Evaluation and treatment of symptomatic pes planus

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Current Opinion in Pediatrics 2011, 23:60–67

Le pied plat physiologique se reconnait par son absence de douleur et la réapparition de l'arche plantaire sur la pointe des pieds ou en relevant les orteils.
Pas de traitement nécessaire car ne pose pas de problème au long terme, orthèse inutiles!
Primary Care 2.11.2011

Purpose of review
To provide the pediatrician with a comprehensive synopsis of pediatric pes planus, also known as flatfoot. The term pes planus is a physical finding that generates some confusion in the medical community because it describes a spectrum of conditions that are diagnosed and managed differently.
Recent findings
Some of the recent data incorporated in this review come from pediatric, orthopaedic, and podiatric literature. These sources describe the clinical features and the latest treatment options for pes planus.
Summary
This article will provide some guidance to evaluate and treat the many causes of pediatric pes planus. Nonsurgical and operative management will be discussed.

Keywords
flatfoot, flexible, pes planus, rigid

Curr Opin Pediatr 23:60–67
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1040-8703

Introduction

The pediatric flatfoot is a common clinical problem and is often a concern of parents and clinicians alike. Despite this, the term pes planus, or flatfoot, has long been used in literature and clinical practice with variable definitions. Multiple practitioners from various disciplines are involved in the identification and treatment of pediatric pes planus. This makes the literature confusing, despite decades of attempted clarification and standardization. In this review, we hope to clarify the definition of pediatric pes planus, in all of its common manifestations, and provide guidance to the clinician in the evaluation and management of this condition.

Pes planus serves more as a descriptive term of a lowered or absent medial longitudinal arch, with or without a valgus heel, than as a diagnosis of the underlying cause [1]. This description encompasses pathologic or nonpathologic, rigid or flexible, and symptomatic or asymptomatic conditions [2]. The first consideration, in the presentation, is the age of the patient (Fig. 1a and b). It is well described and understood that children are born with flatfeet, and the longitudinal arch develops in the first 10 years of life. In a population of 835 children, it was found that the prevalence of flatfeet correlated inversely with age, occurred more frequently in boys than in girls (52 vs. 36%), and demonstrated an increased incidence of flatfeet with increased body weight [3]. A second consideration is whether the foot is flexible, in which the arch only disappears with bearing weight, or rigid, in which the arch is fixed in a lowered position both with bearing weight and not bearing weight. Whereas the flexible flatfoot is considered to be physiologic and usually does not require treatment, the rigid flatfoot is often pathological and requires treatment [1,4].

There is a long-standing debate over whether or not to use orthoses in the treatment of pediatric pes planus [5]. The debate centers on the fact that there is no way to distinguish between the flatfeet that will become symptomatic and the flatfeet that will remain asymptomatic throughout a patient's life [4]. Evaluation of the fallen medial arch should include an extensive history, a thorough physical examination, and appropriate diagnostic tests. Pes planus represents the clinical picture for a variety of etiologies; therefore, clinicians must provide an appropriate treatment course for each individual. This minimizes harm done through a generalized approach. Interestingly, the effect of this foot type on other parts of the lower extremity has become more of interest to clinicians. A recent study published in Foot and Ankle International demonstrated a positive correlation between the pes planus foot type and anterior knee and intermittent lower back pain. The researchers found that the adolescent patient who presented with a moderate to severe pes planus demonstrated nearly double the rate of anterior knee pain and intermittent back pain. The authors suggest that prophylactic measures, such as prescription and nonprescription orthotics, would probably prove beneficial to these patients with moderate to severe pes planus [6].

 DOI:10.1097/MOP.0b013e32834230b2

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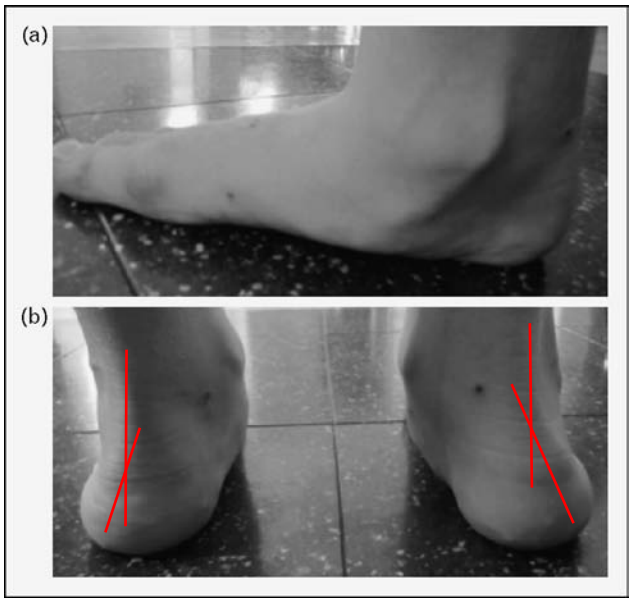
Figure 1 Pes planus



(a) Medial view. (b) posterior view.

Key points

- Pes planus describes a physical finding that represents a multitude of possible etiologies.
- Pes planus may be flexible or rigid.
- Pes planus may be painful or asymptomatic.
- Regardless of the cause, pes planus usually is managed nonoperatively and infrequently may need surgical treatment.

History

As with any orthopedic condition, a thorough history often can lead to the correct diagnosis. The age of clinical presentation is important to determine if the flatfeet are physiologic or pathologic in nature. In addition, a positive family history may help uncover the underlying cause of pes planus and may give the clinician an idea of whether or not the flatfeet are a variation of normal that will remain asymptomatic, or whether they are secondary to hereditary arthritis or familial ligamentous laxity (e.g., Ehlers–Danlos syndrome) [7]. Furthermore, if a patient presents with pain or no pain, that is crucial to establish a proper differential diagnosis. A thorough evaluation of the pain quality, severity, and time of onset helps to differentiate the cause of the pes planus. For example, a painful flatfoot without bearing weight should raise suspicion of tumor, arthritis, or infection; these all need to be worked up appropriately [8]. However, altered activity level or the presence of a limp may be the only indication of discomfort in young children, as they do not always complain of pain [5]. Historical questions such as participation in bare foot sports (e.g., martial arts and gymnastics) and recent trauma should be asked. Other factors, such as the presence of neuromuscular disorders, must be considered in context of the clinical presentation of pediatric pes planus [9•].

Physical examination

A similarly thorough approach is a necessity in the physical examination of the patient, beginning with the gait. The patient should ambulate in shoes and bare feet to avoid false negative pronation due to supportive shoe wear [10]. A toe walk and a heel walk also should be observed. Inability to complete either exercise, with or without pain, or asymmetry between the two feet, should raise suspicion of an underlying neuromuscular condition [9•]. Further, body habitus should be noted, given the increased incidence of pes planus in the obese pediatric population. Evaluation of spinal curvature is essential for evaluating two possible causes of pes planus. If kyphosis or scoliosis is detected in the setting of pes planus, one should be suspicious of hereditary neurological conditions, including Charcot–Marie–Tooth disease [11,12]. Additionally, ligamentous laxity (e.g., Ehlers-Danlos and Marfan syndromes) may cause trunk rotation in the setting of flatfeet [13]. The 'too many toes' sign can help a clinician evaluate the degree of deformity. The posterior view of a normal foot shows only the fifth phalanx, but the posterior view of a planovalgus foot with midfoot abduction demonstrates as many as all four lateral toes. Table 1 provides a comprehensive differential diagnosis list for pes planus.

Illustration

Rotational alignment of the hip, femur, patella, tibia, and ankle joints all can contribute to the malalignment responsible for the pes planus, and thus evaluation of limb positioning should be part of the physical work up. Limb alignment should be assessed both dynamically,

Table 1 Causations of pediatric pes planus

Flexible	Rigid
Physiologic variant of normal	Congenital vertical talus
Limb rotation	Tarsal coalition: talocalcaneal, talonavicular, calcaneonavicular
Accessory navicular bone	Peroneal spastic flatfoot
Ligamentous laxity: Ehlers–Danlos syndrome, Marfan syndrome Down syndrome, Charcot–Marie–Tooth disease	Traumatic
Obesity	Iatrogenic
Hypotonia	
Calcaneovalgus	
Other biomechanical causes (i.e., equinus, varus and valgus deformities)	

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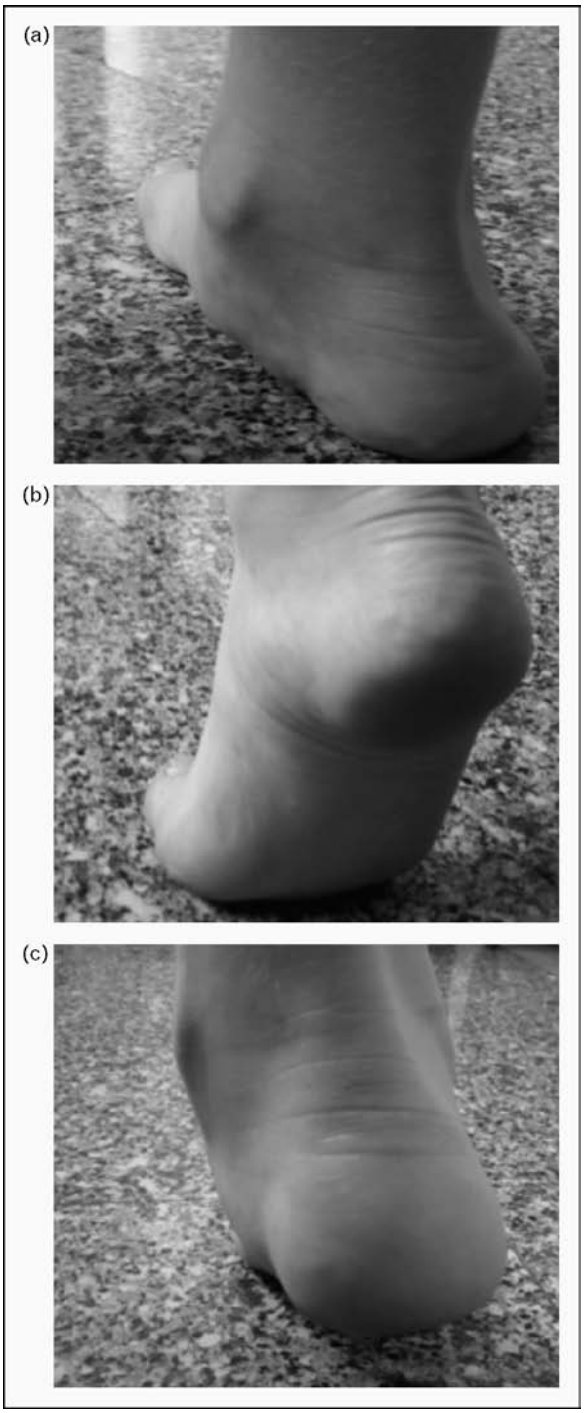
through observation of the gait cycle, and statically, via range of motion and relationship of parts assessment on the examination table. Hip, knee, and ankle range of motion will uncover joint contractures and/or torsional differences between limbs or parts of the same limb. For example, if a patient has severe femoral anteversion, or internal rotation of the femora, and external tibial torsion, or external rotation of the tibiae, he or she may produce a medial rotation of the leg on the talus leading to pronation of the subtalar joint which may contribute to the pes planus. The best way to evaluate torsion in the extremities is to place the patient prone upon the examination table. Hips can be internally and externally rotated to uncover anteversion, while at the same time the thigh foot angle is measured to determine tibial rotation [9•].

With the patient supine, flexion and extension of all joints can be assessed, with particular emphasis on the ankle joint. The Silverskiold test is used on the ankle joint to determine if an equinus is due to the gastrocnemius muscle, the soleus muscle, or both muscles. The ankle joint is dorsiflexed with the knee extended and with the knee flexed. If the range of dorsiflexion increases with the knee flexed, it is likely that only the gastrocsoleus muscle is contributing to the Achilles tendon contracture. If the dorsiflexion range remains the same with the knees flexed or extended, then both muscles contribute to the equinus [14]. The knowledge gained from analysis of rotation and range of motion is important in the treatment decision process.

Upon assessment of the pediatric flatfoot, it is of utmost importance to determine if the deformity is flexible or rigid. A flexible flatfoot deformity can be distinguished from a rigid one in that the flexible collapsed arch is present only when the patient bears weight, and then a normal medial longitudinal arch reappears in a toe stand or when the ankle is plantar flexed. Thus, one should assess the flatfoot both in the stance phase and in the toe off portion of swing phase of the gait cycle. Single or double heel rise is another method to observe whether or not the medial longitudinal arch reconstitutes (Fig. 2a–c).

The foot itself must also be carefully examined for ligamentous laxity, strength, sensation, tenderness, and range of motion of the joints. If the deformity is flexible, hereditary ligamentous laxity may be responsible for a lowered medial longitudinal arch [15]. A flexible flatfoot can also develop from strength imbalance in the lower limb, which can be measured with a hand held dynamometer [16]. A rigid deformity should be evaluated for range of motion of both the tibiotalar and subtalar joints to determine the approximate location of the deformity or possible bony coalition.

Figure 2 How to distinguish flexible from rigid pes planus



(a) Pes planus. (b) Flexible pes planus. (c) Rigid pes planus.

Flexible flatfoot

In addition to the above-mentioned findings and causes, there is also an association with an accessory navicular bone and the flexible flatfoot. However, fewer than 1% of accessory navicular bones are symptomatic [17]. A patient will present with point tenderness and redness over the

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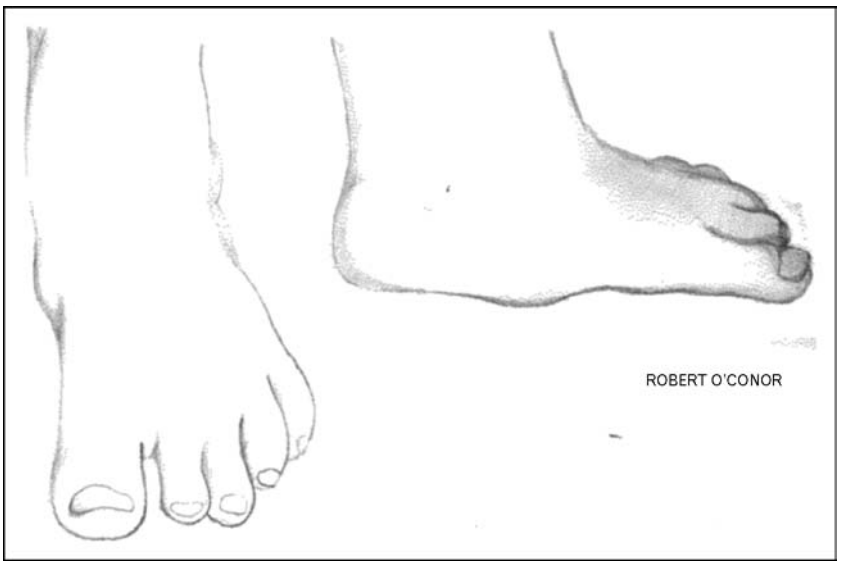
Figure 3 Clinical appearance of an accessory navicular bone



medial arch of the foot upon shoe removal. In this circumstance, a radiograph will help make the diagnosis [18]. In addition, the presence of the accessory navicular may contribute to a flatfoot as a result of an altered pull at the insertion of the anterior and posterior tibial muscles (Fig. 3).

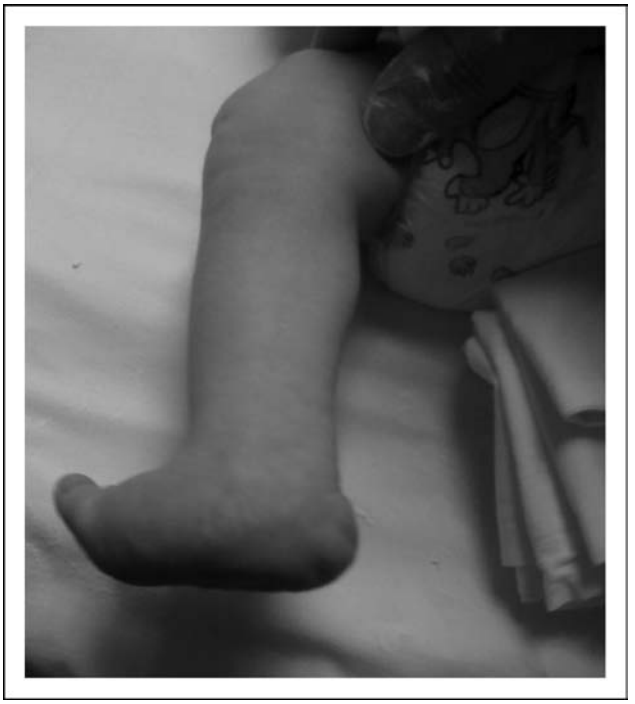
Rigid flatfoot

Tarsal coalitions, or unions between two or more tarsal bones, are the primary cause for fixed flatfeet. Up to 25% of rigid flatfeet due to tarsal coalitions may become symptomatic; therefore, it is essential to uncover the causation and design an appropriate treatment plan [19]. Fifty to 60% of all coalitions are bilateral, and may occur in multiple joints of the same foot [20]. Therefore, if one tarsal coalition has been discovered, it is important to look for additional fusions. These coalitions may be osseous, and thus identifiable on radiographs, or cartilaginous or fibrous, in which MRI is useful [21,22]. The overall prevalence of tarsal coalitions is approximately 1%, with talocalcaneal and calcaneonavicular accounting for the majority of cases [23]. The presence of calcaneonavicular, talonavicular, and calcaneocuboid coalitions is less common but also needs evaluation during the physical evaluation of the foot.

Another cause of the rigid flatfoot is the presence of congenital vertical talus (CVT). CVT is a fixed dislocation of the talus in plantar flexion (this is an error – talus is plantarflexed with navicular dorsiflexed on the head and neck of talus) with respect to the navicular bone, which causes an equinus deformity at birth. It is associated with skeletal muscle anomalies up to 62% of the time [24]. However, CVT also may be idiopathic, and not associated with other underlying comorbidities. The classic presentation is an equinus ankle and a rocker bottom foot [7] (Fig. 4).

Excessive point tenderness may be indicative of a fracture or an osteoid osteoma, and must be followed-up with appropriate imaging studies. Sensory deficits

Figure 4 Rocker bottom foot



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may uncover neurogenic causes of rigid pes planus; hence sensation must be evaluated during the physical examination.

Ancillary studies

Frequently, the cause of a symptomatic flatfoot cannot be evaluated fully from the history and physical examination alone. In this case, additional tests are necessary. These tests may include radiographs, MRI or computed tomography (CT), blood work, and sometimes gait laboratory analyses. The specific ancillary studies that should be ordered are determined by the clinical presentation and physical examination findings.

Radiographs

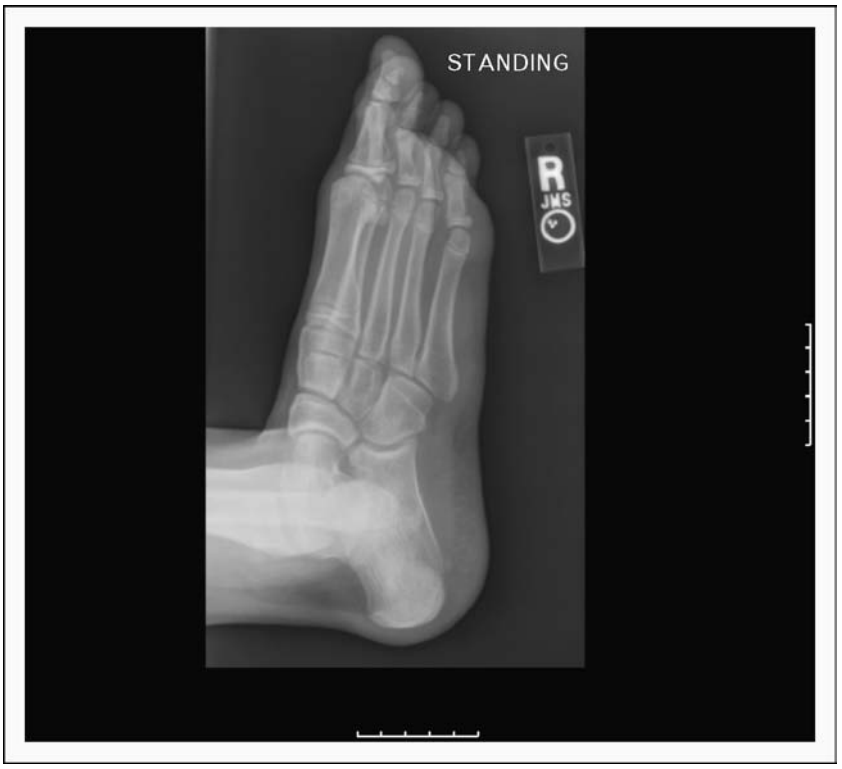
In the case of both rigid and flexible pes planus, a series of plain radiographs often are sufficient to make a diagnosis in combination with the clinical picture. In the case of talocalcaneal coalition, the subtalar and midtarsal joint motion is reduced substantially on physical exam [9•]. To view bony coalitions in these middle facet coalitions, anteroposterior (AP), lateral, and Harris–Beath radiographs should be evaluated [25,26]. For the calcaneonavicular coalition, the degree of rigidity often is less. This is due to a younger age of onset; therefore, the decreased subtalar-joint motion will be less pronounced than in the case of a talocalcaneal coalition. Normal gliding and rotation of the subtalar joint will be limited by calcaneonavicular motion [23]. In order to view this joint space AP, lateral, and internal (medial) oblique radiographs are needed (Fig. 5).

A suspected accessory navicular bone should be evaluated with AP, lateral, and external oblique radiographs [27]. In the case of suspected congenital vertical talus, stress plantarflexion and stress dorsiflexion lateral views confirm the diagnosis [25].

Magnetic resonance imaging and computed tomography

Some coalitions are fibrous or cartilaginous; therefore, they will not be visible on plain radiographs. If the joint range of motion in the subtalar or midfoot region is limited as described above, and plain radiographs are negative for coalition, an MRI or CT scan aids in making the diagnosis. The CT scan is the gold standard used to diagnose a coalition, because it shows not only whether the coalition is osseous or nonosseus, but also the full extent of coalition and secondary degenerative joint disease [25]. All of these considerations are essential in designing an operative plan. MRI and ultrasound also may be useful in surgical planning [7]. MRI also can be

Figure 5 Calcaneonavicular coalition



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used if the examiner suspects that the flatfoot is due to abnormalities in the posterior tibialis or peroneal tendons.

Laboratory work

Blood work should be used in the case of suspected infection, tumor, or inflammatory arthritis. In the case of suspected infection, a complete blood count with C reactive protein analysis can aid in diagnosis. Inflammatory markers, such as rheumatoid factor, antinuclear antibodies and others help confirm a diagnosis of arthritis. Suspected tumor should be worked up with a bone scan and appropriate blood tests.

Gait laboratory analysis

Three-dimensional gait data now is available to analyze the feet and legs throughout the gait cycle while walking or running. Models such as the Vicon 370 system (Oxford Metrics Ltd, Oxford, UK and Bertec Corp., Columbus, Ohio, USA) assess the lower extremities throughout swing and stance phases of gait [28]. Although this analysis is not routinely performed, the future for such technology may aid in determining the cause of an individual's flatfeet when compared with norms for specific diagnoses.

Treatment

Once the flexibility of the pes planus is evaluated, a treatment algorithm can be established.

Flexible pes planus

There have been numerous attempts to standardize and treat children with flexible flatfeet with various orthoses. Additionally, orthoses have been shown to have little impact on the course of progression of pediatric pes planus, yet corrective shoes and inserts are still prescribed at great financial expense. Approximately 10% of children with pes planus use some form of orthoses, despite the fact that only 1–2% had pain [3]. In a study of 129 children with flatfeet by Wenger *et al.* [29], all patients improved over the course of 3 years, with no significant differences between controls and patients treated with corrective shoes or inserts. Kulcu *et al.* [28] evaluated the effect of over-the-counter silicone insoles on gait pattern and found no beneficial effect in normalizing forces acting on the foot and the entire lower extremity. In the case of the asymptomatic flexible flatfoot, no treatment is required and no treatment has demonstrated any long-term improvement [20].

For symptomatic flexible flatfeet, many conservative therapies may be beneficial to resolve pain and aid in avoiding surgical intervention. Stretching of the tendo-achilles complex may counteract an equinus deformity [30]. Nonsteroidal anti-inflammatory medication, rest from offending activities, and ice massage may be helpful to reduce the pain associated with overuse [7]. Strengthening physical therapy is indicated in the case of muscle weakness, with or without an underlying neuropathy. Orthotics designed to provide medial arch support and reduce hyperpronation, such as the University of California Laboratory orthotic device, heel stabilizers and custom molded orthoses, may provide symptom relief, despite the absence of curative data [5]. Prefabricated devices, when well designed to reduce abnormal motion and stabilize the rear foot, may have a minimal place in managing very mild cases, particularly in younger patients. In more severe cases and in patients with biomechanical and other comorbidities, a custom orthosis made from a casted or scanned model of the foot offers an opportunity to prescribe a treatment that neutralizes or reduces many of the structural influences that are leading to compensation within the foot. For a more severe deformity, an ankle–foot orthosis with more proximal stability may be indicated [31]. Only a single study has evaluated and proven pain reduction quantitatively with custom-made orthoses. This was a randomized controlled trial of patients with juvenile chronic arthritis and pes planus [32,33•].

Rigid

Conservative management of the rigid flatfoot may be indicated in the absence of pain or with minimal symptoms. In the absence of symptoms, no treatment is necessary but the patient should be instructed to return if pain occurs. For moderate to severe symptoms, a heel-cup with arch supports may prove to be helpful. If this treatment is not helpful, a short-leg walking cast with varus correction should be employed [23].

When nonsurgical options fail, operative intervention is warranted. Once the cause for the flatfoot is established clearly, appropriate procedures are completed to ensure pain relief and deformity correction. If an accessory navicular bone or a tarsal coalition causes pain despite trials of orthotic and/or cast treatment, excision of the accessory navicular bone or the coalition is rendered to alleviate discomfort in the midfoot or hindfoot. In addition to excision, a soft tissue interposition using fat or muscle may be utilized; this depends on the size and location of the coalition. Realignment of the hindfoot by a variety of osteotomies may in select cases prove beneficial. Postoperatively, the medial longitudinal arch usually remains flat with bearing weight but the pain resolves and the arch should reconstitute with plantar flexion of the foot. Soft tissue procedures may need to be performed in addition to bony resection in order to correct fully the flatfoot deformity [31]. In the case of a painful flexible flatfoot that has not responded to nonsurgical management, the goal of treatment is to restore the alignment of the tarsal and tibiotalar joints, to correct the bony deformity, and finally to balance out

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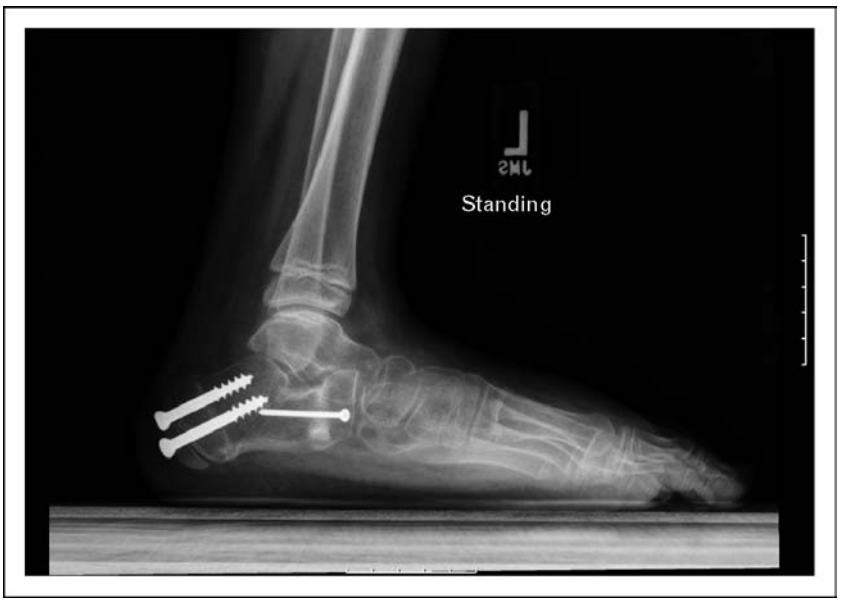
Figure 6 Hindfoot osteotomy



the muscle and tendon forces. These goals are established through corrective osteotomies, ostectomies, tendon lengthenings and/or tendon transfers [34] (Fig. 6).

When all of the above procedures fail to correct deformity or to alleviate pain, salvage procedures, such as the triple arthrodesis, may be necessary.

Conclusion

Pes planus is truly a diagnosis of common appearance with variable etiologies. Each patient must be evaluated thoroughly to determine the underlying cause of the flatfeet. Treatment plans should be individualized to the cause and reserved for the symptomatic cases or cases where family history, gait dysfunction, or other comorbidities suggest the likelihood of greater dysfunction over time.

Acknowledgements

The authors would like to thank Robert Doyle for allowing them to photograph his flatfeet and Robert O'Conor for the sketches of the foot with the accessory navicular bone seen in Fig. 3.

References and recommended reading

Papers of particular interest, published within the annual period of review, have been highlighted as:

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- •• of outstanding interest

Additional references related to this topic can also be found in the Current World Literature section in this issue (p. 133).

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