Review Article

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Flatfoot in Children: How to Approach?

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Abstract

Although the exact incidence of flatfoot in children is unknown, it is very common and is, in fact, one of the most common conditions seen in pediatric orthopedic practices. All children are born with flat feet, and more than 30% of neonates have a calcaneovalgus deformity of both feet. This condition is not painful and generally resolves without treatment; very rarely is corrective casting necessary. For the pediatrician evaluating flatfoot, it is important to differentiate between flexible and nonflexible (rigid) flatfoot, and to classify the condition as painful or painless. Most children who present to a pediatrician for evaluation of flatfoot will have a flexible flatfoot that does not require treatment. On the other hand, other conditions that do require treatment, such as congenital vertical talus, tarsal coalition, and skew-foot often present as nonflexible flatfoot. Surgical management is rarely indicated for a true flexible flatfoot. The longitudinal arch of the foot is not present at birth and slowly develops during childhood, usually by about age five or six. It is a process that occurs throughout growth and is not affected by the presence or absence of external arch support. Sometimes the arch takes even longer to take shape, but this still usually does not cause any problems. A variety of tendon transfers and reconstructive procedures have been advocated, but none has proved uniformly successful. Nor have any of the various types of supports ever been shown to change the arch architecture. It should be borne in mind that painful flexible flat foot requires treatment, often with several types of shoe inserts and supports and as a last resort by operative procedures. Although parents are often concerned about pediatric flatfoot, the child is usually found to be asymptomatic, and no treatment is indicated. In most instances, the best treatment is simply taking enough time to convince the family that no treatment is necessary.

Key Words: Flatfoot, Flexible, Rigid, Children, Deformity

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Introduction

Flatfoot rarely causes disability, but it remains a major concern of parents. Children from the neonatal period to the preschool age are ordinarily brought to the general or the pediatric orthopedist because of their foot and gait problems, which may or may not be developmentally or clinically significant[1,2]. Among them, the development of flatfoot is the most common. As the parents observe their child standing they can't help but worry about the abnormal appearance, with the arch fallen, the feet pressed flat to the floor and the heels that seem to rotate out to the sides. They wonder how the child can possibly get around on those things, and worry about the possibility of future difficulties or discomfort. These concerns spark questions like, "Will this ever get better?" "Will he need special shoes?" or "Does this need to be fixed?"[3]

For the pediatrician evaluating flatfoot, it is important to differentiate between flexible and nonflexible (rigid) flatfoot, and to classify the condition as painful or painless. To do this, it is essential to know what the characteristics of a newborn foot are and how it develops to become a normal adult foot.

Normal development of foot in children

Despite its small size, the newborn foot is complex, consisting of 26 to 28 bones. The foot can be divided into three anatomic regions (Figure 1): the hindfoot or rearfoot (talus and calcaneus); the midfoot (navicular bone, cuboid bone, and three cuneiform bones); and the forefoot (metatarsals and phalanges)[3]. All children are born with flat feet. Almost every child's foot initially has a large fat pad on the inside arch which slowly decreases as they grow. The longitudinal arch of the foot is not present at birth and slowly develops during childhood, usually by about age five or six. It is a process that occurs throughout growth and is not affected by the presence or absence of external arch support. Sometimes the arch takes even longer to take shape, and the normal foot arch develops in the first decade of life, but this still usually does not cause any problems[4]. Flexible flatfoot is considered to be a manifestation of a constitutional laxity affecting all ligaments and joints, and if the foot arch appears abnormal, it is usually the result of weight-bearing stresses. Most children with flatfoot achieve a partial correction spontaneously[5].

Pathophysiology

Function and structure of the medial longitudinal arch are affected by numerous anatomic structures, all offering potential contributions to the pathophysiology. The posterior tibial muscle and corresponding tendon are crucial to hindfoot position and foot flexibility during the gait cycle. Originating from the posterior aspect of the tibia, interosseous membrane, and fibula, the posterior tibial muscle and subsequent tendon passes posteromedially behind the medial malleolus and then inserts via multiple bands into the navicular, cuneiforms, metatarsal bases[6-8], and the sustentaculum tali. Ankle plantarflexion and forefoot adduction-supination with resultant subtalar inversion are key functions of the posterior tibialis tendon because of its posteromedial position. During the gait cycle, the foot must transition from a flexible construct at heel strike to accommodate irregular surfaces to a rigid construct at push off to maintain a rigid lever for ambulation[9]. At heel rise, PTT initiation of transverse tarsal joint adduction with resultant subtalar inversion causes the talonavicular and calcaneocuboid joint axes to be perpendicular and therefore locked.

The natural antagonist of the posterior tibial muscle is the peroneus brevis, which is responsible for forefoot abduction and subtalar joint eversion. When PTT insufficiency occurs, several deforming forces are produced. Peroneal musculature overpull may cause forefoot valgus combined with long-term heel valgus, which produces Achilles tendon contracture and transforms the gastrosoleus

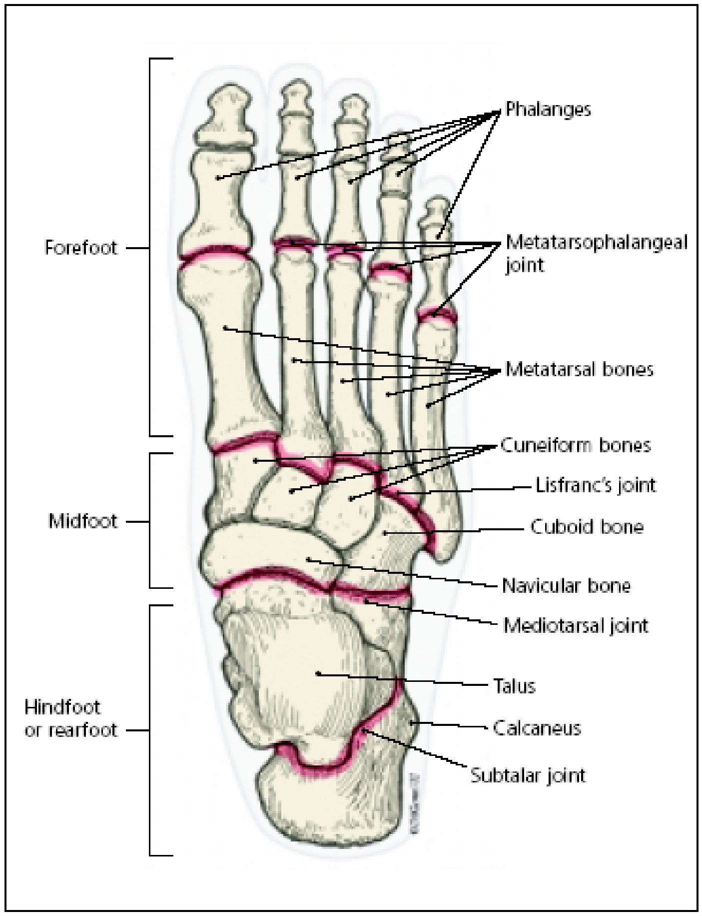

FIGURE 1. Bone structure and divisions of the adult foot.

muscles into heel everters (rather than inverters); all contribute to dynamic factors in the deformity[10].

Other structures vital to the medial longitudinal arch are considered static. Individual shape and size of the bony architecture of the medial arch offer significant stability. Recently, the spring ligament complex has received much attention as an important stabilizer of the medial arch[11]. The complex ligamentous support system surrounding the talonaviculocalcaneal joint is comprised of several parts, including the superomedial calcaneonavicular ligament, inferior calcaneonavicular ligament, and a portion of the superficial deltoid. The degree of stability contributed by the spring ligament complex and deltoid ligament remains unclear. The relationship of the central component of the plantar fascia to medial arch support has long been attributed to the windlass effect.

So for normal foot function, the most important thing is the fact that it should transition from a flexible construct at heel strike to accommodate irregular surfaces to a rigid construct at push off to maintain a rigid lever for ambulation, irrespective to its medial longitudinal arch height.

The tendency to develop flexible flatfoot is inherited, and the source of many kids' flat feet can be traced to a parent or another relative. The etiology of this condition is most likely excess laxity of the joint capsules and ligaments that allow the tarsal arch to collapse when weight is applied. Baby fat and ligamentous laxity at this age predispose to flattening, and rapid growth can make it even more apparent.

Several studies have shown that the critical age for the development of the longitudinal arch is before six years. If wearing shoes does contribute to failure of development of the arch, the age at which it begins should influence the onset of flat foot. Shoe-wearing before the age of six would predispose to flat foot whereas if it were delayed until the child was older, the propensity for flat foot would be less[12,13].

Rigid flatfoot is a congenital deformity caused by failure of the tarsal bones to separate, leaving a bony, cartilaginous or fibrous bridge between two or more of the tarsal bones. The coalition limits normal subtalar and midfoot motion, leading to inflammation of the involved joints. The peroneal tendon crosses over the subtalar joint and often goes into spasm secondary to subtalar inflammation, hence the term "peroneal spastic" flatfoot. Tarsal coalition is present in approximately 1 percent of the population and is bilateral in 50 to 60 percent of patients[14]. Talocalcaneal coalitions comprise 48 percent of all coalitions and generally become symptomatic when patients are between eight and 12 years of age[14]. Calcaneonavicular coalitions occur in 43% of patients and become symptomatic between 12 and 16 years of age[15].

Clinical Manifestation

Flexible flatfoot in a child almost never causes any problems. Children with flexible flatfoot, in general, are asymptomatic. If it persists into adolescence, some may experience mild aching along the bottom of the foot. Flexible flatfoot may become symptomatic in adolescents. Symptoms begin to develop as the contracted Achilles tendon limits full ankle dorsiflexion, thus transferring forces to the midfoot. Over time, these forces result in the breakdown of the tarsal joints. Patients complain of vague pain in the medial arch and ankle. On physical examination, the foot has a flat or rocker bottom, and the calcaneus valgus is apparent when standing. When the patient is standing on tiptoe, the calcaneus inverts slightly but not fully. Ankle dorsiflexion is limited to less than 5 degrees secondary to a contracted Achilles tendon. The normal subtalar and transverse tarsal motion is decreased by approximately 50 percent[18]. Roentgenographs demonstrate a decreased dorsiflexion pitch of the calcaneus, sag at the talonavicular joint with dorsal breaking, and occasionally a rocker-bottom foot.

In the opinion of Cohen-Sobel et al[19] and D'Amico[20], flatfoot may cause gait disorders in the future, although it is often overlooked. With the belief that the developmental flatfoot is the precursor of foot dysfunction and resultant disability later in life, some practitioners have been enthusiastic to design a management program for flatfoot today and the foot health needs of tomorrow. Wenger et al[21] argue that the natural course of flatfoot is relatively benign and is not statistically altered by a corrective shoe. Thus, the arguments for or against the arch support for correcting flatfoot persist without general agreement. This debate has led to continued efforts to investigate the natural history, long-term result with treatment, and the correlating factors of flatfoot[22].

Patients with tarsal coalition have insidious and occasionally acute onset of arch, ankle or midfoot pain. Patients are predisposed to frequent ankle sprains secondary to the limited subtalar motion. On physical examination, the patient will have a slightly flattened or flat arch. A standing calcaneal valgus is present, which will fail to invert when standing on tiptoe. Little to no motion is present in the subtalar and transverse tarsal joints, and stress on these joints frequently causes pain. Standard roentgenographic evaluation includes antero-posterior, lateral, oblique and Broden's views.

Bony calcaneonavicular bars are best visualized with the oblique view, and the Broden's view best demonstrates talocalcaneal bars. A fine-cut CT scan is often necessary to demonstrate a tarsal coalition, since this study better demonstrates small bony bridges and changes consistent with cartilaginous coalitions. Technetium bone scans generally show increased uptake in the involved joints.

Physical examination of the foot

In neonate, simultaneous observation of both feet can reveal many deformities. The skin should be examined for unusual creases or folds that can be formed by various foot deviations. Certain areas of the skin might be abnormally taut, indicating extra tension on the skin, while the skin on the opposite side of the foot might reveal loose, excessive skin folds. During the next part of the examination, various foot and ankle joints are moved through their respective ranges of motion. The joints should be assessed for flexibility or rigidity, unusual positions, lack of motion, and asymmetry. Finally, the vascular examination consists of assessment of capillary refill and skin color, because pulses are difficult to palpate. Fortunately, the majority of newborns exhibit excellent lower extremity vascular supply, unless it is compromised by an extrinsic factor, such as an intrauterine amniotic band[16].

In older children, for the pediatrician evaluating flatfoot, it is important to determine if this is benign flexible flatfoot or a more serious problem, such as vertical talus or a tarsal coalition, and to classify the condition as painful or painless. To determine flexibility, the doctor might observe the foot through a series of maneuvers. While standing they display a dropped medial longitudinal arch, foot eversion and calcaneus valgus. With the child seated and legs dangling, the normal arch contour returns and is accentuated with passive dorsiflexion of the great toe. A nonflexible or rigid flatfoot will remain without a detectable arch in both instances. When the child stands on tiptoe, a flexible flatfoot will demonstrate an arch, with the heel pointing slightly in towards the midline which indicates that calcaneus invert from its valgus position (Fig. 2). Then ask the child to stand on his heels, as ability to do this shows good flexibility of the heel cord or Achilles tendon. Standing on the outer and then inner borders of the foot could demonstrate good mobility of some important joints in the foot. Subtalar and transverse tarsal motion is normal in patients with flexible flatfoot. To determine subtalar motion; the examiner stabilizes the ankle with one hand and grasps the calcaneus with the other.

The calcaneus is then passively everted and inverted. The normal total range of motion is between 20 and 60 degrees, with the inversion component twice that of the eversion component. Transverse tarsal motion is determined by grasping the calcaneus with one hand and the forefoot with the other. The forefoot can normally be adducted 30 degrees and abducted 15 degrees. The physician should consider tarsal coalition if the range of motion is less than that described. Often the child‘s shoes should be examined as well. Looking at what areas of the shoe are showing wear can help demonstrate what is happening to the feet during walking and running. Next, determining whether the foot is painful or painless is simply a matter of asking. The child with pain secondary to flatfoot may describe symptoms such as aching in the arch or cramps at night. Radiography is not necessary in the routine evaluation of flexible flatfoot.

Treatment

In general, painless flatfoot requires no special treatment. Flexible flatfoot in a child almost never causes any problems and asymptomatic flexible flatfoot requires no treatment, and no evidence indicates that early treatment will prevent the development of symptomatic flexible flatfoot as an adult. In one prospective study[22] 98 children with flexible flatfoot were treated with corrective orthopedic shoes, Helfet heel cup, a custom-molded plastic heel cup, or received no treatment.

All of the groups demonstrated a significant improvement on radiographs, with no difference apparent among the groups after three years. Some children, however, may rapidly wear out the medial aspect of standard footwear. Excessive wear on shoes may be minimized by wearing more durable orthopedic oxford shoes, medial longitudinal arch supports and/or medial heel wedges. Proper footwear is important for the developing foot; but, whenever safety and comfort allow, going barefoot stimulates

Figure 2- Tiptoe standing test.
A: heel valgus and flatfoot during weight bearing.
B: during tiptoe standing, the heels turn toward the varus and arches appear which show flexibility of flatfoot.

proprioceptors and encourages muscular coordination and strength. The reduced incidence of flatfoot seen in barefoot populations suggests that muscle strength and mobility may be important factors in the normal development of the arches, and that a child is more likely to develop a flexible, yet strong arch when going barefoot [14,25]. There is also evidence that using arch supports or even wearing shoes regularly before age 6 may worsen flat foot by interfering with the normal development of foot muscles. In addition, arch supports and special shoes are uncomfortable for children. So we need to encourage parents to let their children go barefoot whenever it is safe, and to select shoes based on function, not merely on style or cost. In these cases, it is especially important for the child to spend considerable time barefoot. While 10% of the children were receiving flat foot treatment with arch supports, this treatment was unnecessary in most cases.

Strengthening of the child's lower leg muscles with home exercises, especially tibialis posterior, and internal/external rotation exercises may have a role. Also, having the child perform the towel-gathering exercise ('scrunching' a towel lying on the floor with the toes) for 15 minutes daily may be helpful. But all in all, treatment of children with physiological flat foot is ineffective and produces enormous costs for parents and health service providers [26].

If the child is 10 or older, the flexible flatfoot can be considered permanent, and long-term use of orthotics will be required to prevent future problems in the feet, lower extremities, and spine. This is especially true for overweight or athletically active youngs who are symptomatic. They may experience mild aching along the bottom of the foot. Depending on the nature of the pain, treatment might begin with heel cord stretching exercises. If it persists, shoe inserts might be needed. Surgical treatment for persistent pain is rarely needed.

There are a group of patients in whom flexibility of the foot is decreased by age. This group is called as semi-rigid flatfoot. Treatment consists of a longitudinal arch support with a firm heel counter, such as the UCBL (University of California Biomechanics Lab) orthosis. Patients should be fitted for a heel lift, and aggressive heel cord stretching is recommended if an equinus deformity is present[27].

A child with a symptomatic tarsal coalition should be treated initially with a short leg walking cast for four to six weeks to allow the inflamed joints to rest. An ankle-foot orthosis or posted foot orthosis can then be prescribed to minimize the subtalar and transverse tarsal motion. Patients who fail to respond to conservative treatment or who are involved in competitive athletics should be referred to an orthopedic surgeon[19,28].

Conclusion

Having a flat foot is part of being a young child. It can sometimes persist beyond childhood. But even then there's no evidence to show this leads to any problems in adulthood, nor that any external device can alter its appearance or development. So, is painless flexible flatfoot a problem? Not unless we make it one. For an asymptomatic child, it's best to leave well enough alone and to reassure the parents as well.

References

1. Crawford AH, Gabriel KR. Foot and ankle problems. Orthop Clin North Am. 1987; 18(4): 649-66.
2. Lin CJ, Lin SC, Huang W, et al. Physiological knock-knee in preschool children: prevalence, correlating factors, gait analysis, and clinical significance. J Pediatr Orthop. 1999;19(5):650-4.
3. Mital M. Children's feet: common worries of parents. Prof Care Mother Child. 2000; 10(2): 33-4.
4. Christman RA. Normal development and developmental variants of children foot. In: Christman RA. Foot and Ankle Radiology. Churchill Livingstone, St. Louis. 2003; Pp:57-96.
5. Cappello T, Song KM. Determining treatment of flatfeet in children. Curr Opin Pediatr. 1998; 10(1): 77-81.
6. Wenger DR, Leach J. Foot deformities in infants and children. Pediatr Clin North Am. 1986; 33(6): 1411-27.
7. Fowler AW. Tibialis posterior syndrome. J Bone Joint Surg Br. 1955;37:520-6.
8. Funk DA, Cass JR, Johnson KA. Acquired adult flat foot secondary to posterior tibial-tendon pathology. J Bone Joint Surg Am. 1986;68(1):95-102.
9. Goldner JL, Keats PK, Bassett FH, et al. Progressive talipes equinovalgus due to trauma or degeneration of the posterior tibial tendon and medial plantar ligaments. Orthop Clin North Am. 1974;5(1):39-51.
10. Mann RA, Thompson FM. Rupture of the posterior tibial tendon causing flat foot. Surgical treatment. J Bone Joint Surg Am 1985;67(4):556-1.
11. Teasdall RD, Johnson KA. Surgical treatment of stage I posterior tibial tendon dysfunction. Foot Ankle Int. 1994;15(12): 646-8.
12. Deland JT: The adult acquired flatfoot and spring ligament complex. Pathology and implications for treatment. Foot Ankle Clin. 2001;6(1):129-35.
13. Rose GK, Welton EA, Marshall T. The diagnosis of flat foot in the child. J Bone Joint Surg. l985:67(1):7l-8.
14. Sachithanandam V, Josephthe B. Influence of footwear on the prevalence of flat Foot. A survey of 1846 skeletally mature persons. J Bone Joint Siug. 1995;77(2): 254-7.
15. Scoles PV. Pediatric orthopedics in clinical practice. 2nd ed. Chicago, Year Book Medical Publishers. 1988.
16. Wenger DR, Mauldin D, Speck G, et al. Corrective shoes and inserts as treatment for flexible flatfoot in infants and children. J Bone Joint Surg [Am] 1989; 71( ): 800-10.
17. Gore A, Spencer JP. The newborn foot. Am Fam Physician. 2004;69(4):865-72.
18. Bordelon RL. Flatfoot in children and young adults. In: Mann RA, Coughlin MJ, eds. Surgery of the foot and ankle. 6th ed. St Louis: Mosby. 1993; pp 717-5.
19. Cohen-Sobel E, Giorgini R, Velez Z. Combined technique for surgical correction of pediatric severe flexible flatfoot. Foot Ankle Surg. 1995;34(2):183-94.
20. D'Amico JC. Developmental flatfoot. Clin Podiatr. 1984;1( ):535-46.

21. Wenger DR, Mauldin D, Speck G, et al. Corrective shoes and inserts as treatment for flexible flatfoot in infants and children. J Bone Joint Surg Am 1989; 71: 800-10.
22. Lin CJ, Lai KA, Kuan TS, et al. Correlating factors and clinical significance of flexible flatfoot in pre-school children. J Pediatr Orthop. 2001; 21(3):378-82.
23. Crawford AH, Gabriel KR. Foot and ankle problems. Orthop Clin North Am. 1987; 18(4): 649-66.
24. Rao BU, Joseph B. The influence of footwear on the prevalence of flat foot. A survey of 2300 children. J Bone Joint Surg. 1992;74-B:525-7.
25. Sullivan JA. Pediatric flatfoot: evaluation and management. J Am Acad Orthop Surg. 1999; 7(1): 44-53.
26. Kuhn DR, Shibley NJ, Austin WM, et al. Radiographic evaluation of weight-bearing orthotics and their effect on flexible pes planus. J Manip Physiol Ther. 1999; 22(4): 221-6.
27. Luhmann SJ, Rich MM, Schoenecker PL. Painful idiopathic rigid flatfoot in children and adolescents. Foot Ankle Int. 2000; 21(1): 59-66.