments for the pain and disability caused by flatfeet such as advice and education, footwear selection and modifications, foot orthoses (shoe inserts), exercise including stretching and strengthening, and medication for pain and inflammation. (5)

Advice and education:

The conservative management of flexible flatfoot begins with education of the patient and the parents. Patients and their parents should be counseled regarding the facts that the flatfoot deformity may resolve with maturation depending on the age of the patient and any underlying conditions. Parents should know that there is no evidence that this deformity will lead to a painful condition in adulthood. (6)

Education should consist of the biomechanical findings that support the diagnosis of flatfoot and the purpose of corrective devices. Most flexible flatfeet are physiologic, asymptomatic, and require no treatment. Parents should be notified that physiologic flexible flatfoot follows a natural history of improvement over time. Periodic observation may be indicated to monitor for signs of progression. Normal development and strengthening of the foot may be all the treatment indicated. (7)

Parents should be aware that no physiologic flexible flatfoot is characterized by progression over time and the degree of deformity is more severe. Periodic observation is indicated in these cases. (3)

Footwear selection:

Recommending proper supportive shoe is a valuable first line intervention in the flexible flatfoot. An enclosed sneaker may provide structural support to the skeletally immature foot. The shoe should have a firm sole to prevent the orthosis (if used) from compressing the medial side of the shoe.(7) Nowadays, it is agreed worldwide that specific orthopedic footwear do not influence the natural development of the foot.(8)

Foot orthotics:

One of the primary conservative interventions for pediatric flatfoot is in-shoe foot orthoses and arch supports.

For the flatfoot, one must bring the ground up to meet the sole instead of allowing the hind foot to pronate to the ground. The shoe may require cushioned insoles **[Fig.2]** to relieve painful forefoot and metatarsal phalangeal joints during the push-off stage of gait. Adding a medial heel wedge helps pronation. The shoe must have sufficient depth and width to accommodate foot with orthosis. (9)

Figure (2): Cushioned insole. (10)

The foot orthosis is used primarily to support the foot in a desired position and to accommodate the bone deformities, while providing protection for the soft tissue. The custom orthosis is fabricated from a plaster model of the patient's Foot; the goal is to capture a measure of correction in the cast and to construct an orthosis that intrinsically provides correction. (11)

Studies have demonstrated that although orthotic supports may aid to correct soft tissue deformities, the underlying bony structure is unchanged. Many authors studied the effects of an over-the-counter insert and molded foot orthosis in children, and found no radiographic improvement in flatfoot deformity compared with the bare foot. (6)

Exercise:

Exercise for flatfeet, in the form of barefoot walking and prescribed activities have been used. The focus of exercise program is on stretching tight structures, strengthening the weak components and improving proprioception and postural balance. (7)

NSAIDs:

Nonsteroidal anti-inflammatory drugs may be prescribed if any evidence of inflammation is present. Medial column collapse and strain may present as an inflammatory process and justify the use of anti-inflammatory drugs in conjunction with rest and ice to relieve the symptoms.**(7)**

Surgical Intervention:

The goals of surgery are simple pain reduction or resolution and realignment of the foot. The consensus suggests that if conservative methods have failed, and the child does not have relief of symptoms, surgery is indicated.(12)

Although achieving these goals may be difficult because there are such a wide variety of clinical presentations ranging from mild to severe flatfeet with a multitude of planal dominance contributions, surgical realignment may be challenging. (7)

Indications of surgery:

Pain, which may be described as aching, throbbing, cramping or generalized fatigue, commonly involves the medial longitudinal arch, lateral sinus tarsi region, heel, or posterior calf. (13)

Difficulty in walking or running is secondary to the excessive valgus attitude of the foot and the usually present equines condition.(13)

Physician should not be swayed into operative treatment based on the requests of the parents to have a child with a straight foot. (6)

Types of surgery:

Surgical management of the flexible flatfoot can be grouped into three types of reconstructive procedures, arthrodesis, and arthroereisis. (14)

A) Reconstructive procedures:

These are further divided to soft tissue and bone techniques. Soft tissue reconstruction of the flexible flatfoot is rarely successful as an isolated procedure and a combination of soft tissue and bone procedures are often selected. (15)

Soft Tissue Reconstruction:

Soft tissue procedures usually involve the Achilles tendon, posterior tibialis tendon, and peroneal tendons. The Achilles tendon can be lengthened for Achilles contractures. Depending on the area of contracture, a gastrocnemius recession or Achilles tendon lengthening may be considered. Several procedures have been described that aim to displace the insertion of the posterior tibialis tendon.(6)

Tibialis anterior transfer into talus:

The use of tibialis anterior tendon transfer through the talus for severe flexible pes planus has been derived and modified from its use for the congenital convex pes valgus[Fig.3]. It has been utilized in selected symptomatic patients with severe talar declination and subluxation. (16)

Figure (3): Tibialis anterior transfer through the talus with its distal reinforcement of the medial column. (17)

Young's tendon suspension involves changing the course of tibialis anterior by sliding it into a "keyhole slot" in the navicular **[Fig.4]**. This operation has been very successful for a less severe medial column deformity, significant elongation of the planter talonavicular joint capsule, spring ligament, and tibialis posterior tendon are noted. These must also be addressed. (16)

Figure (4): Outline of Young procedure.(17)

Flexor digitorum longus transfer for posterior tibial tendon: [Fig.5]

This procedure should be generally reversed for cases of chronic tenosynovitis and dysfunction of posterior tibial tendon but without postural deformity. Intra operative examination usually reveals a diseased tendon, often hypertrophied but that may have spontaneously ruptured distal to the medial malleolus. (18)

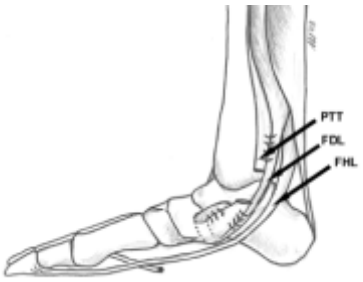


Figure (5): Flexor digitorum longus transfer for posterior tibial tendon. (19)

Tendon Achilles lengthening:

Contracture of the Achilles tendon often accompanies the symptomatic flatfoot. It prevents normal dorsiflexion of the ankle during midstance phase of the gait cycle. The dorsiflexion stress is shifted to the talonavicular joint, subjecting the underlying soft tissues to excessive direct axial loading and shear forces. (15)

In an occasional patient with a tight heel cord despite a vigorous stretching program, judicious heel cord lengthening may have a role in the management of flexible flatfoot, as an isolated procedure or in combination with other procedures.(20)

Bony reconstruction procedures:

Bony procedures include hind foot, midfoot, and forefoot osteotomies. Depending on the plane of dominance of the deformity, lateral column lengthening or medial displacement osteotomy of the posterior calcaneus may be used.(21)

Osteotomies:

Joint-sparing procedures based on osteotomy appear to be the option of choice for a flexible flatfoot at this age group. Such procedures improve alignment while maintain mobility. Two osteotomies hold promise for long-term relief of symptoms. Both are calcaneal procedures, but one translates the calcaneal tuberosity medially whereas the other lengthens the calcaneus with a positive effect on hind foot and forefoot alignment. (20)

1) Evan's calcaneal osteotomy:

The anterior calcaneal osteotomy, specifically the Evans procedure, is a commonly performed operation for the treatment of supple adolescent and adult flatfoot deformity after failure of the non-operative care. Evans originally described treatment of calcaneovalgus deformity with lateral column lengthening using autogenous tibial cortical bone graft. Although auto graft remains the standard choice of biomaterial, allogenic bone has also been used with success. **[Fig.6]** (22)

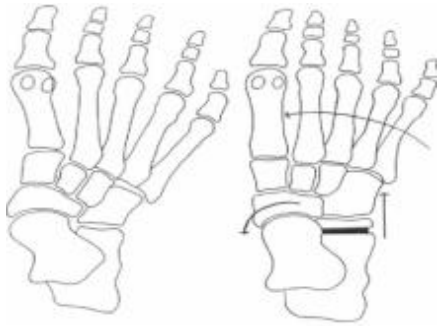


Figure (6): Evan’s calcaneal osteotomy. (22)

2) Medial Displacement Calcaneal Osteotomy: [Fig.7]

The osteotomy is done through the body of the oscalcis, moving the proximal calcaneus medially and derotating it out of valgus and positions the contact portion of the heel more in line with the weight-bearing axis. The osteotomy elevates the medial arch, and centralizes the motion of the subtalar joint. This procedure is indicated in patients who have excessive heel eversion without excessive abduction or varus of the forefoot.(18)

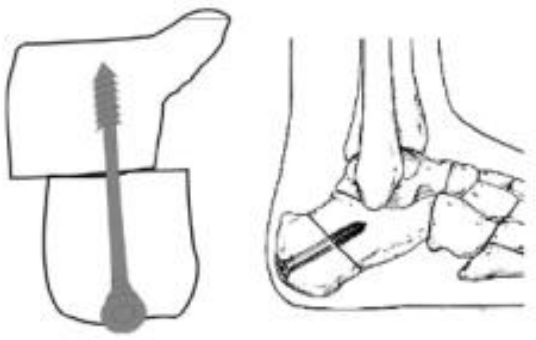


Figure (7): Medial Displacement Calcaneal Osteotomy. **(18)**

B) Arthrodesis:

Arthrodesis of the hind foot has also been described for treatment of symptomatic flexible flatfoot as a salvage procedure. Subtalar arthrodesis is typically performed as the primary procedure. Triple arthrodesis is reserved as a salvage technique for formerly failed surgical treatment. (23)

Marked deformity associated with arthritis or fixed osseous deformity is best managed by arthrodesis. To help stabilize the hind foot, the choices are a talonavicular arthrodesis, a double arthrodesis at Chopart's joint, and a subtalar arthrodesis. In addition, a triple arthrodesis.

Subtalar arthrodesis:

Isolated subtalar arthrodesis are indicated in the presence of a rigid or incompetent subtalar joint accompanied by a flexible forefoot and a stable talonavicular joint. It is an excellent alternative to a double arthrodesis, and when the heel is left in 5 degrees of valgus angulation, excellent motion of the foot is preserved.(24)

Triple arthrodesis:

The operative treatment of severe disabling arthritic pain, deformity and/or instability of the tarsal joints. The aim of this surgical procedure is to establish a painless, stable and plantigrade foot. The patient age should be 12 years or greater.(25)

C) Subtalar Arthroereisis:

Rational:

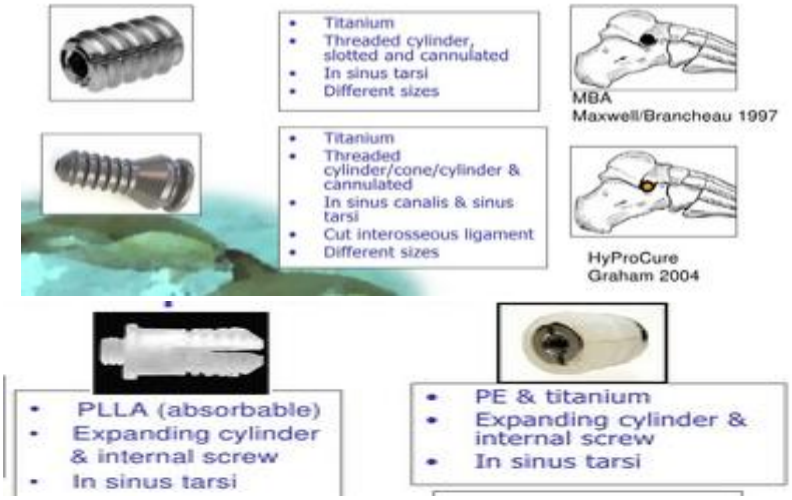
Arthroereisis (derived from Greek arthro meaning joint and ereisis meaning lifting up) is a procedure in which an implant screw is inserted between the posterior and anterior subtalar joints inside the sinus tarsi.

The implantation of the screw expands the subtalar joint vertically, elevating the head of the talus to hold the talus in proper alignment with the calcaneus so this corrects the planter-flexed posture the talus assumed in flexible pes planus, realigns the longitudinal arch of the foot, and subsequently reduces the flatfoot deformity. (26)

This procedure involves insertion of a spacer into the sinus tarsi to restrict subtalar joint pronation. (27)

Implants:

A number of implants have been used including bone, polyethylene disk, silastic, a vitallium staple, and now more recently a titanium screw with soft-threaded design to resist extrusion**. [Fig.8]** No bone drilling is necessary, and no cement is used, thus making arthroereisis a feasible minimally invasive procedure to treat symptomatic flatfoot. (26)



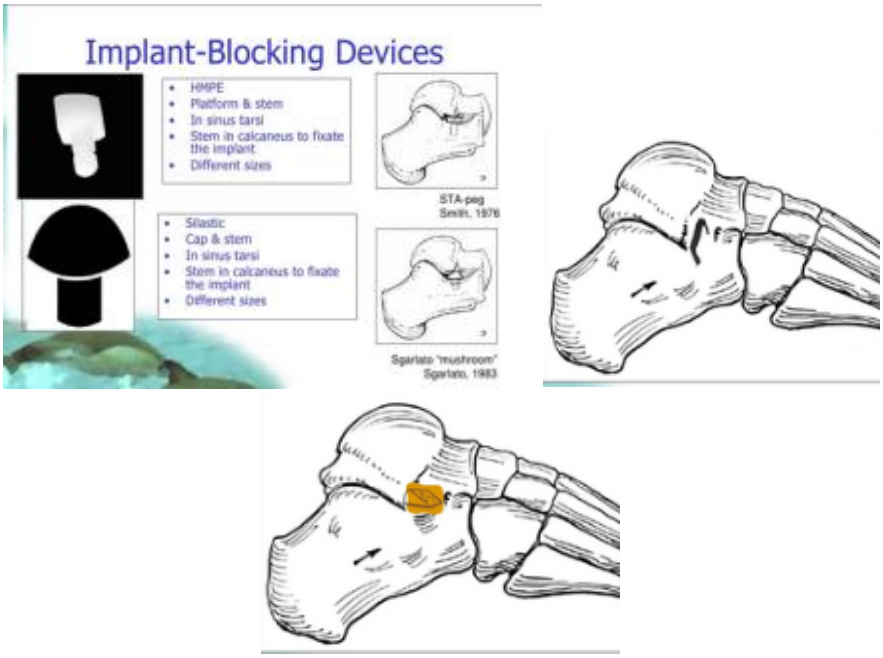


Figure (8): Different material implants used in subtalar arthroereisis. (28)

Technique:

Viladot in1992 introduced a technique in which by means of an external and internal double surgical approach raising the internal arch and simultaneously correcting the hind foot is attempted. A cup like orthosis with a flat base and conical body is inserted in the sinus tarsi **[Fig.9].** Good results using this operation has been reported. (29)

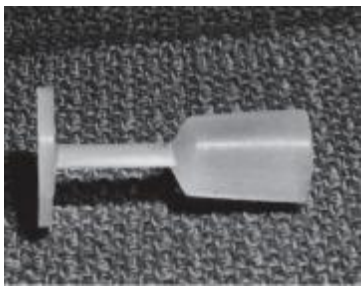


Figure (9): Viladot device. (28)

Giannini et al. has performed extra-articular arthroereisis with use of a bioabsorable implant in the sinus tarsi through a 1cm incision **[Fig.10].**

Outcome:

The procedure is simple and effective in correcting functional flexible flatfoot. They suggested that surgery performed during growth provides an optimal and lasting correction of the deformity, restoring the talocalcaneal alignment with remodeling of the subtalar joint. This correction improves the biomechanics to prevent problems caused by persistent pronation of the foot. The bioabsorable implant proved to be virtually complication-free and did not need to be removed.(30)

Figure (10): Bioabsorable implant in the sinus tarsi. (31)

Arthroereisis provides a three-dimensional correction by preventing the talus from slipping forward, inward, and downward during pronation. Finally, it does not affect the bone development and does not interfere with potential osteotomies that may be needed in the future. (32)

Calcaneus stop (block) technique:

The calcaneal stop technique is a simple extra-articular subtalar arthroereisis procedure introduced by Pisani in the 1980s for the treatment of symptomatic flexible flatfoot. It works by limiting calcaneal eversion and excessive subtalar pronation through insertion of a calcaneal screw, while also providing proprioceptive stimulation to the sinus tarsi receptors, which may help normalize subtalar joint mechanics. The technique is considered easy, minimally invasive, cost-effective, and has shown satisfactory clinical and radiological outcomes.(33)

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