Foot and Ankle

37 Management of Idiopathic and Nonidiopathic Flatfoot
38 Posterior Tibial Tendon Dysfunction in the Adult: Current Concepts
Flatfoot deformity is common. This condition is characterized by collapse of the arch, lateral deviation of the forefoot, and uncovering of the talar head. Although most patients are asymptomatic, when pain is present and there is no response to nonsurgical treatment, surgery may be warranted. This chapter discusses the evaluation and management of idiopathic flatfoot, particularly in conjunction with a tight heel cord (equinovalgus). In addition, the differences in the pathology and treatment in peroneal spastic flatfoot and equinovalgus deformities associated with neuromuscular or connective tissue disorders are outlined.

Epidemiology
A child's foot changes with growth, with continued development of the longitudinal arch. The prevalence of flatfoot deformity in one school-based study was approximately 40% in children aged 3 to 5 years but only 6% in the teenage group. In the younger group, the proportion of children with flatfoot will decrease approximately 14% per year. Flatfoot will normalize in 40% of children over a 1-year period, whereas flatfoot will develop in 10% of children who previously had an arch. Increased weight, neuromuscular delay, and loose connective tissue are risk factors for the development of flatfoot. Children aged 3 to 6 years with delayed motor development are 1.5 times more likely to have flatfoot. In obese children with delayed motor development, the rate of flatfoot is 96%; however, the natural
history of the condition and how many children become symptomatic later in life is unknown.6

In 1947, Harris and Beath7 observed that 23% of Army recruits did not have an arch, but very few reported symptoms. Approximately 25% of adults with flatfoot also have a tight heel cord; this combination is more commonly associated with pain and symptoms.8 Less than 10% of adults with flatfoot have rigid flatfoot, and these cases are associated with symptoms approximately 20% to 24% of the time.9,10

History
In symptomatic patients, there is typically a report of a long period of pain worsened by increased activity and relieved by rest. The pain usually occurs over the medial prominent talar head and is diffuse over the arch and/or the anterolateral foot or ankle from impingement. Some shoes may be more comfortable than others. Nighttime pain is uncommon and may indicate other pathology. There is often a family history of flatfoot.

Examination
On examination, collapse of the arch can be observed. The heel is often in valgus, and midfoot valgus is associated with prominence of the talar head (Figure 1). If the arch reconstitutes when the patient is asked to stand on his or her toes, the deformity is noted to be flexible. The flexibility of the deformity and the motion of the subtalar joint also can be tested while sitting, with the examiner using his or her hand to reduce the foot from the planovalgus position. The tightness of the Achilles tendon can then be assessed but only when the subtalar joint is in a neutral position (Figure 2). This tightness of the Achilles tendon can then be assessed but only when the subtalar joint is in a neutral position (Figure 2). If the foot is not reducible and the deformity is rigid, the physician should evaluate for other pathology, including signs of tarsal coalition or other causes of spastic peroneal flatfoot.

If there is a history of pain, determination of the exact location is important. Tenderness in the calcaneonavicular space could indicate a coalition. Palpating all structures of the foot and ankle to evaluate for tenderness helps rule out other potentially incidental and unrelated causes of pain, such as severe apophysitis or recent injuries. The function and strength of posterior tibialis, peroneal, and anterior tibialis tendons are tested. An evaluation for signs of generalized ligamentous laxity may suggest a connective tissue disorder. Shoes will usually show signs of excessive lateral wear on the sole of the heel. If the foot is not reducible in young infants and toddlers without an arch, radiographs with the foot in plantar flexion should be obtained to rule out congenital vertical talus.

Imaging
Radiographs are generally not indicated for asymptomatic flatfoot. When evaluating a symptomatic patient with flatfoot, weight-bearing AP, lateral, and oblique radiographs are useful to identify the pattern and severity of the deformity, which in certain cases can help guide surgical treatment. The Meary angle can be determined by measuring the angle formed between the long axis of the talus and the first metatarsal on a lateral radiograph; if less than 0°, this indicates plantar sag and loss of the arch. The calcaneal pitch is the angle between a line parallel to the floor and the plantar aspect of the calcaneus and describes the position of the calcaneus (Figure 3, A). In patients with severe neuromuscular equinovalgus foot deformity, the lateral talocalcaneal angle also can be

**Figure 1** Clinical photographs of the AP (A) and PA (B) views of the feet of an ambulatory 7-year-old boy with cerebral palsy and planovalgus deformity. Worsening ability to ambulate was reported because of turning out of a foot.
helpful in determining treatment. A normal lateral talocalcaneal angle is 25° to 55°, whereas more than 55° indicates valgus of the hindfoot or calcaneus. An AP radiograph is used to evaluate for coverage of the talar head. The AP talus-first metatarsal angle can be helpful in quantifying valgus. If there are radiographic signs of severe adjacent joint arthritis, joint-sparing procedures are not likely to be successful. The C sign, a C-shaped line created by the talar dome and the inferior margin of the sustentaculum tali seen on a lateral foot radiograph, is specific for the presence of flatfoot; however, contrary to previous belief, it is not always present in patients with talocalcaneal coalitions. The oblique radiograph best shows a calcaneonavicular coalition (Figure 3, C), whereas CT helps delineate the extent of talocalcaneal coalitions (Figure 3, D).

Radiographic findings do not predict symptoms, but among symptomatic patients the deformity is likely to be more severe than in a cohort of asymptomatic patients. In a retrospective case control study comparing 50 patients with and without symptoms, the average talonavicular angle measured on weight-bearing AP radiographs was 25° for asymptomatic patients and 38° for symptomatic patients.
Treatment of Idiopathic Flatfoot

There is no indication for the treatment of idiopathic asymptomatic flatfoot in a child. Parents often seek care having heard that orthoses in early childhood can prevent flatfoot in adulthood. Wenger et al14 showed that the use of orthoses in childhood does not prevent flatfoot in adulthood and has no bearing on the natural history of the disorder.

Symptomatic flexible flatfoot often can be well managed with orthoses and an arch support. Often, the heel cord is tight (equinovalgus); in these cases, stretching the Achilles tendon may be sufficient to relieve symptoms. Dorsiflexion orthoses used at night can be helpful in stretching the Achilles tendon; however, if the foot is not held in a reduced subtalar position, these orthotic devices can exacerbate lateral sinus tarsi impingement and symptoms. Inverting and reducing the subtalar joint prior to dorsiflexion of the ankle allows a stretch of only the Achilles tendon, without further stress of the sinus tarsi and the talocalcaneal joint. Orthotic inserts may be helpful, but hard orthoses can exacerbate symptoms and, in these cases, soft orthoses can sometimes be useful to cushion the prominent painful talar head.

Surgical Treatment of Symptomatic Idiopathic Equinovalgus Deformity

In patients with an equinovalgus deformity and pain that is refractory to nonsurgical treatment, surgery may be beneficial.

Modified Evans Procedure

The modified Evans procedure has been well described and popularized by Mosca15-17 (Figure 4). A modified Ollier incision is made over the sinus tarsi, with care taken to prevent damage to the sural nerve and the superficial branches of the peroneal nerves. After release of the inferior extensor retinaculum off the calcaneus, the extensor digitorum brevis is elevated off the dorsum of the calcaneus. A Z-lengthening of the peroneus brevis is performed. The location of the calcaneocuboid joint capsule is noted to avoid exposure or injury to the capsule because this may predispose the patient to calcaneocuboid subluxation. The calcaneus is exposed at the interval between the anterior and middle facet and is retracted above and below with Hohmann retractors or jokers. A pin is placed retrograde through the calcaneocuboid joint to prevent subluxation. The calcaneal osteotomy can be completed using a small oscillating saw 2 cm proximal to the calcaneocuboid joint. A 0.062-inch Kirschner wire is placed on either side of the osteotomy to allow manipulation of the fragments, or the wires can be used together with a Hintermann distractor to control widening and rotation of the fragments. Alternatively, a lamina spreader can be used to lengthen the osteotomy site until the desired correction of the foot is obtained. The interval is measured, and a trapezoidal bone allograft of the desired length is placed and impacted. To allow contact between the calcaneal cortex and the allograft to maintain length and strength, care is taken not to impact the allograft too deeply. The calcaneocuboid joint pin is advanced retrograde and bent outside the skin. A gastrocnemius recession or Achilles tendon lengthening is performed, depending on which structure is tight on the Silfverskiöld test. Medially, a soft-tissue plication of the talonavicular joint capsule and the tibialis posterior tendon is performed.

If the forefoot is supinated after correcting the valgus deformity, a plantar flexion osteotomy of the medial cuneiform is performed to restore the tripod and prevent recurrence. Incisions are closed with absorbable sutures. Postoperatively, a well-padded bivalve cast or a splint is placed to allow for swelling. Eight weeks in a non-weight-bearing short leg cast helps protect healing. The calcaneocuboid pin is removed in the office at 6 weeks during a cast change.

Phillips18 reported that 17 of 20 patients had good or better than good results in a study with an average 13-year follow-up. In 1995, Mosca15 reported satisfactory clinical results in 29 of 31 feet treated with the modified Evans procedure for symptomatic severe valgus deformity of the hindfoot. Although 26 patients in this series had an underlying neuromuscular disorder and only 1 patient had symptomatic severe idiopathic flatfoot, this procedure has been popularized and is the most commonly used osteotomy to address symptomatic idiopathic deformities.

Calcaneo-Cuboid-Cuneiform Osteotomy

A calcaneo-cuboid-cuneiform osteotomy entails a sliding calcaneal osteotomy, an opening wedge cuboid osteotomy, and a plantar flexion closing wedge cuneiform osteotomy to address supination (Figure 5). If indicated, lengthening of the Achilles tendon and/or peroneus brevis is performed. The calcaneus is approached laterally, with protection of the sural nerve, and cut with a saw or an osteotome. A narrow bridge is left medially; the cut is then carefully completed with an osteotome or a Kerrison rongeur under
direct vision. The medial soft tissue is freed to allow mobilization of the tuberosity fragment. If needed, removing a wedge of bone medially allows for a closing wedge osteotomy. Through the distal part of this incision, the cuboid opening osteotomy can be performed and the wedge inserted. A medial incision centered over the cuneiform is made. A plantar closing wedge cuneiform osteotomy allows correction of residual supination and re-creates the arch. If needed, a medial ree fing of the talonavicular joint can be performed through the same incision.19

Moraleda et al20 compared lateral calcaneal lengthening with the calcaneocuboid-cuneiform osteotomy in patients with idiopathic equinovalgus. The authors found that both techniques were effective and comparable with regard to clinical and radiographic results. Although the lateral calcaneal lengthening group had slightly better talar head coverage by the navicular on the AP radiograph, complications were also somewhat more frequent and more severe.

Arthroereisis
Arthroereisis involves placing a silicone or metal plug within the sinus tarsi to limit valgus of the subtalar joint. The rationale is that correcting subtalar valgus with a simple and quick procedure allows quick return to weight bearing.

The podiatric literature has many reports of outcomes of subtalar arthroereisis;21 however, indications for the procedure are often unclear in the data presented because the study populations often also include patients with painless pes planus deformities. Concerns among pediatric orthopaedic surgeons include foreign body reaction, synovitis, the effect on a child’s normal cartilaginous surface, a 30% rate of sinus tarsi pain, and the potential need for a repeat procedure to remove the insert.21,22 Researchers from the Rizzoli Institute reported on their experience using a bioabsorbable implant when performing an extra-articular arthroereisis in 22 children (aged, 8 to 15 years) with functional flatfoot. Eighty-one percent of the patients reported discomfort before the procedure, and 5% had discomfort after the procedure.23 There may be specific indications for this procedure to treat idiopathic and nonidiopathic equinovalgus in children and adolescents under specific circumstances; however, these indications have not yet been fully delineated.

Nonidiopathic Pes Planus
In patients with cerebral palsy and spina bifida, the underlying pathology of the equinovalgus deformity is a neuromuscular imbalance. In patients with tarsal
coalitions, there is a structural problem. In other conditions, such as osteogenesis imperfecta and Down, Marfan, and Ehlers-Danlos syndromes, collagen defects are sometimes combined with hypotonia, and treatment principles must address the bony column to optimize success. These conditions may result in a more severe valgus foot deformity, with a higher rate of complications if the initial pathology is not considered carefully when deciding on a surgical plan.

Whenever possible, this chapter’s authors aim to correct a symptomatic foot deformity without fusion to prevent adjacent joint arthritis, which has been reported to be as high as 40% in long-term studies. Fusions may be necessary to maintain correction in some patients with severe neuro-muscular deformity; however, many patients do well with osteotomies or partial fusions. Although the literature has no clear answers as to when deformity correction is sufficient and exactly when a fusion is needed, the following sections may provide help in discerning the indications for various treatment options. Situations in which fusions may result in poor outcomes, such as spina bifida and collagen disorders, are highlighted.

**Tarsal Coalition**

A rigid flatfoot deformity in a child or adolescent may be associated with tarsal

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**Figure 5** Illustrations showing lateral (A through D and G) and medial (E and F) views of a calcaneal-cuboid-cuneiform osteotomy. This triple osteotomy can be used to correct a severe valgus foot deformity. A, The location of the planned calcaneal osteotomy is shown. The sural nerve and peroneal tendons are retracted superiorly. B, A Kerrison rongeur is used to complete the medial cortical osteotomy. C, The tuberosity fragment is mobilized using a Chandler retractor, which is placed medially to displace the calcaneus laterally. This allows easier removal of the medial wedge. D, The cuboid opening-wedge osteotomy is performed with the peroneal tendons retracted inferiorly. E, Location of the closing-wedge osteotomy of the medial cuneiform. Removal of approximately the middle third of the cuneiform is accomplished. F, Plantar flexion and pronation of the forefoot are accomplished with a closing-wedge osteotomy of the medial cuneiform, which reconstructs the longitudinal arch. G, The opening-wedge graft is inserted from the cuneiform into the cuboid.
coalitions, and the patient usually has pain in the area of the coalition. Radiographs may be helpful in identifying a coalition, and CT can help delineate the extent of the bony coalition, which will help guide treatment. MRI may be helpful in fibrous coalitions. Surgery is indicated if the coalition is symptomatic and nonsurgical treatment has been unsuccessful. If the tarsal coalition can be excised and good subtalar motion obtained, treatment can proceed as would be indicated for an idiopathic flatfoot. If the deformity is unlikely to be symptomatic, a simple excision is indicated. If symptoms arise, deformity correction can be addressed at a later time. In a retrospective review of 49 feet, Gantsoudes et al,28 reported that 34% of the feet treated with coalition excision later needed an osteotomy to correct foot alignment. In severe cases, in which there is marked deformity (hindfoot valgus more than 16°), pain from the deformity under the talar head or in the sinus tarsi area, and symptoms from the deformity that are expected to continue after resection, combining the resection with deformity correction should be considered.27 Mosca and Bevan27 recently advocated a release of the talonavicular joint to loosen foot stiffness when performing a modified Evans procedure in addition to coalition resection. If joint stiffness remains in the subtalar, talonavicular, or calcaneocuboid joint after resection of the talar coalition, a sliding calcaneal osteotomy, medial closing wedge osteotomy, cuboid opening wedge osteotomy, and cuneiform closing wedge osteotomy can help address the deformity without necessitating a fusion.19 Subtalar or triple arthrodesis are salvage procedures and are indicated only as a last resort in patients with an extensive coalition or with arthritis of the subtalar or Chopart joint.28-31

Equinovalgus Foot Deformities in Patients With Cerebral Palsy

The indications for reconstruction of a valgus deformity in a child with cerebral palsy include an unbraceable foot, skin breakdown, or severe lever arm disease affecting gait. Khadim and Miller32 showed that correcting the equinovalgus foot deformity alone in ambulatory patients with cerebral palsy and a crouched gait could partially correct the gait abnormality. In their series, the extent of improvement in knee extension was directly related to the decrease in ankle dorsiflexion afforded by the deformity correction.

A thorough preoperative evaluation of both radiographs and muscle spasticity is important before choosing surgical treatment options for a severe pes valgus deformity in a patient with cerebral palsy. When poor outcomes are observed in medium- and long-term studies, they usually are the result of recurrence, undertreatment, or overcorrection.18,33 When deciding on a treatment plan for a patient with cerebral palsy and a symptomatic flatfoot deformity, it is important to differentiate spasticity from dystonia or hypotonia. When spasticity is not a clinical issue, the deformity can be treated as an idiopathic deformity. When spasticity is present, treating the deformity itself is the key to successful treatment because botulinum toxin injections and isolated lengthening of the peroneals or the gastrocnemius does not provide long-term relief.

When there is no notable arthritis, osteotomies to correct the deformity can be effective. Andreacchio et al34 recommended using lateral-column lengthening in ambulatory children with cerebral palsy when the deformity was mild to moderate and a subtalar fusion for more severe cases. Their data also illustrated the importance of correcting forefoot supination to prevent recurrence. Yoo et al11 further delineated the indications for lateral column lengthening in children with cerebral palsy, using radiographic indicators. They showed a 75% rate of satisfactory outcomes after performing calcaneal lengthening on 92 feet in 56 children with cerebral palsy. Based on their results, lateral column lengthening was recommended only if the preoperative talocalcaneal angle is less than 35°, the talo-first metatarsal angle is less than 25°, and the calcaneal pitch is more than 5° on a standing lateral radiograph.11,35 When there is concomitant tibialis posterior spasticity, overcorrection is a risk. Yoo et al11 reported a 7% incidence of postoperative hindfoot varus deformity, which was often associated with increased spasticity of the posterior tibialis tendon.

The triple C osteotomy described by Rathjen and Mubarak19 also can be effective in correcting deformity and relieving symptoms in patients with cerebral palsy and symptomatic pes valgus. Kim et al36 compared the outcomes of lateral opening wedge osteotomy with the calcaneo-cuboid-cuneiform osteotomy in 60 feet undergoing correction for symptomatic planovalgus feet. Twenty-five percent of the cases reviewed were idiopathic, and the remainder were neuromuscular in origin. No difference was found for mild to moderate deformities; however, with severe deformities, the correction was slightly better after a triple C osteotomy.
Foot and Ankle

Amputation status should influence the choice of procedure. Approximately 80% of the ambulatory patients with cerebral palsy had satisfactory results with lateral column lengthening compared with approximately 50% satisfactory results in the nonambulatory patients. Arthrodesis is likely a better option in a nonambulatory patient with severe deformity and spasticity.13,37,38 Adjacent joint arthritis has been reported after triple arthrodesis but is less likely to be an issue among nonambulatory patients in whom the most concerning complication is recurrence. An extra-articular arthrodesis can be beneficial in nonambulatory children with cerebral palsy who are younger than 10 years and have growth remaining.39,40

**Extra-articular Arthrodesis: Grice and Dennyson-Fulford Techniques**

Extra-articular arthrodesis was first described by Grice41 in 1952 as a procedure for patients with polio, but it also can be a treatment option in young, ambulatory patients with cerebral palsy (Figure 6). In this procedure, a lateral incision is made in the sinus tarsi and, after exposure, a narrow osteotome is used to prepare the location and bed for the bone graft within the inferior portion of the neck of the talus and the dorsal surface of the calcaneus. A tricortical bone graft is taken from the iliac crest, fibula, or tibia, and is shaped appropriately to fit in the narrow groove and formatted to allow the desired correction of the deformity. After closure, a short leg cast or splint is applied and should remain in place until union, which may take 10 to 12 weeks.41,42

The Dennyson-Fulford technique of arthrodesis is a modification of the Grice technique and is aimed at obtaining a more stable graft position, which decreases the risk of nonunion. In this technique, cancellous bone instead of a cortical graft is used, and internal fixation stabilizes the deformity correction. After exposure of the sinus tarsi, the area is prepared by removing the cortical bone from the undersurface of the talar neck and the dorsal surface of the calcaneus. An area is exposed on the dorsal surface of the talar neck, between the extensor digitorum longus and the neurovascular bundle, to prepare for a 4.5-mm talocalcaneal screw. Cancellous bone from allograft or the iliac crest is then packed into the sinus tarsi. After closure, a splint is placed and a cast is worn until full union is achieved, usually at 6 to 8 weeks. Some physicians allow weight bearing at 3 weeks.43

Shore et al40 reported functional improvement across all patients in a retrospective review of 46 children treated with a modified Dennyson-Fulford technique that incorporated extra-articular subtalar arthrodesis with internal fixation. Yoon et al44 reported reliable correction of hindfoot valgus but less consistent improvement in supination or calcaneal pitch when using extra-articular subtalar arthrodesis to treat valgus deformity in ambulatory patients with spastic diplegia. Dogan et al45 compared lateral-column lengthening and Dennyson-Fulford extra-articular arthrodesis and found comparable results in a group of patients with equinovalgus of mixed etiology. The exception was the most advanced cases, where the Dennyson-Fulford technique resulted in slightly better deformity correction than lateral column lengthening. Although many authors have reported successful results with extra-articular arthrodesis, others caution that these results are not universally reproducible, and failure can occur in as high as two-thirds of cases.19,47-49

**Arthroereisis in Neuromuscular Disorders**

The use of arthroereisis also has been reported in patients with neuromuscular disorders. In 1990, Crawford et al40 described 85% good to excellent radiographic results using subtalar staple arthroereisis. Vedantam et al41 reported 96% satisfactory results in 1,135 patients using a silicone plug. However, revision surgery was required in approximately 50% of the feet (16 of 34) treated with staple arthroereisis when used to address severe flexible planovalgus deformity in patients with neuromuscular conditions.52 Although arthroereisis is simple and has less immediate postoperative morbidity, lateral column lengthening is often preferred because it is not associated with foreign-body complications and has the same rate of recurrence.19,33-35
Talonavicular Fusion
Talonavicular fusion is a useful addition to an osteotomy if joint pain is present or in hyper lax, severe equinovalgus foot deformities in patients with neuromuscular disorders. In a cadaver study, Astion et al \(^5\) evaluated the effect of fusion of the subtalar, calcaneocuboid, or talonavicular joint on motion of the foot. A fusion of the subtalar joint resulted in 26% of the motion of the talonavicular joint and 56% of the motion of the calcaneocuboid joint. A simulated calcaneocuboid joint arthrodesis resulted in 67% of the motion of the talonavicular joint. Any combination of fusions that included the talonavicular joint limited motion of the other joints to approximately 2°. To prevent under-correction or recurrence of deformity, Huang et al \(^5\) recommended adding a talonavicular fusion to the Evans procedure when treating severe symptomatic valgus deformities in patients with cerebral palsy. Although this fusion eliminates most subtalar motion, it can be argued that subtalar motion was limited preoperatively because of the severity of the deformity and spasticity.

Triple Arthrodesis
Triple arthrodesis, a fusion of the subtalar, talonavicular, and calcaneocuboid joints, is indicated only for severe, rigid, spastic valgus foot deformities or cases where marked arthritis has been noted. In this procedure, wedges of the joints are resected, allowing correction of the deformity, and are fixed with staples or screws (Figure 7). Soft tissues are balanced as needed. Postoperatively, the patient is placed in a non-weight-bearing cast, followed by a walking cast, and later an orthosis until the fusion is secure.\(^4\)

Complications include malalignment from undercorrection of deformity, nonunion of the talonavicular fusion, and later adjacent joint arthritis. Long-term follow-up has shown up to a 40% incidence of adjacent joint arthritis, including the ankle joint.\(^2\),\(^2\),\(^3\),\(^8\),\(^9\)

Additional Deformity Evaluation and Correction
Concomitant deformities should be noted and addressed to optimize outcomes. When examining valgus of the foot and the subtalar joint, it is important to ensure (through a weight-bearing AP radiograph of the ankle) that there is no distal tibial valgus masking as subtalar valgus. In a skeletally immature patient, ankle valgus may be corrected with guided growth. It is important to correct rotational malalignment, particularly external tibial torsion, at the time of equinovalgus foot deformity correction. In patients with cerebral palsy, a concomitant dorsal bunion (dorsiflexion of the first metatarsal) may require correction.

Myelomeningocele
Ankle and foot valgus is common in ambulatory patients with spina bifida.\(^5\) Indications for corrections usually include a poor lever arm or skin breakdown. It is important to determine the extent of the deformity that is arising from the ankle or the subtalar joint and if there is associated external tibial rotation.
Sharrard and Grosfield\(^6\) highlighted the advantage of soft-tissue correction in children with spina bifida compared with other neuromuscular etiologies because paralyzed tendons could be divided without undue concern. They noted that additional soft-tissue releases often provided more correction than originally expected, and procedures performed earlier in life had the best outcomes. They also reported a 4% incidence of cast sores after surgery, which were all attributed to overenthusiasm in obtaining postoperative correction.

Extra-articular arthrodesis was designed to allow early deformity correction in young patients who have substantial remaining growth. Hoiness and Kirkhus\(^5\) reported good long-term deformity correction and function after extra-articular subtalar arthrodesis in 35 feet in 25 young ambulatory children with spina bifida. Torosian and Dias\(^6\) showed good results using a medial sliding osteotomy in 27 patients with myelomeningocele.

Caution is advised against the use of foot arthrodesis in patients with spina bifida because heel ulcers can result from the insensate foot.\(^5,6,63,64\) Additional procedures addressing related deformities are often necessary, in particular tibial derotation osteotomies, Achilles tendon lengthening, and anterior tibialis tendon transfers. Concomitant ankle valgus can be addressed with guided growth or, in very young patients, an Achilles tendon–fibular arthrodesis.\(^6\)

### Correction of Flatfoot Associated With Collagen Disorders

The most difficult group of patients to treat with joint-preservation surgery are patients with hyperlaxity and associated syndromes, such as Down or Marfan syndromes, and osteogenesis imperfecta. The incidence and rate of symptoms vary depending on etiology. In a study by Berglund et al.,\(^66\) 55% of the patients with Ehlers-Danlos syndrome reported having flatfoot and a median pain level of 5 of 10 compared with 0 of 10 in control patients. In contrast, Lindsey et al.\(^67\) recently showed that the incidence of flatfoot in patients with Marfan syndrome is similar to the general population.

As with idiopathic flatfoot, surgical treatment should be indicated only if symptomatic and when nonsurgical treatment has failed. If surgery is indicated, soft-tissue procedures are of limited or no benefit and should never be considered in isolation. Although there are no simple answers regarding the best procedure in these cases, it is important to aim for restoring the bony column and obtaining optimal deformity correction. Careful attention to soft-tissue complications, such as poor healing, also is important. A modified Evans procedure may fail, but some surgeons are adding an arthroereisis to this procedure to prevent recurrence. Additional follow-up studies will determine if this is an effective method.

### Summary

Idiopathic flatfoot causes symptoms in most patients. If pain is present, addressing heel cord tightness nonsurgically and using supportive soft orthotics may relieve symptoms. When nonsurgical treatment fails to relieve pain, a modified Evans procedure can address the deformity. Careful attention to indications and technique and the proper selection of deformities to treat can help optimize outcomes. Arthroereisis is gaining popularity, particularly in podiatry practices, but evidence to clearly delineate indications and outcomes is pending.

In patients with nonidiopathic planovalgus, such as tarsal coalitions, neuromuscular deformities, or collagen disorders, careful attention to the specific pathology will help the surgeon choose the optimal procedure. Surgical options include a modified Evans procedure, triple C osteotomy, extra-articular arthrodesis, talonavicular arthrodesis, subtalar arthrodesis, and triple arthrodesis.

### References


