CHAPTER **59**

THE COTTON OSTEOTOMY IN CONJUNCTION WITH MAXWELL BRANCHEAU ARTHROEREISIS FOR CORRECTION OF PEDIATRIC FLEXIBLE FLATFOOT DEFORMITY

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CLINICAL FINDINGS

The most important factor in determining the appropriate treatment for flexible flatfoot deformity is the understanding of the primary plane of deformity and compensation. Knowledge of planal dominance of the three major joint axes is essential. Clinically, a relatively normal appearing foot and medial arch is seen when non-weight bearing. When weight bearing in angle and base of gait, loss of the medial arch, bulging of the talar head, calcaneal eversion, and abduction of the forefoot in relation to the rearfoot can be seen. STJ and medial column reducibility should be assessed with Jack's test and the Huebscher maneuver. Additionally, standard weight bearing radiographs in STJ neutral position can help to confirm reducibility. One should recognize and address any co-existing deformities, the most important being the presence of equinus. Whether equinus is the primary deforming force or a secondary adaptive change, it must be addressed at or before surgery.[1]

RADIOGRAPHIC FINDINGS

In order to properly evaluate the flexible flatfoot, standard AP and lateral weight bearing radiographs are taken in both angle and base of gait and STJ neutral positions. Neutral STJ radiographs are taken to demonstrate the degree of flexibility of the pre-operative foot as well as results that are attainable with surgical intervention. There are numerous radiographic indicators of a flatfoot deformity. When evaluating an AP projection in angle and base of gait, one finds an increase in the talocalcaneal angle of Kite. Normally this angle measures 20-25 degrees.[2] The increase in this angle results from talar adduction, which is often greater than 30 degrees in flatfoot deformity. Also, there is a notable increase the cuboid abduction angle. This angle normally measures 0-4 degrees. Often, there is a subluxation of >50% of the TN joint as the talus adducts and the forefoot abducts.

When evaluating the lateral weight bearing projection, frontal and sagittal plane components of the flatfoot deformity may be quantified. There is a decrease in the talar declination and calcaneal inclination angles. Also, an anterior break in the Cyma line may be readily identifiable with noted superimposition of the talonavicular articulation over the calcaneocuboid joint. In addition, collapse of the medial column may be noted by a decreased 1st metatarsal declination angle in relation to the weight-bearing surface.

SURGICAL PROCEDURE

The Cotton osteotomy is primarily indicated when medial column instability results from metatarsus primus elevatus.[3,4] Cotton described an opening wedge osteotomy of the first cuneiform to produce plantarflexion of the medial column, utilizing an allogenic femur graft.[5,6] This procedure is generally limited to deformities in which elevatus of the medial column continues to exist after the rearfoot components of flexible flatfoot deformity have been addressed surgically.[7,8]

A dorsal incision overlying the medial cuneiform and 1st metatarso-cuneiform articulation is utilized. Dissection is carried to the periosteal structures of the medial cuneiform. A longitudinal, capsular and periosteal incision is performed and these tissues are reflected both medially and laterally to gain exposure to the underlying cuneiform. Care must be taken to avoid disruption of the tibialis anterior tendinous insertion.[9]

A transverse osteotomy is made in the middle of the medial cuneiform using a power saw. The plantar cortex is left intact (Figure 1A). Next, the osteotomy is pried open the approximate number of degrees needed to correct the 1st ray elevatus (Figure 1B).

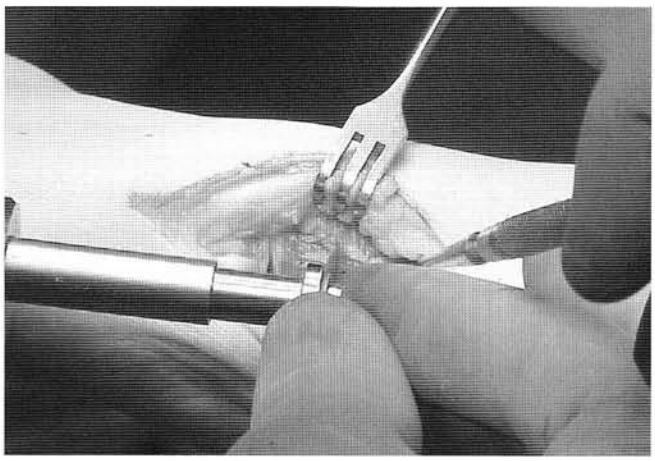

Figure 1A. A transverse osteotomy is made in the middle of the medial cuneiform using a power saw.

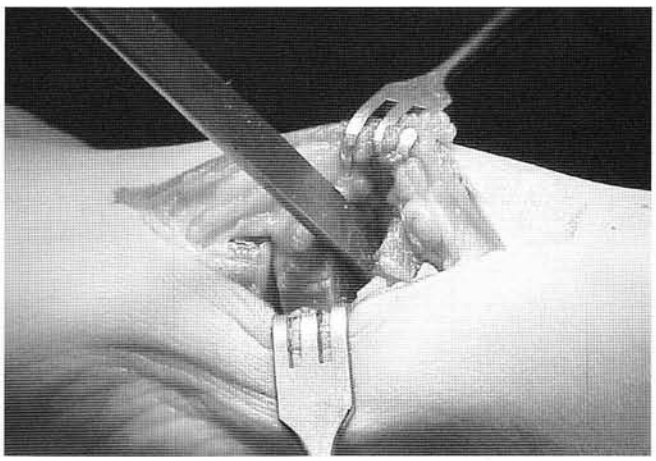

Figure 1B. The osteotomy is then pried open enough to correct the 1st ray elevatus.

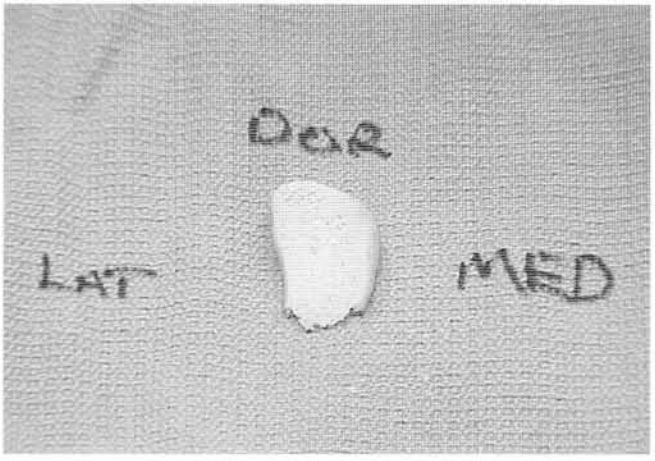

Figure 1C. Freeze dried patellar allograft in a wedge shape.

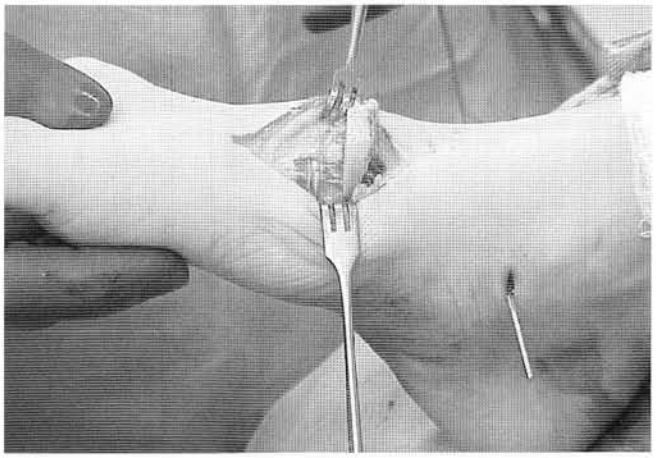

Figure 1D. Allograft being inserted into medial cuneiform. Notice the guide wire crossing the subtalar joint used for accurate placement of the MBA implant.

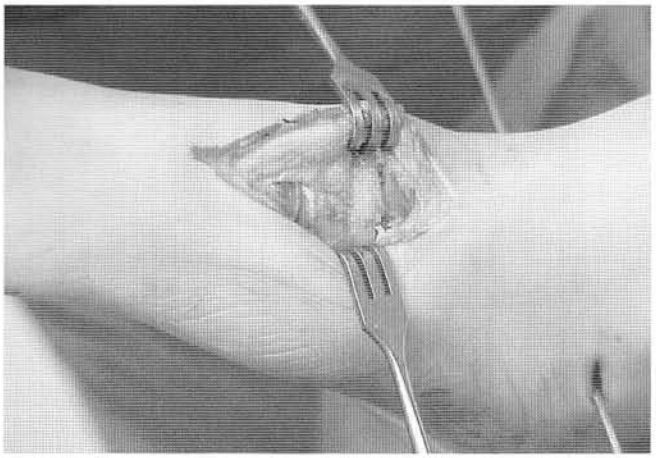

Figure 1E. Allograft is in place within the body of medial cuneiform.

Reconstituted, freeze-dried, patellar allograft is fashioned into a wedge shape and placed into the open osteotomy to maintain correction (Figures 1C, 1D, 1E). Fixation is not necessary but may be used if so desired. Closure of the capsular and periosteal tissue may prove difficult. Therefore, additional reflection may be needed to ease tissue tension and facilitate closure.

After completion of the procedure, a fiberglass below-the-knee cast is applied and cast immobilization is continued for 10–12 weeks or until radiographic evidence of osseous consolidation is seen.

MATERIAL AND METHODS

A total of 31 patients were reviewed radiographically and clinically. Pre- and postoperative radiographs were examined on 32 feet. Of the 31 cases reviewed, the average patient age at the time of surgery was 11.9 years, with an age range of 7 to 17 years. Thirteen patients were male and eighteen patients were female.

Conservative treatment prior to surgical intervention included: over-the-counter and custom made orthotics (28 patients), NSAIDs (15 patients), shoe modification including taping and strapping (7 patients), cast boot immobilization (1 patient).

All 32 feet reviewed underwent the Cotton osteotomy in combination with MBA implantation. Each foot also had a gastrocnemius recession. Additionally, one lateral opening wedge calcaneal osteotomy was performed to address a residual forefoot abductus deformity. Procedures unrelated to the correction of the underlying deformity were: one removal of a dislocated MBA implant, one resection of a middle facet fibrous coalition, and three modified Kidner procedures.

RESULTS

Postoperative radiographic evaluation revealed an average Kite's angle of 21.23 degrees, a decrease of 7.89 degrees (27.1%). Preoperative radiographs revealed an average calcaneal inclination and talar declination angle of 13.47 degrees and 36.58 degrees, respectively. Postoperative calcaneal inclination and talar declination angles averaged 18.05% and 31.53% respectively. The calcaneal inclination angle increased by an average of 4.58 degrees (25.4%) while the talar declination angle decreased 5.05 degrees (13.8%) on average.

The first metatarsal declination angle increased an average of 6.06 degrees (28.1%) from 15.47 degrees to 21.53%. The lateral talar/first metatarsal angle decreased from 27.74 degrees to 7.89 on average, a difference of 19.85 degrees (71.5%). A summary of preoperative and postoperative radiographic data is shown in Table 1.

Table 1

	Kites<	Calc Inc<	Talar Dec<	1st Met Dec<	Tal/1st Met<
Preop	29.12	13.47	36.58	15.47	27.74
Postop	21.23	18.05	31.53	21.53	7.89

DISCUSSION

Many procedures have been utilized for surgical correction of flexible pes valgo planus. A review of the above procedures sets forth a definitive criteria for correction of this tri-planar deformity. The surgeon must consider a stepwise anatomical approach when surgically correcting the pediatric flexible flatfoot deformity.

Gastrocnemius equinus is the underlying sagittal plane deformity of the rearfoot to leg relationship. A significant equinus deformity also contributes to midtarsal joint transverse plane instability. This condition, which is correctable with gastrocnemius recession, allows the patient to adapt to the new rearfoot position established by arthroereisis implantation. In addition, gastrocnemius recession prevents some long-term sequelae of excessive pronation.[10]

The next step in the surgical approach is correction of the frontal and transverse plane components of the rearfoot. Preoperative clinical and radiographic assessment of these planar deformities usually presents with talar ptosis, calcaneal valgus, superimposition of the cuboid and TN joints noted by an anterior break in the Cyma line. These flexible conditions are readily correctable with the MBA arthroereisis.

After subtalar joint pronation is restricted to 0-2 degrees valgus with the MBA arthroereisis, consideration of residual transverse plane deformity of the midtarsal joint can be corrected with an opening wedge osteotomy of the calcaneus (i.e. Evans calcaneal osteotomy).

The final step to consider is the sagittal plane forefoot to rearfoot relationship. After reduction of the rearfoot deformity, consequentially the first ray will often present as a structural or positional forefoot varus or metatarsus primus elevatus. Surgical correction is accomplished with the opening wedge plantarflexory Cotton osteotomy and insertion of patellar allograft bone wedge without need for internal fixation, as detailed earlier in this article.

The authors have found the Cotton osteotomy to be a reliable adjunctive procedure for correction of the forefoot varus component of pediatric flexible flatfoot deformity. The advantages and benefits of the Cotton osteotomy include: no incidences of non-union, no displacement of graft, and excellent incorporation of the graft substance into the surrounding bone. The authors have found structural correction to be far superior with fewer complications and better long-term results than addressing the deformities with soft tissue procedures alone.

CASE STUDY 1

An eight-year-old female presented with her parents complaining of progressively worsening flatfoot deformities. Her parents stated that she complained of intermittent pain. They noticed that her feet rolling in and collapsing. They stated that both feet are turned outward and she seemed to walk awkwardly. They felt the problem was progressing and were concerned with the overall condition of her feet. Past treatment included a referral by another podiatrist who intitially evaluated and casted her for orthotics, which the parents did not believe corrected her deformity. Clinically both feet exhibited marked subtalar pronation with severe collapse of the medial longitudinal arches with weight bearing. She had calcaneal valgus deformity with hypermobility of the forefoot in the sagittal and transverse planes. She demonstrated talar ptosis with medial bulging of the talus at the talonavicular joint bilaterally.

Her subtalar and midtarsal joint ranges of motion were markedly hypermobile. She also demonstrated gastrocnemius equinus with the inability to dorsiflex the feet past 90 degrees.

Gait analysis exhibited severe abnormality with calcaneal valgus and subtalar with midtaral joint pronation. Abduction of the forefoot on the rearfoot in the transverse plane was noted with compensation through the midtarsal joint due to severe equinus and abduction of the forefoot.

Correction of her flatfoot deformity was obtained with a gastrocnemius recession, lateral calcaneal opening wedge osteotomy, MBA subtalar joint arthroereisis implant, and Cotton osteotomy.

Comparison of the right foot pre- and postoperative radiographic angles demonstrates significant reduction of the angular deformities in all three planes (Table 2). Preoperative radiographs are seen in Figure 2A and 2B and postoperative radiographs are shown in Figure 3A and 3B. Three preoperative clinical photographs of the right foot are shown in Figure. 4A-4C. Three postoperative clinical photographs of the right foot are shown in Figures 5A-5C.

Table 2

	Kites<	Calc Inc<	Talar Dec<	1st Met Dec<	Tal/1st Met<
Preop	32	8	20	14	8
Postop	20	20	24	22	2

Figure 2A. Preoperative AP radiograph, right foot.

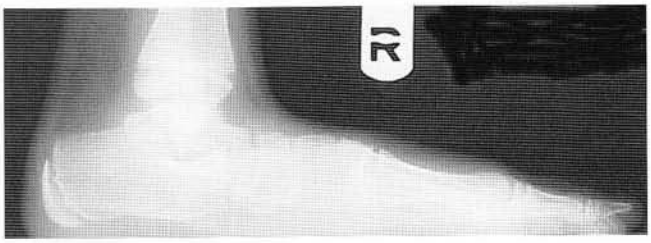

Figure 2B. Preoperative lateral radiograph, right foot.

Figure 3A. Postoperative AP radiograph, right foot.

Figure 3B. Postoperative lateral radiograph, right foot.

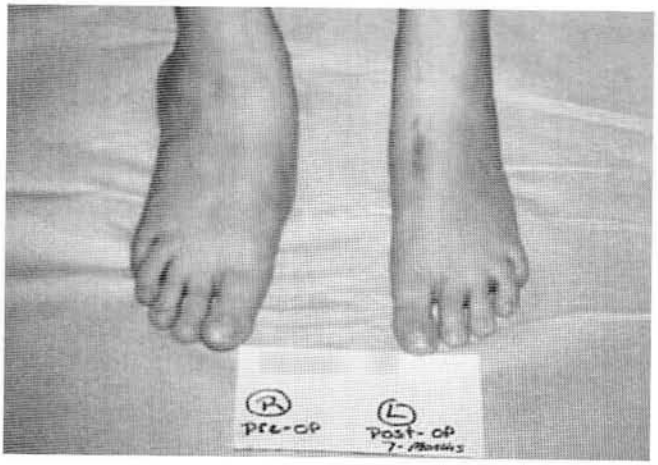

Figure 4A. Preoperative clinical photograph, anterior view. Note, left foot has already undergone surgical correction.

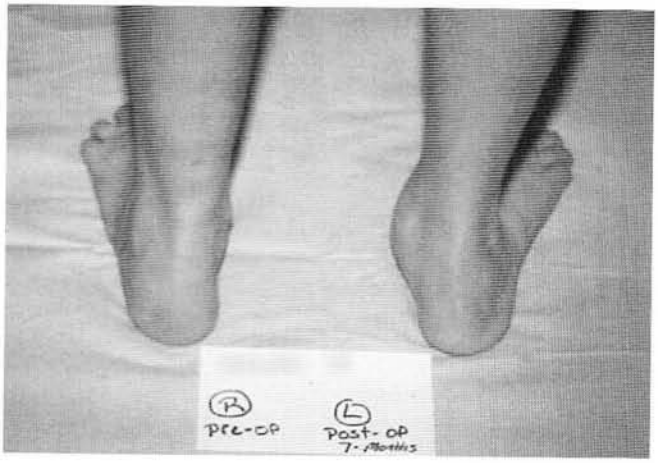

Figure 4B. Preoperative clinical photograph, posterior view. Note, left foot has already undergone surgical correction.

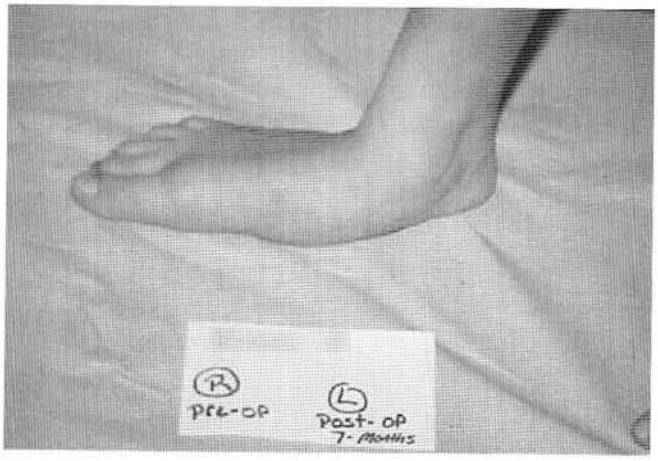

Figure 4C. Preoperative clinical photograph, medial view.

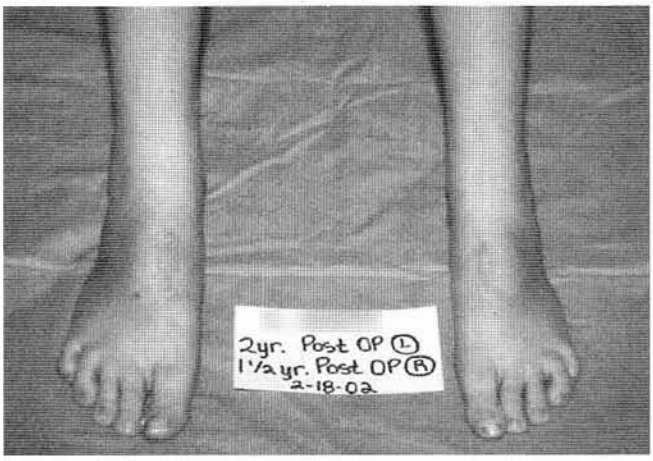

Figure 5A. 18 month postoperative clinical photograph, anterior view.

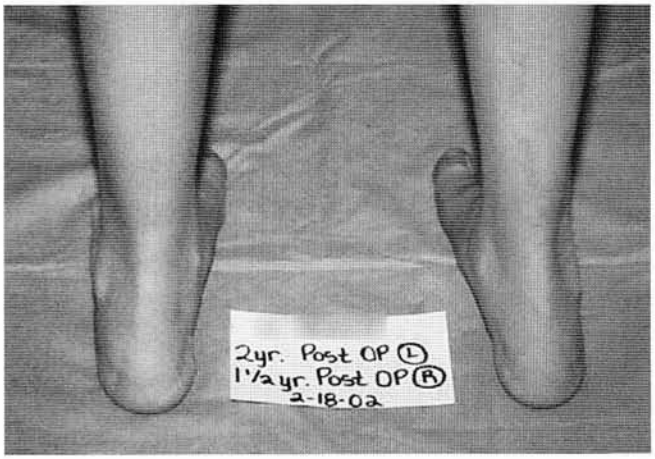

Figure 5B. 18 month postoperative clinical photograph, posterior view.

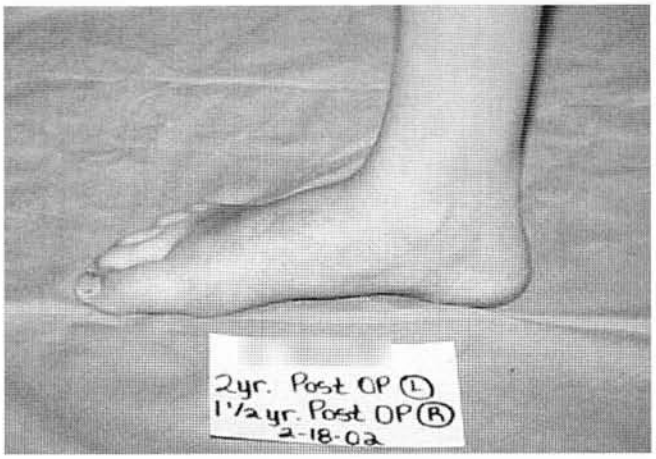

Figure 5C. 18 month postoperative clinical photograph, medial view.

CASE STUDY 2

An eleven-year-old male presented with his mother with progressing bilateral foot pain and deformity. His mother complained that her son's feet roll in severely and also turn in. The patient frequently participated in sports and outdoor hunting activities. He complained of continued pain especially on the inside of his feet when active.

The patient was referred by another podiatrist who took initial radiographs. Also, the patient underwent conservative therapy consisting of prescription orthotics. He wore the orthotics for six months but continued to complain of pain. His mother believed the devices were not helping to relieve his symptoms.On clinical examination there was erythema over the medial arches as a result of talonavicular bulging. Neurovascular exam was unremarkable. Range of motion of the ankle, subtalar, and midtarsal joints were without pain. There was no evidence of tarsal coalition. Marked equinus deformity was noted with inability to dorsiflex the feet past 90 degrees. The midtarsal joints were adducted with marked hypermobility of the forefoot on the rearfoot in the transverse and sagittal planes. In addition there was talar ptosis. Stance revealed approximately ten degrees of calcaneal valgus with subtalar joint hyperpronation.

Gait analysis revealed marked abduction of the forefoot and the rearfoot with abductory twist and midtarsal joint compensation due to early heel off of the equinus deformity.

The right foot was initially surgically addressed. For the purposes of this paper, the left foot was evaluated. Surgical correction of the deformity was undertaken with a gastrocnemius recession, MBA subtalar joint arthroereisis implant, Cotton osteotomy with insertion of allograft, and modified Kidner procedure.

Comparison of the pre and postoperative radiographic angles of the left foot demonstrate significant reduction of the angular deformities in all three planes (Table 3). Preoperative radiographs of the left foot are seen in Figs. 6a and 6b. Postoperative radiographs of the left foot are shown in Figures 7A and 7B. Preoperative clinical photographs are shown in Figures 8A and 8B. Postoperative clinical photographs are shown in Figures 9A-9C.

Table 3

	Kites<	Calc Inc<	Talar Dec<	1st Met Dec<	Tal/1st Met<
Preop	28	10	33	16	29
Postop	16	13	18	21	4

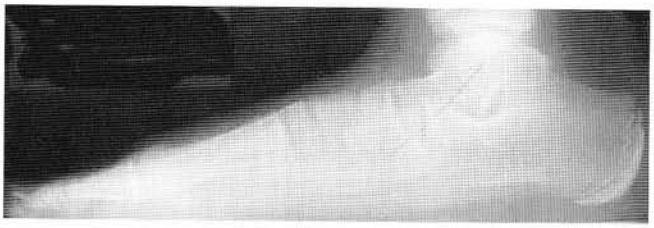

Figure 6B. Preoperative lateral radiograph, left foot.

Figure 6A. Preoperative AP radiograph, left foot.

Figure 7A. Postoperative AP radiograph of left foot.

Figure 7B. Postoperative lateral radiograph of left foot.

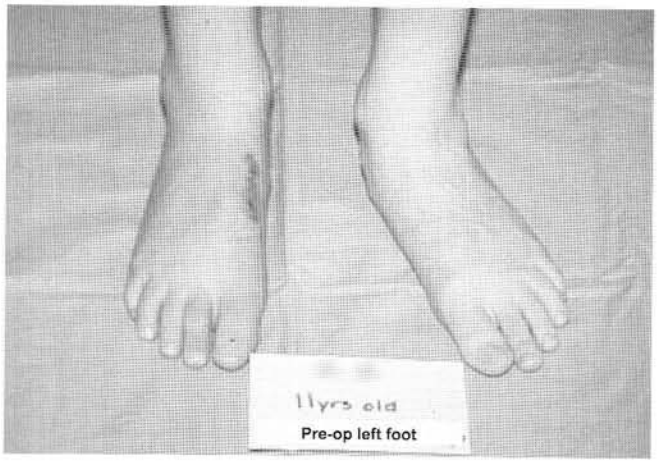

Figure 8A. Preoperative clinical photograph, anterior view. Note, right foot has already undergone surgical correction.

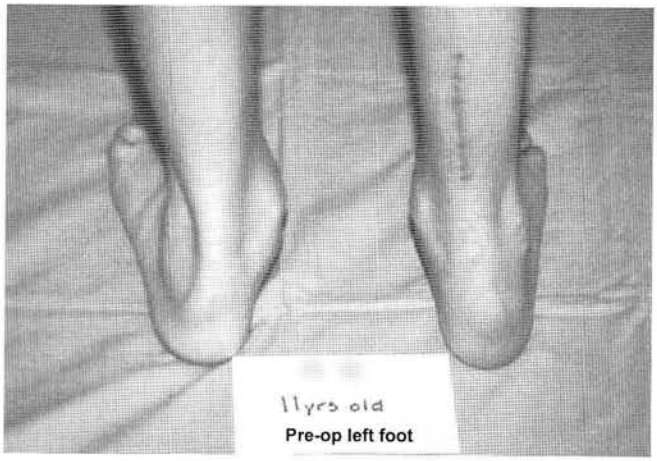

Figure 8B. Preoperative clinical photograph, posterior view. Note, right foot has already undergone surgical correction.

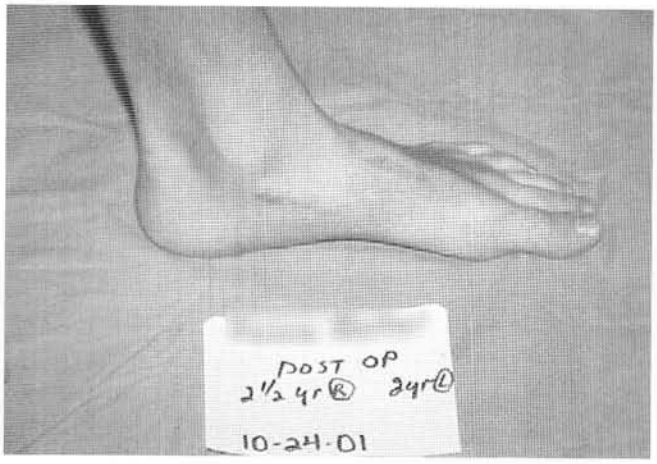

Figure 9A. 2 year postoperative photograph, medial view left foot.

Figure 9B. 2 year postoperative photograph, anterior view left foot. Note, right foot is now 2.5 years postoperative.

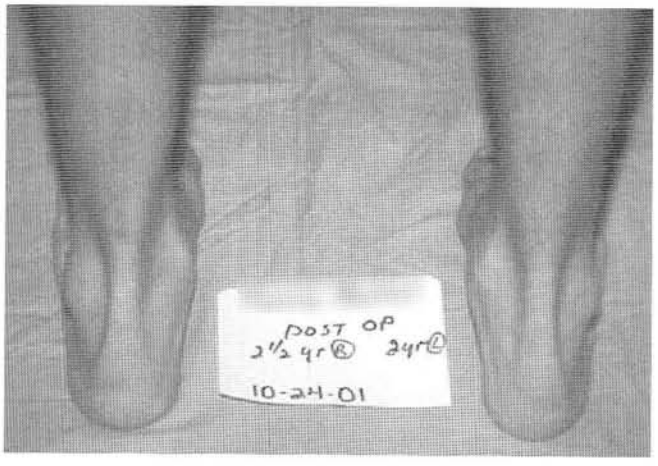

Figure 9C. 2 year postoperative photograph, posterior view left foot. Note, right foot is now 2.5 years postoperative.

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