CHAPTER **14**

PEDIATRIC PERITALAR SUBLUXATION

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Surgical treatment of pediatric peritalar subluxation is an area of controversy, largely because terminology and diagnostic criteria have not been standardized. Although the place for surgical treatment of the rigid flatfoot is clear, surgical treatment of the unstable flatfoot still requires much greater scientific explanation and foundation before we can apply the same types of exacting standards.

DEFINITION

In discussing pediatric flatfoot, the term peritalar subluxation is used to indicate the true pathology. Sigvard T. Hansen, MD (Seattle, Washington) has used similar terminology in describing the adult flatfoot.[1] The author believes that there is some merit to using this type of terminology, as opposed to using the word flatfoot, which simply connotes a foot with a low arch. Some of the structural considerations seen in the pediatric flatfoot include talonavicular subluxation, equinus, calcaneal eversion, talocalcaneal divergence, and a lack of ligamentous integrity. (Fig. 1) Functionally what we see is the lack of effective brakes on pronation with no re-supination. The prolonged pronation is associated with midtarsal joint breech and instability, resulting in a medial shift of the force of weightbearing.

The concept of planal dominance has been useful as part of the mechanical explanation for how compensation occurs in peritalar subluxation. This concept is based upon the true axis of the subtalar joint and midtarsal joint and defines the dominant plane of compensation for the excessive pronation seen in flexible flatfoot. This concept was described by Dr. Martin Pressman at the Pennsylvania College of Podiatric Medicine and illustrated by Donald Green, DPM and Adelle Carol, DPM.[2]

Compensation occurs perpendicular to the axis of motion. Therefore, for example, a foot with a more vertical subtalar axis is expected to compensate in the transverse plane. A more transverse axis may result in more sagittal plane compensation. This hypothesis clearly explains some aspects of peritalar subluxation.(Fig. 2) It may require greater evidence in order to be useful on a more practical level. In addition, the use of this terminology has occasionally led to incorrect assumptions. An example is the description of the Evans procedure as being primarily used for patients who have transverse plane deformity. Although the correction is quite significant in the transverse plane, it is often quite significant in the sagittal plane as well.

Chronic peritalar subluxation may create adaptation of the talar head, similar to what occurs in adolescent hallux valgus with the development of a high proximal articular set angle. Distal unlocking can cause hallux abducto valgus and other pathology. There are proximal effects creating valgus stress on the

Figure 1A. Fourteen-year-old boy with painful flatfoot both feet, much worse on the left. Clinical photo of patient in stance.

Figure 1B. Bilateral AP radiographs. Left side shows C-N bar and adapted talar head.

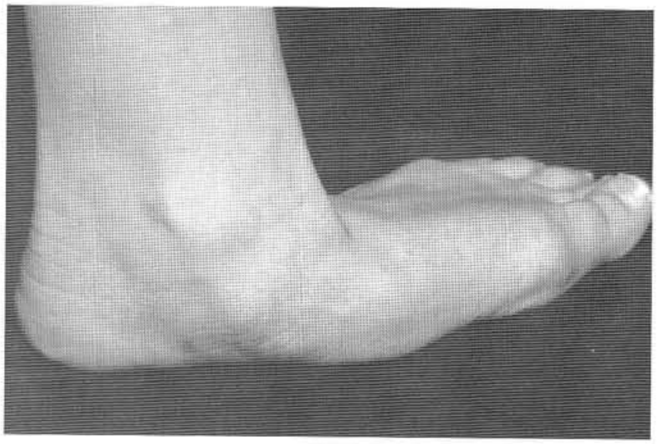

Figure 2A. Fourteen-year-old girl with painful unilateral left flatfoot. This medial clinical photo shows extreme talar adduction and midfoot collapse. Compensation demonstrates both transverse and sagittal plane dominance as confirmed by weight-bearing x-rays.

Figure 2B. Bilateral AP radiographs show talocalcaneal divergence, tarsal-metatarsal abduction and second metatarsal hypertrophy in the left foot.

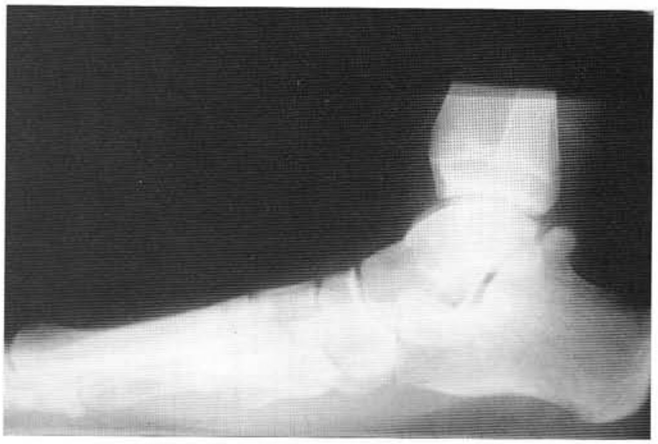

Figure 2C. Lateral radiograph shows navicular cuneiform sag.

Figure 3. AP radiograph showing adaptation of the talar head in an adolescent flatfoot.

knee, while ligamentous structural integrity in the foot becomes deformed, possibly creating additional secondary equinus. Finally, an unstable foot frequently causes pain. The key word in discussing pathology associated with peritalar subluxation is instability.

MYTHS

Unfortunately there are a number of myths that have surrounded treatment of pediatric peritalar subluxation. These include:

1. The child will out-grow the deformity.
2. Even if one assumes that the child will not out grow the deformity; it is better to wait until growth is completed before performing correction.
3. "Growing pains" cause the foot pain associated with peritalar subluxation.
4. Flatfoot is normal.
5. Shoes and orthotics have a long-term effect on the unstable foot.

Clearly these are myths against treating this deformity. This is a deformity that consists of major joint instability. There are very significant proximal joint effects, distal joint effects, and long-term development of degenerative joint disease when it is left untreated.(Fig. 3)

INDICATIONS FOR SURGERY

Indications for surgery in peritalar subluxation include pain not responsive to orthotics or other types of therapy. This includes arch pain, sinus tarsi pain or muscle cramps in the foot or leg. Other indications include an uncontrollable unstable foot, even in the absence of identifiable pain and severe equinus or other uncontrollable deformity in a stable foot that may progress to further deformity.

In surgical treatment of peritalar subluxation, goals include realignment of the talonavicular joint, stabilization of the subtalar joint and the tarsal joints, removal of deforming forces such as equinus, elimination of pain, improvement of foot function, and prevention of progression of deformity.

PROCEDURE CHOICES

Historically, a number of procedures have been described for the treatment of the foot with peritalar subluxation. In the author's practice, this large list of procedures has been refined to include the Evans calcaneal osteotomy (displacement lengthening of the lateral column), the Koutsogiannis medial translational osteotomy, medial arch tendo suspension, arthroereisis, Cotton osteotomy, talar neck osteotomy, Lapidus and Hoke fusions, and peroneus brevis transfer to the talar neck.

THE EVANS OSTEOTOMY

The most powerful procedure for realignment is the Evans calcaneal osteotomy. This procedure consists of an osteotomy one centimeter proximal to the calcaneal cuboid joint with the placement of a truncated wedge of allogeneic iliac crest bone for lengthening of the lateral column. In the adolescent, the graft is usually 8 to 10 millimeters at its widest, truncated down to 6 or 7 millimeters. The procedure accomplishes realignment of the talonavicular joint, stabilization of the lateral column, reduction in pronation range of motion, and stabilization of the subtalar joint and the midtarsal joints. In contrast to arthroereisis procedures, no artificial material is left in the patient. The procedure has some significant incapacitation associated with it, including casting for 8 to 10 weeks.

The structural changes after the Evans are pronounced. Radiographs show decreased cuboid abduction angle, a decrease in talocalcaneal divergence, reduction in the uncovering of the talar head, increase in the calcaneal inclination angle and decrease in the talar declination angle. There is plantarflexion of the forefoot on the rearfoot, particularly in the lateral column. The apparent equinus is increased due to the production of a forefoot equinus. Peroneus longus becomes more effective because the lateral column is more stable. 3D MRI sequential motion studies performed at the Temple University School of Podiatric Medicine and the University of Pennsylvania by Dr. Bruce Hirsch demonstrated significant reduction in frontal plane motion at the calcaneal cuboid joint after the Evans calcaneal osteotomy. The author believes the Evans is effective for treatment of peritalar subluxation. It may one day become the gold standard for the surgical treatment of pediatric peritalar subluxation.[3] (Fig. 4)

In a study of the functional effects of the calcaneal osteotomy performed at the Temple University School of Podiatric Medicine, with partial funding from the American Podiatric Medical Association and the American College of Foot and Ankle Surgeons, Mahan, Hillstrom, and Bhimji demonstrated statistically significant changes in static pronation as measured by the malleolar valgus index. There resulted an increased center of pressure excursion index indicating improved dynamic function and improvement in the malleolar torsion.[4] This is one of the few if not the only study documenting positive functional changes following surgical treatment of flatfoot.

EVANS OSTEOTOMY TECHNICAL CONSIDERATIONS

The Evans osteotomy is performed through an oblique incision along the relaxed skin tension lines and centered over the lateral aspect of the calcaneus. The sural nerve and the peroneal tendons are retracted inferiorly. The osteotomy is performed 1 centimeter proximal to the calcaneal cuboid joint. This lengthening graft is shaped in a truncated wedge format using tricortical iliac crest allogeneic bone. A second piece of graft is used to fill in the remaining defect. Fixation is not usually necessary, provided that the ligaments of the calcaneal cuboid joint have not been destabilized. In terms of sequence, dissection for the Evans calcaneal osteotomy is performed first. A lamina spreader is inserted in the osteotomy to make the determination of the required graft size. At this time the effect of that lengthening on the equinus and the stability of the column is analyzed. A tendo Achillis lengthening and medial arch suspension may be performed at that time. Lastly, the graft is placed in position.

Some concerns with the Evans calcaneal osteotomy may include use of allogeneic bone, incomplete healing, and proximity to the middle

Figure 4A. Thirteen-year-old boy with painful collapsing flatfoot. Lateral radiograph showing negative calcaneal inclination angle due to severe equinus.

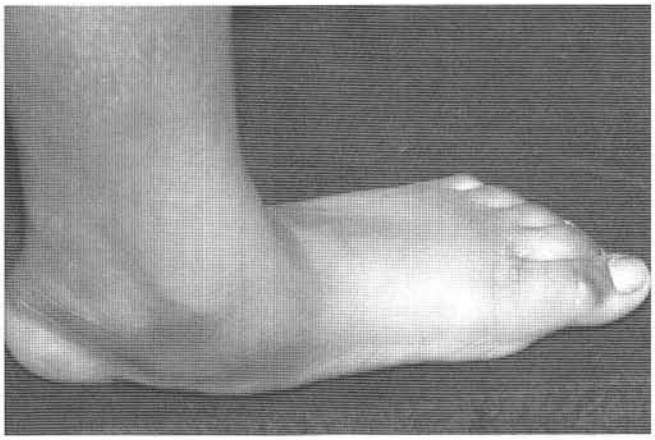

Figure 4B. Medial clinical photo showing talar adduction and plantarflexion.

Figure 4C. Lateral radiograph six months postoperative after talar neck osteotomy Evans, Cotton, TAL, and Medial Arch Suspension.

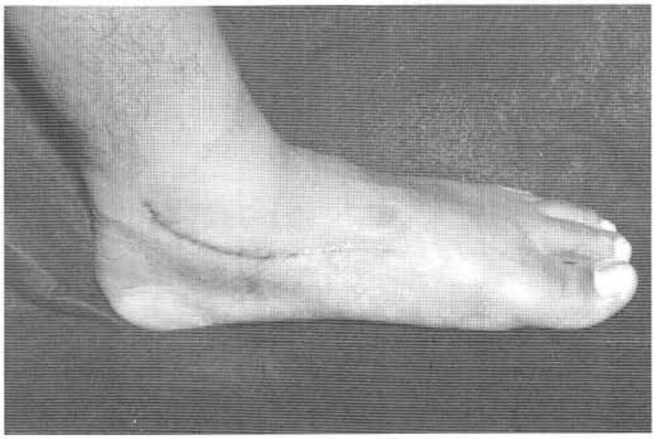

Figure 4D. Medial postoperative view showing restoration of alignment.

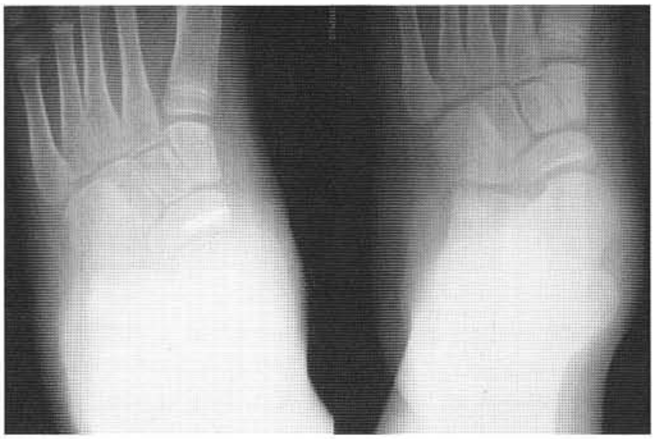

Figure 4E. AP radiographs postoperative and preoperative.

facet and the sural nerve, possible inflammation of the peroneal tendons and the creation of anterior equinus. Finally it should be noted that very severe transverse plane talocalcaneal divergence may not be fully corrected by the Evans calcaneal osteotomy.

Certain precautions should be observed in order to reduce the chances of problems following this procedure. These precautions include avoiding the intermediate dorsal cutaneous nerve at the superior margin of the incision and the sural nerve on the inferior margin. The middle facet of the subtalar joint can be avoided by identifying its position with a Freer elevator prior to performing the osteotomy. Violation of the calcaneal cuboid joint should also be avoided both in terms of disrupting the soft tissues and also in terms of placing the osteotomy. If the osteotomy is angled anteriorly it may actually enter into the anteromedial aspect of the calcaneal cuboid joint.

In sequence, the skin incision is mapped out by locating the calcaneal cuboid joint, the peroneal tendons, and the relaxed skin tension lines. The incision is deepened through superficial fascia and the extensor digitorum brevis muscle belly is retracted superiorly. The peroneal tendons and the sural nerve are retracted inferiorly. A Freer elevator can be used to feel for the location of the middle facet. Initially a power saw is used to osteotomize the calcaneus in a lateral to medial direction. An osteotome is then used to ensure that the cut is complete, prior to use of the lamina spreader. The lamina spreader, with the teeth ground smooth, is then inserted in the osteotomy and opened. Once the desired amount of correction has been obtained, a measurement is taken and the graft is cut to appropriate size. When it is time to place the graft in position, it is important not to countersink the graft past the cortex in order to avoid the graft sinking into the calcaneus. Intraoperative x-rays may be helpful in confirming proper location of the graft.

TALAR NECK PASA

In the very severe foot with peritalar subluxation, adaptation of the talar head articular cartilage may occur. This most likely results from long-term subluxation, although anatomical deformity within the talus itself of a congenital origin can not be excluded. The deformity is uncommon, but clearly important. Failure to correct this malalignment can result in treatment failure since the navicular will not be able to seat on the talar head. The osteotomy is performed proximal to the articular cartilage and stabilized with 2 or 3, 2.4 mm bone pins. In this area, circulation to the talus is quite good. Nonetheless, the effect of additional procedures in the area of the blood supply should give caution to the wide-spread use of the talar neck osteotomy. The procedure has been previously described by Dr. Nicholas Grumbine as a component of flatfoot reconstruction.[5] Another element of this osteotomy is relocation of the talonavicular joint. The spring ligament can also be fully stabilized following this procedure. This adaptation may occur not just in the transverse plane but also in the sagittal plane.

MEDIAL COLUMN PROCEDURES

Medial column procedures can be divided into soft tissue and structural procedures. Structural procedures include the Cotton osteotomy of the medial cuneiform bone, the first metatarsaocuneiform joint fusion, naviculocuneiform joint fusion, and talar osteotomy. Soft tissue procedures include advancement of tibialis posterior, Young's tendosuspension if the navicular is large enough, spring ligament tightening, and peroneal transfers, such as peroneus brevis to longus and peroneus brevis to the talar neck.

The combination of procedures known as the medial arch tendo suspension is extremely functional. The procedure as introduced by McGlamry combined the effects of the Young's tendo suspension, advancement of tibialis posterior and occasionally use of all or a portion of flexor digitorum longus. Dr. John Ruch further refined the procedure along with other surgeons from The Podiatry Institute.[6] Important observations regarding this combination of procedures include the following:

1. A new plantar navicular cuneiform ligament is produced to address navicular cuneiform instability. This new ligament holds up over time.
2. The procedure removes tibialis anterior as an antagonist to the peroneus longus.
3. Advancing tibialis posterior increases its mechanical effect.
4. Stability actually increases over approximately eighteen months.

The tendo suspension does not "stretch out" after transfer anymore than use of a tendon for lateral ankle ligament secondary repairs results in stretching.

The medial arch suspension procedure begins with a medial incision extending from the inferior medial malleolus to the base of the first metatarsal. The medial marginal vein is retracted dorsally. The fascia over the tibialis interior is incised to expose tendon and then mobilize it. The incision is extended over the tibialis posterior tendon, which is retracted down with

the abductor hallucis muscle belly. The spring ligament is then incised exposing the talar head cartilage and allowing later tightening of the spring ligament. A medium-sized trephine plug is placed through the navicular, angled slightly dorsal-distal to plantar-proximal, being careful not to engage either of the adjoining joints. A power saw is used to cut out the slot in the navicular. The tibialis anterior is then longitudinally split and a portion is preserved and tagged for later use as a reinforcing medial ligament. The main body of the tibialis anterior is then suspended through the navicular with the insertion of tibialis anterior still intact in order to create significant tightening. As an alternative to the medial navicular slot, a Mitek bone anchor may or may not be necessary or used for holding the tendon position.

A Cotton osteotomy may also be performed. Exposure of the medial cuneiform is performed and a saw is used to cut through the first cuneiform dorsal to plantar with a slight plantar hinge left intact. An osteotome is used to pry the site open and once the desired correction is achieved then the amount of bone graft necessary to fill the osteotomy can be measured. An allogenic graft is then placed into position in order to hold the site open. The tibialis posterior is incised beneath the navicular and advanced. The remaining portion of the tibialis anterior is sutured back into the spring or deltoid ligament for reinforcement.

ARTHROEREISIS

Arthroereisis procedures about the subtalar joint have a long history involving osteotomy approaches as well as a variety of artificial materials to limit joint motion. Currently, the MBA implant arthroereisis procedure seems to be most commonly performed. It appears to be a "simple" procedure but should be viewed with some caution. Clearly it has significant effects in decreasing subtalar joint motion. Extensive dissection is not necessary in the sinus tarsi; however the size of the implant itself may cause disruption of the vascular supply in the area. The postoperative course is relatively short. A foreign body is retained and there is no long-term guidance as to when or if the device should be removed. The author believes it is advisable to consider removal of these devices at some point in time, especially from children. More definitive studies are necessary in order to define the criteria for this. The development of tibialis anterior spasm may occur with over-correction following this procedure. The author finds this procedure most useful in a smaller child whose bone maturity is not adequate for osseous surgical reconstruction.(Fig. 5)

EQUINUS RELEASE

In terms of equinus release, this can be performed with either a tendo Achillis lengthening (TAL) or gastrocnemius recession. A TAL can be performed either as an open procedure or by a percutaneous approach. The procedure can be performed with the patient supine with the leg externally rotated. There is a greater tendency to over-lengthen with the use of a TAL rather than a simple gastrocnemius recession. There is also prolonged recovery even in adolescents. Gastrocnemius recession is more selective with less power loss. However, it must be done prone which causes more operating time and more manipulation of the patient. Recovery time is clearly quicker with the gastrocnemius recession than it is with the TAL.

It is also important to avoid the sural nerve. In children, the common sural nerve appears to exit the

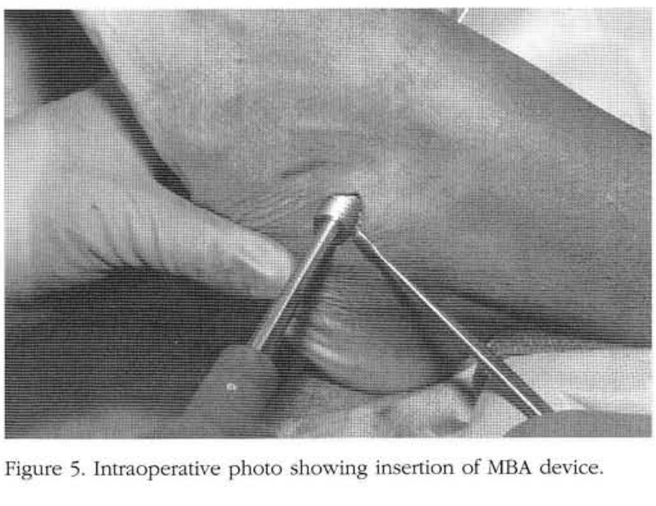

Figure 5. Intraoperative photo showing insertion of MBA device.

deep fascia more medially than in an adult. Therefore the incision needs to be medial to the midline in order to avoid disruption to the sural nerve.

COMPARING PEDIATRIC VS ADULT PERITALAR SUBLUXATION REPAIR

Repair of this deformity differs quite a bit in the child or adolescent patient versus adults. In children, fusion procedures are uncommon and are not desirable. Although occasionally a navicular cuneiform fusion or first metatarsocuneiform fusion may be necessary, these procedures should be viewed as undesirable in a child with consequential later effects on adjacent joints. The Evans procedure is joint-sparing and creates great stability in the pediatric patient where large grafts seem to be well-tolerated. The medial arch tendosuspension is very effective in these patients, particularly when combined with the Evans osteotomy. There appears to be less deformity in the small and medial column joints in these patients. In adult patients, stabilization fusions are more often necessary ranging from the Lapidus fusion to the subtalar fusion. Adult patients cannot seem to tolerate larger Evans grafts or arthroereisis devices on a long-term basis. Adult patients can also have more proximal changes and more degenerative joint disease.

COMPLICATIONS

Complications associated with this repair include inadequate correction, non-union or delayed bone healing, scarring, nerve entrapment, and posterior weakness. Despite this, the revisional surgery rate in children with peritalar subluxation is very low. Standardized terminology, classification, and functional measurements are badly needed in order to advance the study of this deformity. Pediatric peritalar subluxation is clearly a real entity. Although uncommon, it has significant effects on foot and leg function. It is clear that functional improvement occurs with the Evans calcaneal osteotomy. This type of surgery should be considered to be still in the evolutionary stage even though substantial advancements have occurred. Structural correction can usually be achieved in these children without the need to resort to fusion types of procedures.

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