CHAPTER 8

THE VALENTI STJ ARTHROEREISIS IMPLANT: A Ten-Year Retrospective Study

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"Flatfoot is a biomechanical dysplasia of tarsal joint function".[1] Certain deformities such as metatarsus adductus, equinus, internal tibial torsion, and forefoot varus can contribute to excessive pronation of the subtalar joint. During normal foot function, the foot will pronate after contact to become a mobile adapter for uneven terrain. The foot will then begin to resupinate during midstance to produce a rigid lever necessary for propulsion. When the subtalar joint pronates excessively, the foot loses its ability to resupinate during the midstance phase of gait. This results in a hypermobile foot during the propulsive phase of gait. This imbalance of joint position and muscle function during the gait cycle is the initial etiological factor that can contribute to the deformity of hallux valgus, hammertoes, posterior tibial dysfunction, and degenerative joint disease. Closed kinetic chain pronation at the subtalar joint is a triplanar motion comprised of simultaneous eversion of the calcaneus and adduction and plantar flexion of the talus. As the talus adducts and plantarflexes, it also anteriorly displaces on the calcaneus. The concept of arthroereisis is to allow the normal amount of subtalar joint pronation, around four to six degrees, but to restrict the abnormal, excessive motion at the subtalar joint.[2]

HISTORICAL REVIEW

In 1946, Chambers was the first to apply the arthroereisis concept to the subtalar joint. Chambers described abnormal excursion of the talus on the calcaneus with the talus contacting the floor of the sinus tarsi. He remedied this with his "abduction block" procedure during which a wedge-shaped bone graft was impacted into the anterior leading edge of the posterior facet of the calcaneus. This prevented excessive anterior displacement of the talus upon the calcaneus, thus limiting the amount of excessive pronation of the subtalar joint.[3]

Subsequently, Baker and Hill in 1964, developed a pronation limiting osteotomy in the form of a lateral opening wedge of the posterior facet, for the treatment of flatfoot in the cerebral palsy patient. In order to prevent interference with STJ motion, a wedge-like bone graft was used to improve the weight-bearing alignment of the calcaneus.[4] LeLievre, in 1970, described the utilization of an accessory bone graft placed in the sinus tarsi.[5] Subotnik followed, and replaced the bone graft with a silastic plug in 1974.[6] This brought new insight to the arthroereisis procedure by the use of a high molecular weight device instead of bone.

Smith el al. in 1976, created a high molecular weight polyethylene plug, which is cemented into the calcaneal sulcus against a resected portion of the posterior calcaneal facet.[7] This procedure was coined "STA-peg" (subtalar arthroereisis-peg), and is probably the most common of all STJ arthroeresis procedures today. This procedure does not block excessive pronation, but rather, alters the axis of motion of the subtalar joint. Viladot created a silastic plug with a medial stem also inserted into the sinus tarsi. Lanham used the silastic stem of a Swanson hemi great toe implant in the sinus tarsi.[8] Valenti, in 1976 first proposed a cylindrical implant made of polyethylene.

The Valenti procedure, unlike the STA-peg, is an extra-articular procedure that involves the placement of a high molecular weight polyethylene, threaded device into the sinus tarsi (Fig. 1). This blocks the anterior and inferior displacement of the talus, allowing normal STJ motion, but blocking excessive pronation.

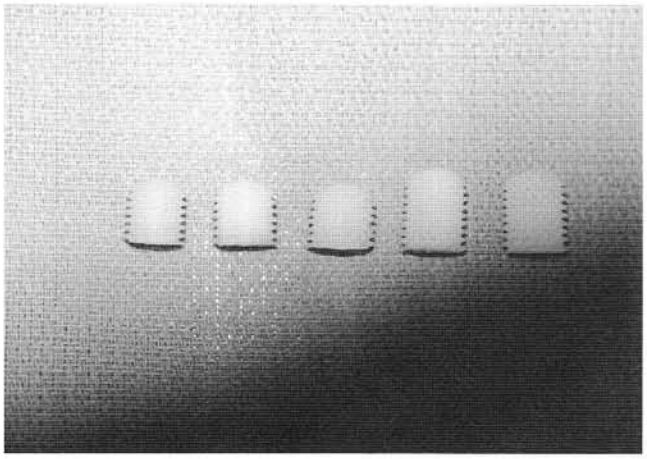

Figure 1. Various sizes of the Valenti high molecular weight sinus tarsi threaded implant.

INDICATIONS AND CONTRAINDICATIONS

The prime indication for performing surgery on hyperpronated individuals is the presence of significant symptomatology. In a pediatric patient, this may include the parameters outlined by Smith et al.[7] such as walking intemperance, night cramps, athletic abstinence, sedentary hobby pursuits, arch pain, and postural pain to the foot and leg. The prominent feature of the clinical exam is a foot which appears essentially normal when non-weight bearing, but displays prominent calcaneal eversion and collapse of the medial longitudinal arch when standing (Figs. 2A-2B). Other clinical findings may include medial bulging of the talar head, excessive forefoot abduction, equinus, and forefoot supinatus.

Contraindications to the Valenti procedure include a flatfoot deformity with an absence of calcaneal eversion. This stems from the fact that the Valenti device is primarily geared towards correcting a rearfoot deformity with frontal plane dominance. Langford et al. state that children with little or no calcaneal eversion in closed kinetic chain motion do not meet the criteria for STJ arthroereisis stating that this would result in a supinated foot. A rigid flatfoot deformity would also be a contraindication. The etiology of a rigidly fixed flatfoot should be evaluated and treated appropriately. Commonly, a rigid flatfoot is the result of a tarsal coalition, and the use of arthroereisis for this deformity is felt to be an absolute contraindication.

RADIOGRAPHIC FINDINGS

Standard dorsoplantar and lateral weight bearing radiographs taken in the angle and base of gait are necessary to properly evaluate the flexible flatfoot. Also helpful is a Harris-Beath projection which may yield information about the posterior and middle subtalar joints.

There are several radiographic indicators of a flatfoot. When evaluating a dorsoplantar projection, one will find an increase in the talocalcaneal divergence angel, or Kite's angle. This angle is normally reported to fall between 20 and 25 degrees. The increase in this angle is a result of the talar adduction and in flatfoot deformity is often greater than 30 degrees. As the forefoot abducts, and the talus adducts, there will be a subluxation at the talonavicular joint. This subluxation is often

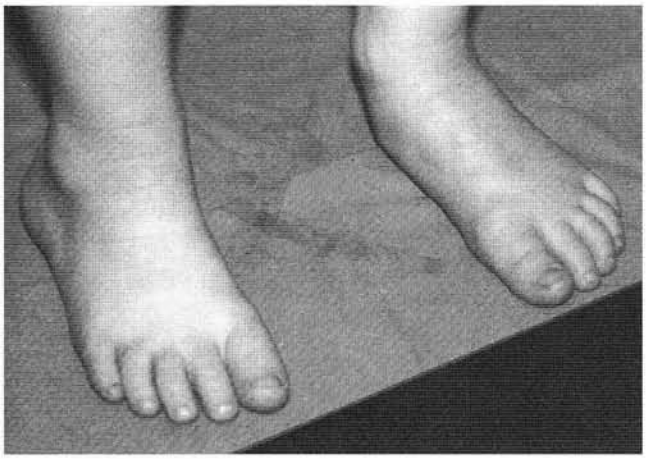

Figure 2A. Clinical preoperative view of a patient demonstrating excessive calcaneal eversion and bulging of the talar head.

Figure 2B. Clinical preoperative view demonstrating excessive collapse of the medial arch when standing.

greater than fifty percent. One also sees an increase in the cuboid abduction angle, denoting increased abduction of the forefoot. (Fig. 3A).

When evaluating a lateral projection, one sees a decreased calcaneal inclination angle, and an increased talar declination angle, both leading to an increased talocalcaneal angle. An anterior break in the Cyma line, and faulting of the medial column may be present and are easily identified[2] (Fig. 3B).

Figure 3A. Dorsoplantar projection demonstrating the Kite's angle (normal 20 to 25 degrees), subluxation of the talar navicular joint, and the calcaneal cuboid angle.

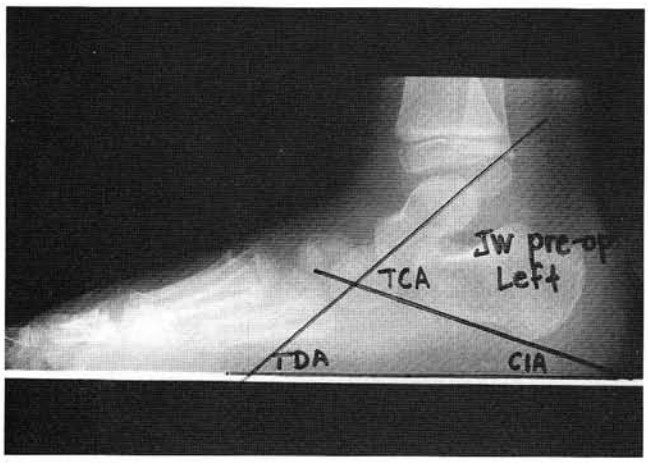

Figure 3B. Lateral projection demonstrating the calcaneal inclination angle, the talar declination angle, the talocalcaneal angle, and the position of the Cyma line.

SURGICAL PROCEDURE

The Valenti STJ arthroereisis procedure may be performed under local or general anesthesia with or without the use of a tourniquet. If a tourniquet is desired, then a well-padded upper thigh tourniquet should be used, along with general anesthesia. Figure 4 depicts the instrumentation used in the surgical implantation of the Valenti sinus tarsi arthroereisis device.

Attention is directed to the area of the sinus tarsi where a four centimeter oblique incision is placed following the relaxed skin tension lines. Care is taken to avoid the intermediate dorsal cutaneous and sural nerves, which may course through the incision area. The extensor digitorum brevis muscle and deep fascia are bluntly dissected to the side to allow entrance into the tarsal canal. The interosseous talocalcaneal ligament is identified and sectioned (Fig. 5). The torpedo-shaped probe is then inserted through the sinus tarsi from lateral to medial, until tenting is noted on the medial skin. A small incision is then placed medially to allow passage of the blunt probe. The probe should exit just superior to the tibialis posterior tendon as it passes along the medial aspect of the foot.

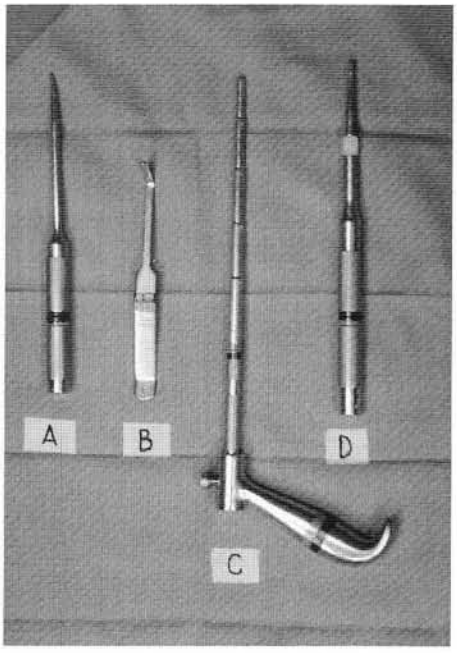

Figure 4. Surgical instrumentation used in the surgical implantation of the Valenti sinus tarsi arthroereisis device. A. Probe, B. Sinus tarsi retractor, C. Sizer, D. Inserting device with the implant in place.

The probe is then used to slightly dilate the tarsal canal and is then removed. The sizer, which has a shaft composed of a series of graduated cylinders, is then inserted into the sinus tarsi from lateral to medial through the tarsal canal (Fig. 6). The sizer is progressed until a satisfactory amount of calcaneal eversion has been eliminated. Approximately four to six degrees of calcaneal eversion should be maintained to allow for a physiologic amount of subtalar joint pronation during gait. The numbered cylinder within the sinus tarsi can then be noted and will correspond with the diameter of the implant to be used.

The desired implant is then placed into the inserting device and placed into the sinus tarsi (Fig. 7), tip first, and threaded into place, locking itself into the interosseous talocalcaneal ligament and surrounding soft tissues. The tip of the inserter should be noted exiting the medial incision. It is important that the implant be threaded at least 3 to 5 millimeters medial to the most lateral aspect of the posterior facet to ensure satisfactory placement of the implant. The tip of the inserter is then removed medially and the handle of the inserter is removed laterally. The area should be copiously irrigated, and STJ motion should be re-evaluated. Significant reduction of excessive subtalar joint pronation should now be appreciated. However, it is important that 4 to 6 degrees of eversion be preserved for normal physiologic function. Closure of the deep, subcutaneous, and skin layers is then performed, and the patient is placed in a mildly compressive postoperative dressing.

Postoperative care, (assuming no adjunctive procedures were performed), consists of 3 to 5 days of non-weight bearing, followed by protected weight bearing in a removable below knee walking cast for up to two weeks. The patient is then allowed full weight bearing, and a gradual return to full, normal activity is begun in one month.

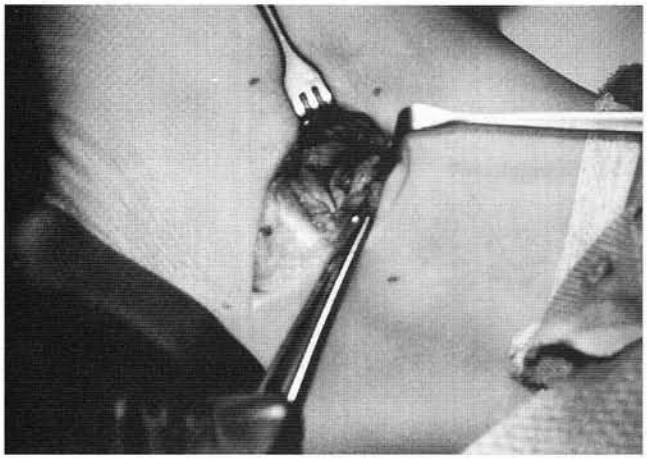

Figure 5. Proper sinus tarsi dissection with complete transection of the interosseous talocalcaneal ligament.

ADJUNCTIVE PROCEDURES

The Valenti STJ arthroereisis device is not a panacea for flexible flatfoot. It is always important to fully evaluate any coexisting deformities that need to be addressed when reconstructing a flexible flatfoot. Occasionally, if the symptomatic flatfoot is reconstructed before secondary changes such as equinus and severe medial column faulting have occurred, then arthroereisis may be the only procedure necessary.

The single most important coexisting deformity may be the presence of equinus. Equinus

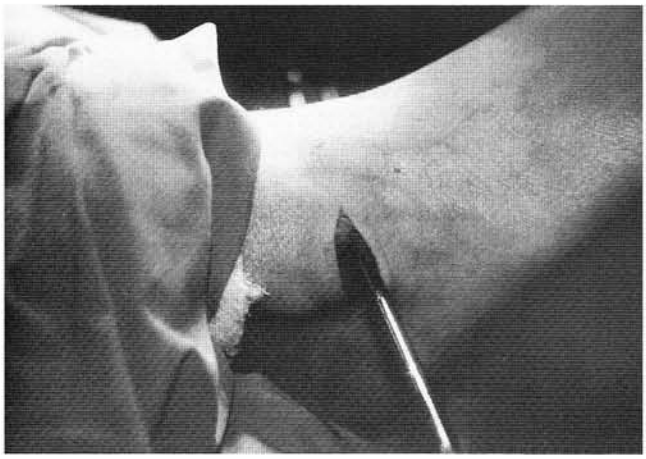

Figure 6. The sizer will be inserted through the sinus tarsi from medial to lateral.

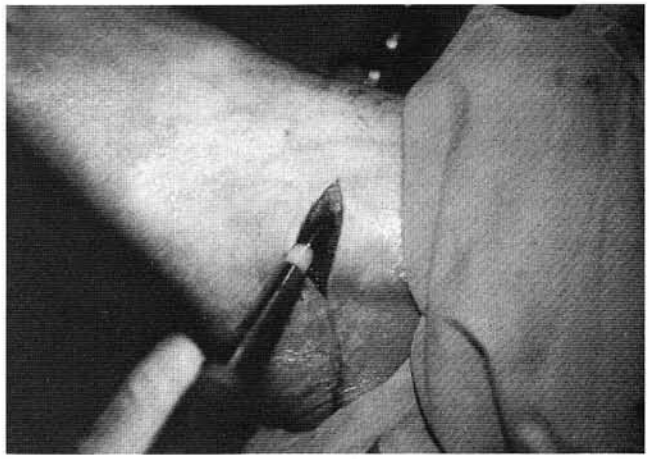

Figure 7. The implant is placed on the inserting device, and is inserted into the sinus tarsi.

may be the primary deforming force or it may be a secondary adaptation. Regardless of the origin of the equinus, it must be addressed at the time of surgery. If the flatfoot is reconstructed during late adolescence or adulthood, then selective joint fusion may also be indicated.

METHODS AND MATERIALS

Thirty-four Valenti procedures were performed on eighteen patients. All charts were extensively reviewed for subjective complaints. All eighteen patients had subjective complaints of leg cramps, arch pain, and inability to engage in strenuous activity. Clinical examination of all thirty-four feet revealed a resting calcaneal stance position of nine degrees of valgus or greater. All thirty-four feet were manually correctable, and none of the patients had concomitant torsional or versional deformities. Of the thirty-four feet, ten were found to have a gastrocnemius equinus that was also addressed at the time of surgery with a gastrocnemius recession. All patients were evaluated at follow-up for subjective complaints and were objectively examined clinically. Pre-and post-operative dorsoplantar and lateral radiographs were also evaluated.

RESULTS

A total of eighteen patients (34 feet) were evaluated (Table 1). The average age at the time of surgery was 8.8 years, with a range of 4 to 12 years. The average age of patients undergoing isolated arthroereisis (24 feet) was 7.1 years, while patients who underwent an arthroereisis and a gastrocnemius recession (10 feet) had an average age of 11.4 years. Eleven patients were male, and seven were female. The average length of follow-up was 32.6 months with a range of 5-120 months.

Clinical examination at follow-up revealed an average resting calcaneal stance position of 2.4 degrees valgus, with a range of 1 to 5 degrees valgus. The foot assumes a normal, rectus appearance upon weight bearing. Preoperative radiographs revealed an average talar declination angle of 36.4 degrees, with a range of 23 to 46 degrees. The average preoperative calcaneal inclination angle was 14.9 degrees with a range of 6 to 26 degrees. The average preoperative Kite's angle was 31.7 degrees, with a range of 21 to 38 degrees.

Postoperative radiographs revealed the average talar declination angle to be 26.0 degrees with a range of 19 to 36 degrees. The average calcaneal inclination was 17.7 degrees with a range of 10 to 27 degrees. Postoperatively, the average Kite's angle was 22.0 degrees, with a range of 14 to 32 degrees. The talar declination angle decreased an average of 10.4 degrees (28.6%). The calcaneal inclination angle increased an average of 2.6 degrees (17.4%). Kite's angle decreased an average of 9.7 degrees (30.6%).

Two patients (5.9%) had occasional pain in the initial postoperative period that was treated conservatively with nonsteroidal anti-inflammatories, heat, and steroid injections. All eighteen patients were asymptomatic at the time of follow-up. All patients related an increase in activity level, decrease in postural symptomatology and a decrease in arch pain.

DISCUSSION

The Valenti subtalar arthroereisis device is a threaded, self-locking device that can be utilized in the treatment of flexible pes plano valgus. The Valenti device is composed of ultra-high molecular weight polyethylene (UHMWPE). This material characteristically has a low friction coefficient.[9] So far, UHMWPE has been well tolerated by patients and has been known to have favorable wear qualities with minimal soft tissue reactivity.[10]

The Valenti device has several advantages over some alternative implants. First, the procedure is technically easy to perform. The instrumentation is simple, and there are very few steps to perform. There is minimal dissection, and the procedure is completely reversible. Secondly, the Valenti implant is entirely extra-articular, therefore, no bone resection or drilling is required. This reduces the chance of developing osteomyelitis and detritic synovitis, as may occur when an arthroereisis procedure requires resection of bone.[11] In addition, no polymethylmethacrylate (PMM) is used to anchor the device. Other forms of STJ arthroereisis require the use of PMM to anchor the device. PMM has a variety of adverse effects on local tissue that can be avoided by utilizing the Valenti device.[12] The fact that the device is threaded affords the device added inherent stability with a decreased chance of extrusion or dislodging of the implant. This has been a common complication of other arthroereisis procedures.[8,11,13,14]

Table 1 Patient Information

Patient	Age	Sex	Follow-Up (months)	Foot	Preop Values TDA	Preop Values CIA	Preop Values Kite's	Postop Values TDA	Postop Values CIA	Postop Values Kite's	Adjunctive Procedures
TF	11	F	5	R	41	6	36	31	10	22	none
				L	24	9	29	19	14	18	none
LN	10	F	96	R	43	20	27	31	22	20	none
				L	46	20	33	36	20	22	none
JW	5	M	60	R	42	20	29	33	24	18	none
				L	42	19	32	33	26	27	none
RS	6	M	13	R	28	24	23	21	26	18	none
				L	38	20	32	31	21	32	none
TP	4	F	7	R	34	8	22	29	12	20	none
				L	33	10	23	25	11	22	none
WK	5	F	24	R	30	17	25	26	18	24	none
				L	44	14	25	28	14	22	none
CH	12	M	14	R	29	14	34	20	14	22	none
				L	28	12	31	24	14	20	none
KS	10	M	120	R	41	12	35	26	14	19	MGR
				L	45	13	21	28	14	14	MGR
DM	12	F	14	R	35	10	33	24	18	22	MGR
				L	29	10	32	24	14	24	MGR
RO	9	M	6	L	24	13	28	21	15	18	none
JD	11	M	22	L	37	11	28	21	15	22	MGR
				R	38	9	29	27	13	21	MGR
PG	6	M	22	L	44	18	35	29	20	21	none
				R	35	17	32	31	21	20	none
SB	12	M	14	L	37	12	26	24	16	20	MGR
				R	38	14	30	22	19	18	MGR
AF	11	M	24	L	39	15	37	31	18	27	none
				R	36	18	35	30	20	22	none
MM	12	M	84	L	25	26	37	21	27	29	MGR
				R	23	22	35	22	26	28	MGR
RB	6	F	25	L	43	15	36	25	21	29	none
				R	39	21	35	20	23	20	none
DM	11	F	7	L	32	11	34	22	14	22	none
JH	8	M	6	R	42	14	36	27	14	22	none
				L	44	15	38	23	13	23	none

TDA: Talar Declination Angle
CIA: Calcaneal Inclination Angle
Kite's: Dorsal Plantar Talo-Calcaneal Angle
MGR: Modified Gastrocnemius Recession

The authors also performed a modified gastrocnemius recession for concomitant equinus deformity on ten of the thirty-four feet. All of these patients were between ten and twelve years of age (average age 11.4). The authors believe that the equinus deformity was a secondary adaptation, and not the primary deforming force, since none of the younger patients had an equinus deformity. The authors further believe that if symptomatic flexible flatfoot presents at an early enough age, only a STJ arthroereisis may be indicated. This will allow the patient to adapt to the new rearfoot position and prevent some long-term sequelae of excessive pronation.

Figures 8 and 9 demonstrate preoperative and postoperative radiographs of two subjects in the study. Note that in each postoperative dorsoplantar projection, the talocalcaneal divergence angle (Kite's angle) has decreased, the articulation between the talus and navicular demonstrates normal congruency, and the cuboid abduction angle has returned to a more normal one. On postoperative lateral projections, of particular interest is the normalization of the talar declination angle and the restoration of a normal appearing Cyma line. Figures 10A and 10B show the clinical appearance of a patient at 8 years postoperative. The heel no longer rests in severe calcaneal eversion, and the medial longitudinal arch does not collapse with weight bearing, and medial talar bulging is minimal. This patient is an active participant in athletics and no longer exhibits walking intemperance, leg cramps, and arch pain.

The authors believe that the Valenti STJ arthroereisis device is a predictable and reliable procedure for limiting excessive subtalar joint pronation in pediatric hypermobile pes plano valgus. Postoperative follow-up and radiographic data have shown the Valenti procedure to have desired effects with few complications.

Figure 8A. Preoperative dorsoplantar radiograph demonstrating an increased Kite's angle and incongruity of the talonavicular joint.

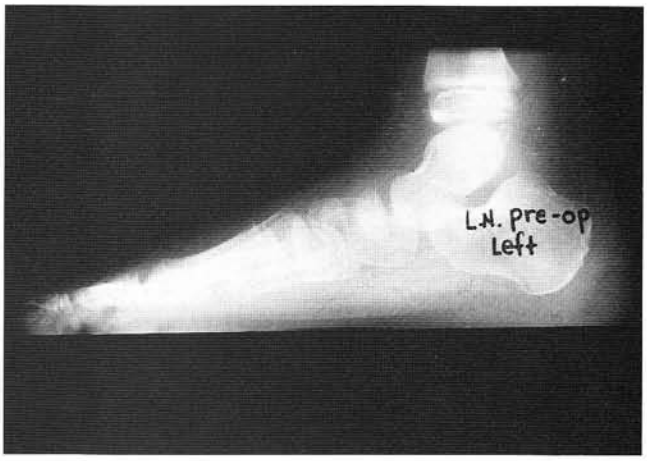

Figure 8B. Preoperative lateral radiograph show an increased talar declination angle, decreased talocalcaneal angle, and an anterior break in the Cyma line.

Figure 8C. Postoperative dorsoplantar radiograph demonstrating correction of Kite's angle and normal congruency of the talonavicular joint.

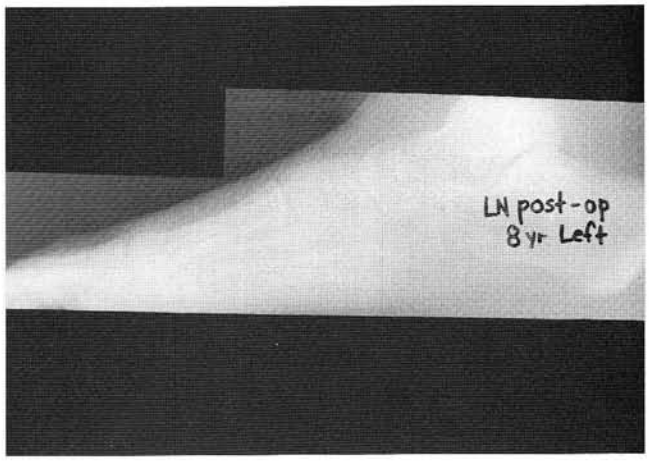

Figure 8D. Postoperative lateral radiograph showing correction of the talar declination angle, and restoration of a normal appearing Cyma line.

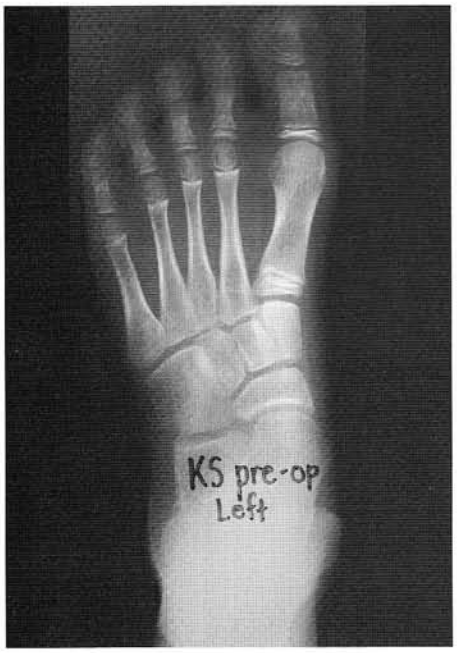

Figure 9A. Preoperative dorsoplantar radiograph demonstrating increased Kite's angle and incongruity of the talonavicular joint.

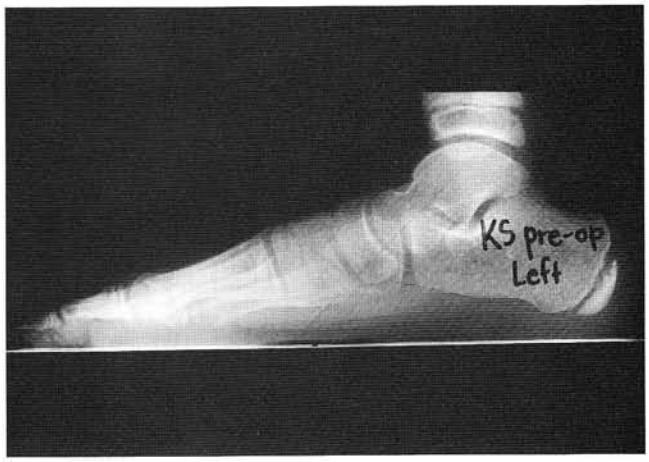

Figure 9B. Preoperative lateral radiograph showing increased talar declination angle, decreased talocalcaneal angle, and an anterior break in the Cyma line.

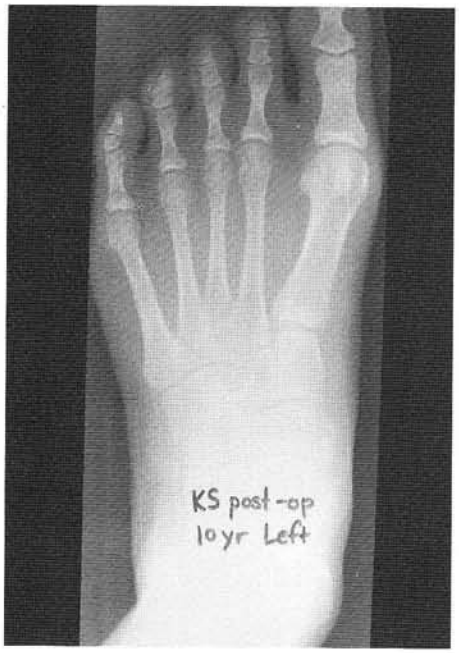

Figure 9C. Postoperative dorsoplantar radiograph demonstrating correction of Kite's angle and normal congruency of the talonavicular joint.

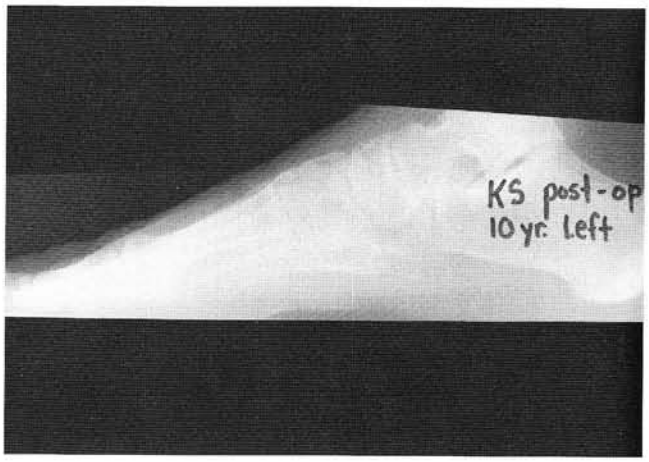

Figure 9D. Postoperative lateral radiograph showing correction of the talar declination angle, and restoration of a normal appearing Cyma line.

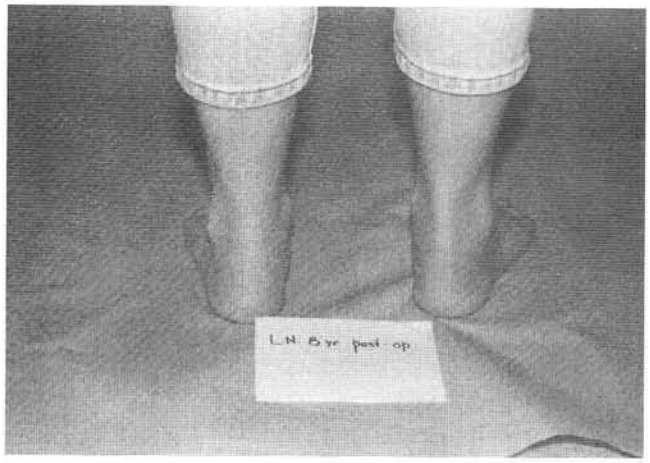

Figure 10A. Clinical appearance of patient LN at 8 years post-operative. The heel no longer rests in severe calcaneal valgus, and medial longitudinal arch does not collapse when standing. The medial talar bulging is noted to be minimal

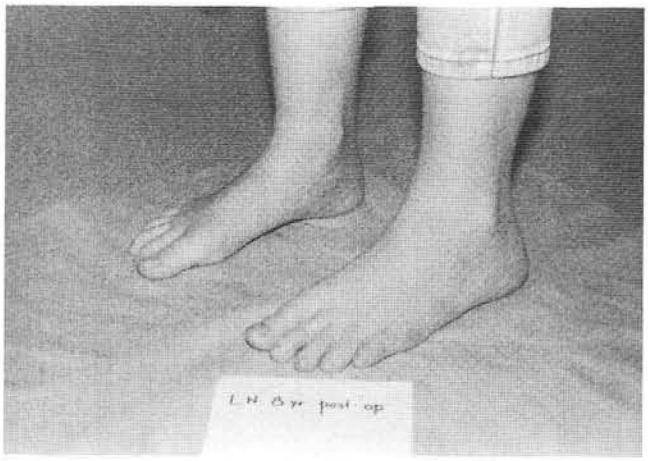

Figure 10B. Patient LN at 8 years postoperative.

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