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The Modified Lepird Procedure for Correction of Metatarsus Adductus

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ABSTRACT

Metatarsus adductus is a common transverse plane congenital foot deformity. Achieving anatomic correction can be challenging, as all osteotomy procedures have a steep learning curve. A multitude of complications can occur when using traditional pan-metatarsal osteotomy approaches. The modified Lepird procedure is performed with proximal base osteotomies on all 5 metatarsals oriented dorsal distal to plantar proximal. All screws are inserted parallel to each other, allowing the forefoot to move laterally as a unit. The foot and ankle surgeon is able to dial in with precision the exact amount of forefoot abduction necessary to correct the deformity. The modified Lepird procedure dynamically corrects the metatarsus adductus deformity so it can easily prevent any over- or undercorrection that may occur intraoperatively. The author recommends this procedure when pan-metatarsal base osteotomies are required for correction of metatarsus adductus and associated deformities.

Metatarsus adductus (MTA) is the most common congenital foot deformity, with a worldwide incidence of 1:1000 live births (1). A review of the worldwide literature has shown that the choices available for surgical correction have evolved over the last 75 years, with fewer complications and more accurate correction of this transverse plane deformity with the passage of time. Although the exact timing and invasiveness of treatment remains controversial, most foot and ankle surgeons agree that osseous treatment in children ages 8 to 12 years is technically easier and safer and has less risk of reoccurrence than in the younger adolescent (2). This article will present the modified Lepird procedure for dynamic correction of MTA.

Surgical Technique

The patient (Figs. 1*A* and *B*; 2*A* and *B*) is brought to the operating room and placed on the operating room table in the supine position. A time-out is performed using the standard Association of periOperative Registered Nurses operating room protocol. After the establishment of general anesthesia, a thigh tourniquet is applied, and the lower extremity is prepped and draped in the usual aseptic fashion. Any adjunctive procedures such as a gastrocnemius recession, Evan's, etc., are performed first followed by the modified Lepird procedure.

The standard 3-incision dorsal forefoot approach begins with the lateral incision (Fig. 3) exposing the fifth through the first metatarsal consecutively. An assembly-line surgical technique is followed to ensure meticulous dissection. Once all dorsal bases are exposed and joint spaces identified, the first guide and over-drill holes for a 2.7-mm solid cortical screw are placed in the fifth metatarsal oriented dorsal-proximal to plantar-distal. Each hole is countersunk, measured, and tapped in the usual fashion, and 2 mm of additional screw length is added (explanation described later). Next, the first 0.045-inch Kirschner- (K) wire is placed into the fifth metatarsal drill hole and left in place to serve as a reference guide for the placement of the remaining 4 metatarsal drill holes. It is critical that all 5 drill holes, and, therefore, all K-wires are placed parallel to each other (Fig. 4).

Next, the K-wire from the fifth metatarsal hole is removed, and an oscillating saw is inserted into the wound. The blade is oriented 6 to 8 mm distal to the drill hole and perpendicular to the fourth K-wire. An oblique osteotomy is performed ensuring that it is placed perpendicular to the screw hole. The drill hole should be in the center of the osteotomy. A single skin hook is inserted into the wound and placed under the distal cortex, thereby stabilizing the osteotomy while the 2.7-mm cortical screw is inserted. This process is repeated for the remaining 4 metatarsals in an assembly-line fashion.

Once all screws are inserted, the fluoroscopy unit is placed in a dorsoplantar position on the foot (Fig. 5). Each screw is then unscrewed 2 turns (hence the need for each screw to be 2 mm longer than measured), and under fluoroscopy direction, the forefoot is abducted as a unit while visualizing the correction on the monitor (Fig. 6).

Once reduced, the assistant tightens each screw with 2-finger tightness. An additional screw can be inserted into the first metatarsal base to increase stability of the construct. The calcaneal bisector can be used to confirm restoration of the longitudinal bisection of the hindfoot to the forefoot (Fig. 7).

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Conflict of Interest: None reported.
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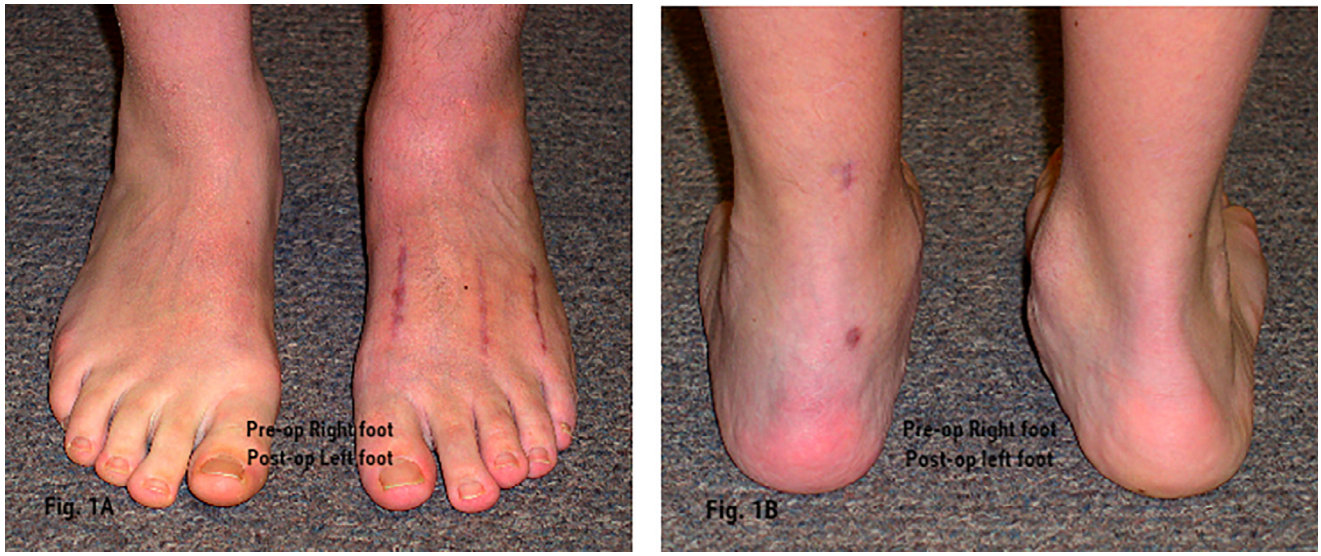


Fig. 1. Twelve-year-old male who presented for preoperative right foot tendon Achilles lengthening (A, B), Evan's, and modified Lepird procedures. The left foot is 6 months postoperative.

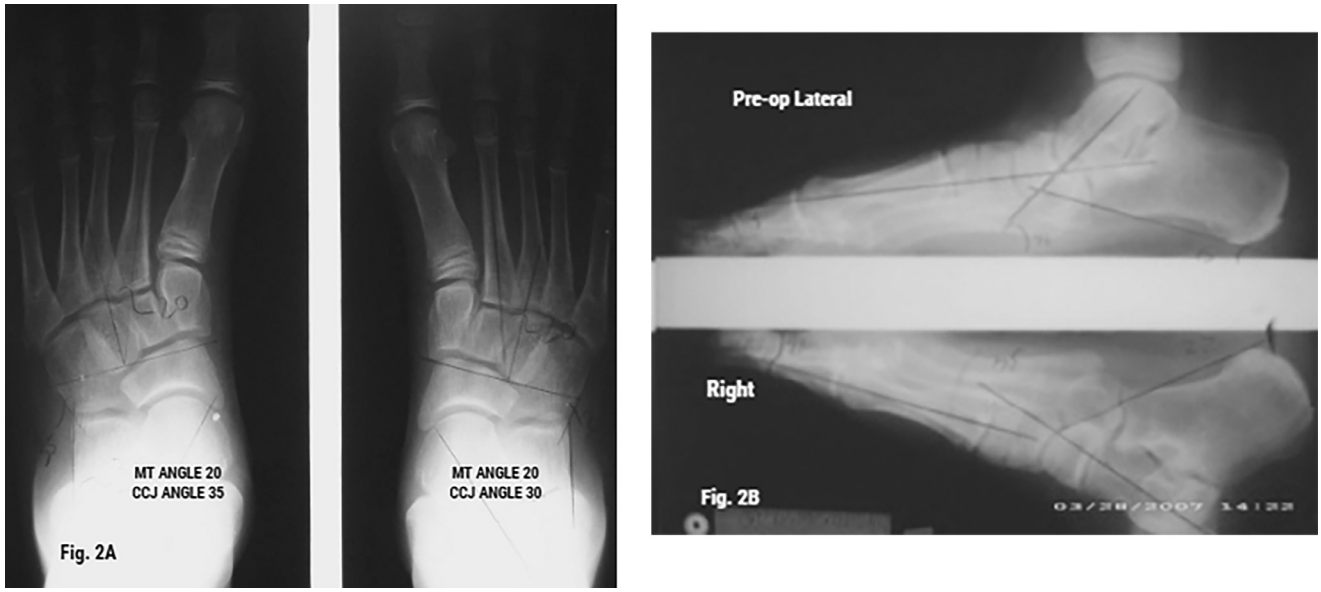


Fig. 2. Radiographic imaging (*A*) confirmed the presence of a moderate bilateral skewfoot deformity. The dorsoplantar angular relationships were measured as follows: metatarsus adductus angles were 20° bilateral, and there was squaring off of all metatarsal bases 1 to 5. The first metatarsal proximal physeal centers were open. The calcanealcuboid joint angles were right 30°, left 35°. The talonavicular joint was 45% subluxed, and the talo-first metatarsal angles were normal. Lateral radiograph (*B*) revealed both increased talar declination and decreased calcaneal inclination angles. There was superimposition of all metatarsal bases and an anterior break in the midtarsal joint.

The tourniquet is then deflated, and the wounds are lavaged copiously. Once the posthyperemic response has concluded, the wounds are then closed with nonabsorbable suture, and a dry sterile dressing is applied. A Jones compression splint is placed for 2 weeks, sutures are removed, and a non-weightbearing fiberglass cast is placed for an additional 4 weeks. Patients are able to return to full activities by 10 weeks. Radiographs will confirm 100% consolidation of all osteotomies and any allograft used (Fig. 8*A* and *B*).

Discussion

Strictly speaking, MTA is a uniplane forefoot deformity involving the transverse plane (3). The forefoot at Lisfranc's joint is the apex of the deformity or center of rotation and angulation (4,5). The MTA deformity can be measured by comparing the lesser tarsus axis with the longitudinal axis of the second metatarsal, and can be classified as mild (15° to 20°), moderate (21° to 25°), and severe (>25°) (6–9). Additionally, numerous secondary deformities can present radiographically with MTA and include, but are not limited to, a splayfoot (hallux valgus with Tailor's bunion), hammertoes, and multiple triplane deformities including the cavoadductovarus, cavoadductovalgus, and pes planoadductovalgus (skewfoot) foot types (1,2,10–14).

When radiographically assessing the midfoot on the DP view, the medial cuneiform may be abnormally shaped, hypoplastic, or atavistic (Fig. 9*A* and *B*): short medial border versus normal lateral borders, which drives the MTA and or hallux valgus deformity. If a congenital pes planus coexists with the MTA, pronatory compensation through the midfoot and or hindfoot may cause the development of a skewfoot (Z-foot, serpentine foot) deformity. Skewfoot can clinically mask a moderate MTA deformity that is compensated through the midfoot. Therefore,

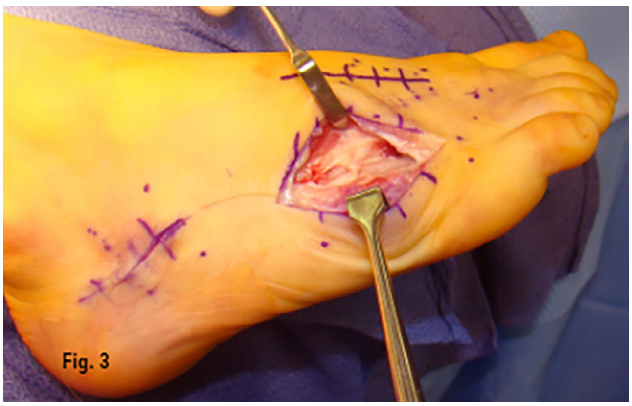


Fig. 3. The standard 3-incision dorsal forefoot approach began with the lateral incision exposing the fifth through the first metatarsals consecutively. An assembly-line surgical technique is followed to ensure meticulous dissection, especially in children.

isolated correction of the flatfoot deformity will unmask, increase the previously compensated MTA, and create an unwanted adducted postoperative deformity. Additionally, neglected MTA commonly causes pain with shoegear from hallux valgus, hammertoes, irritation of the prominent styloid process of the fifth metatarsal, and pes planus pain in the arch and midfoot secondary to end-stage arthritis (Fig. 10*A* and *B*), sinus tarsi syndrome, plantar fasciitis, Achilles and posterior tibial tendinopathies, and knee, hip, and lower back pain. Numerous axial skeleton conditions can occur concomitantly, contributing to the intoed gait pattern including but not limited to lower extremity torsional conditions (femoral anteversion, lack of tibial torsion), and lordosis and or scoliosis (8).

The degree of flexibility of the MTA deformity, not age, determines the type of treatment. Initially, all infants from birth to 9 months of age are treated conservatively with manipulation of the foot and serial casting, and this continues as long as the deformity progressively improves,

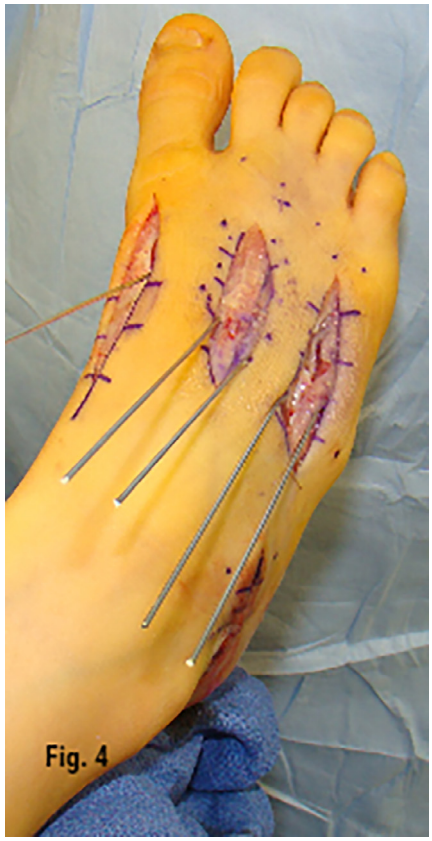
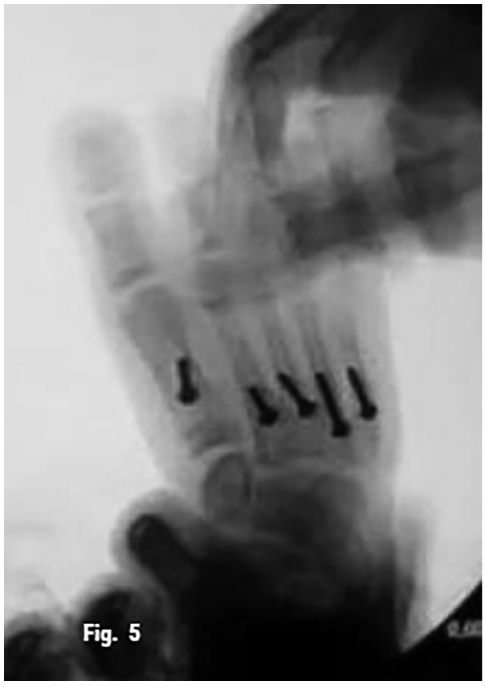


Fig. 4. The first 0.045-inch K-wire is inserted into the fifth metatarsal drill hole and left in place to serve as a reference guide for placement for the remaining 4 metatarsal drill holes. It is critical that all 5 drill holes, and, therefore, all K-wires are placed parallel to each other.



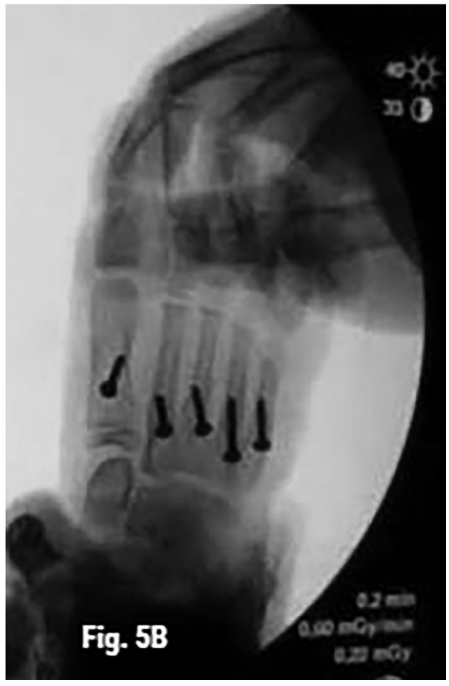


Fig. 5. Once all screws are inserted, the fluoroscopy unit is placed in a dorsoplantar position on the foot. Each screw is then unscrewed 2 turns (hence the need for each screw to be 2 mm longer than measured).

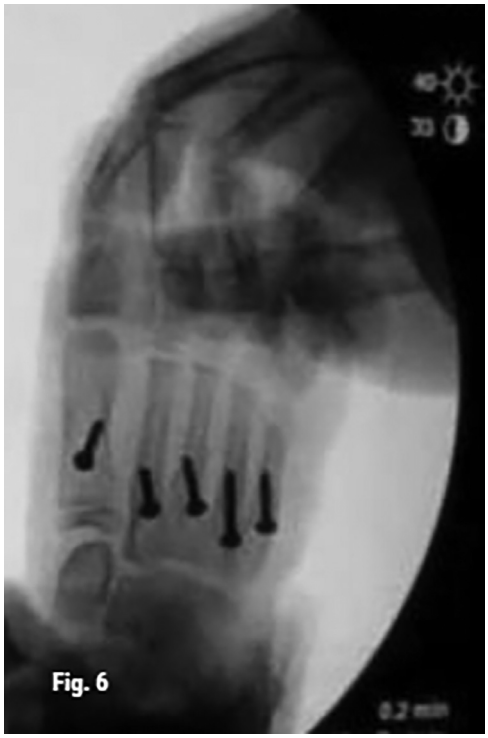


Fig. 6. Under direct fluoroscopic direction, the forefoot is abducted as a unit while visualizing the correction on the monitor.

and the patient remains asymptomatic (15). Thompson and Simons (2) documented success in children up through 4 years of age. Surgery is warranted when the MTA deformity becomes resistant or recurs following casting, straight-last shoes, and bracing, or the patient is unable to be controlled with custom orthotics. Additionally, if the patient is unable to play sports, gains weight, trips frequently, or has postural pain with routine daily activities, surgical intervention may be indicated. Historically, soft tissue procedures have been described for flexible and semiflexible deformities in children 6 months through 6 years of age. Osseous procedures are indicated when the deformity becomes rigid and tend to be used for patients >8 years of age (12,16). Children in the 6- to 8-year age range fall into a gray zone of treatment. In select cases, such as when the metatarsal bases have squared off, osseous procedures are warranted and soft tissue procedures now become adjunctive (17–24).

Steytler and Van der Walt (25) were the first to talk about pan-metatarsal osteotomies in 1966. They proposed oblique V-shaped osteotomies of all metatarsal bases with the apex pointed proximally. In 1971, Berman and Gartland (16) presented their classic article that introduced crescent-shaped osteotomies of all the metatarsals, with maintenance by a single transfixation pin through the first and fifth metatarsal heads that was incorporated into their cast. Reported complications included osseous bridging between the metatarsals and shortening of the first metatarsal, which was thought to be owing to a damaged physis and difficulty with fixation.

In 1987, a procedure was initially described by Lepird to the faculty of the Podiatry Institute, and his findings were published by Yu and Wallace (4), who detailed a modification of the Berman-Gartland procedure to address fixation complications by incorporating techniques. He proposed that oblique osteotomies of metatarsals 2 to 4 be made in a distal-dorsal to proximal-plantar orientation, in addition to oblique lateral closing wedge osteotomies of metatarsals 1 and 5, with each osteotomy fixated with a single AO screw. Reported complications of this procedure include stress risers of the dorsal cortex, loss of purchase

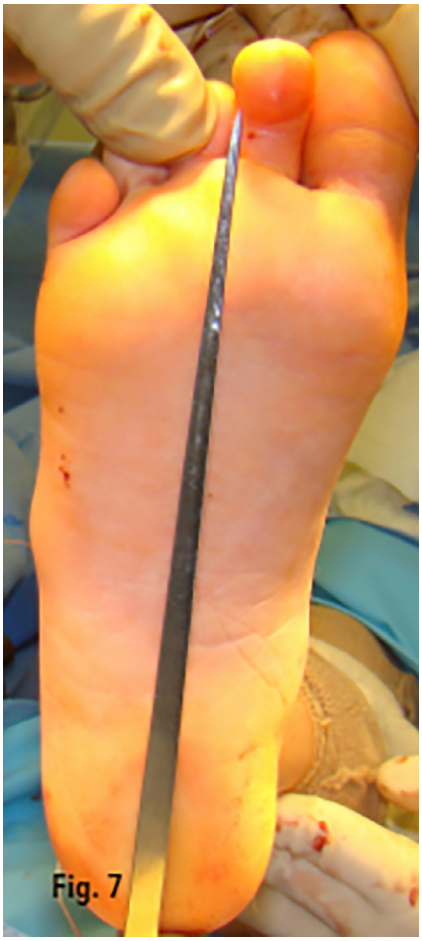
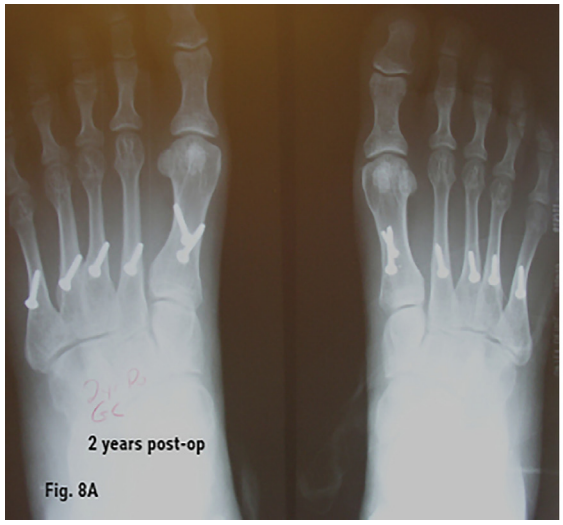


Fig. 7. The calcaneal bisector was used to confirm restoration of the longitudinal bisection of the hindfoot to the forefoot.

of distal cortex, inability to hold correction once achieved, and unequal removal of bone when performing the first and fifth oblique wedge osteotomies. This led to over- or undercorrection and the need for bone grafting.

In 1993, this author (S.J.S.) modified the Lepird procedure and addressed the complications associated with both the Berman-Gartland and Lepird procedures. His modifications included uniform osteotomies of all 5 metatarsals in the same dorsal-distal to plantar-proximal orientation, as opposed to only the central 3 metatarsals, and lateral closing wedge osteotomies of first and fifth metatarsals. The modified Lepird procedure allows a dynamic anatomic repositioning of the entire forefoot as a single unit, and when fluoroscopy is used during reduction, any over- or undercorrection can be prevented. This is not possible with previously described procedures, as the first and fifth metatarsals with the Lepird procedure and all 5 metatarsals with the Berman-Gartland procedure receive the same osteotomy wedge cuts. With this simple modification, the risk of over- or undercorrection is essentially removed.

Although the risks of over- or undercorrection in the transverse plane are minimized with the modified Lepird procedure, osteotomy hinge fracture, nonunion, malunion associated with proximal shifting, and sagittal plane elevation of the first and fifth osteotomies are potential complications seen with traditional Lepird oblique osteotomy configurations (4,18). The technique of parallel placement of each of the 5 screws is an essential component of the procedure to allow perfect translation around the single axis, and, therefore, eliminate the risk of sagittal plane malposition during deformity correction.



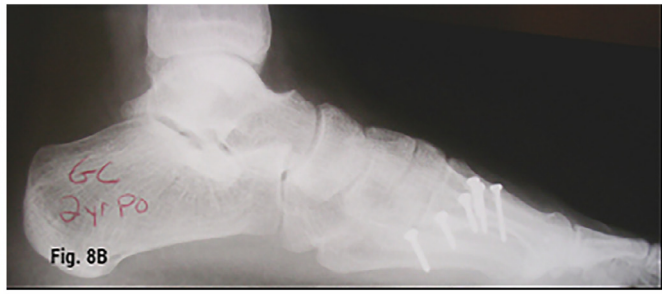
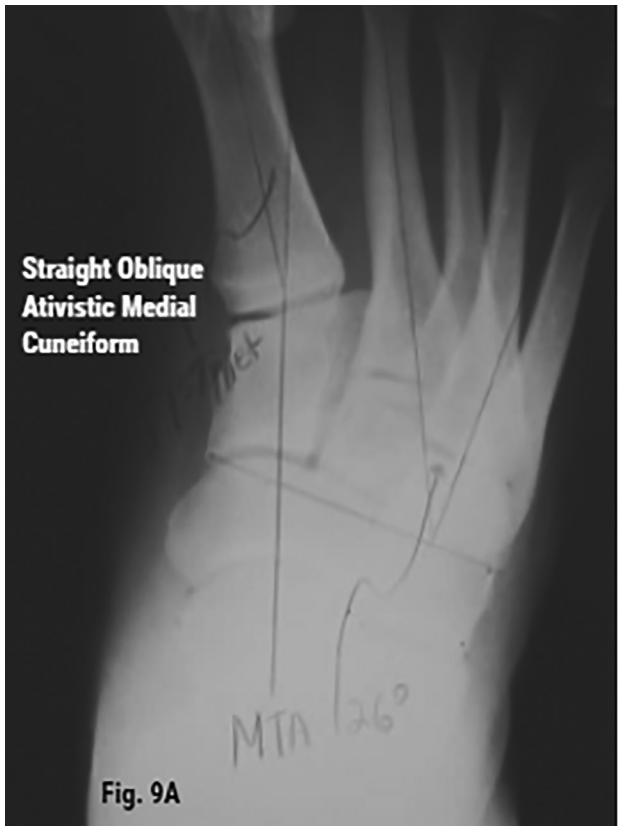


Fig. 8. (*A* and *B*) Radiographs confirmed 100% consolidation of both Evan's allograft and all osteotomies at the 2-year postoperative follow-up visit.

It is important that the inserted screws are 2 mm longer than the originally measured length. This is a vital step that ensures that the surgeon does not lose purchase of the distal fragment when each screw is loosened before live fluoroscopic manipulation of the forefoot. Another key step in this procedure is placement of the osteotomies. The osteotomy must be as close to parallel to the floor as possible and must bisect the guide hole close to the halfway point between the dorsal and plantar cortex where the K-wire exits. The more inferior the osteotomy is from this midpoint location, the more the ability of gaining a solid purchase of the distal cortex is at risk. If the osteotomy is placed to superior, intra-articular encroachment is likely.

A limitation of this procedure is the inability to use cannulated or partially threaded screws. Because of the need for all wires to be parallel to each other and the need for an assembly line technique, the wires must be removed before the osteotomy can be performed. Because the screw length is 2 mm longer than he guide hole measured, use of partially threaded screws increased the risk of failure to purchase the distal cortex.



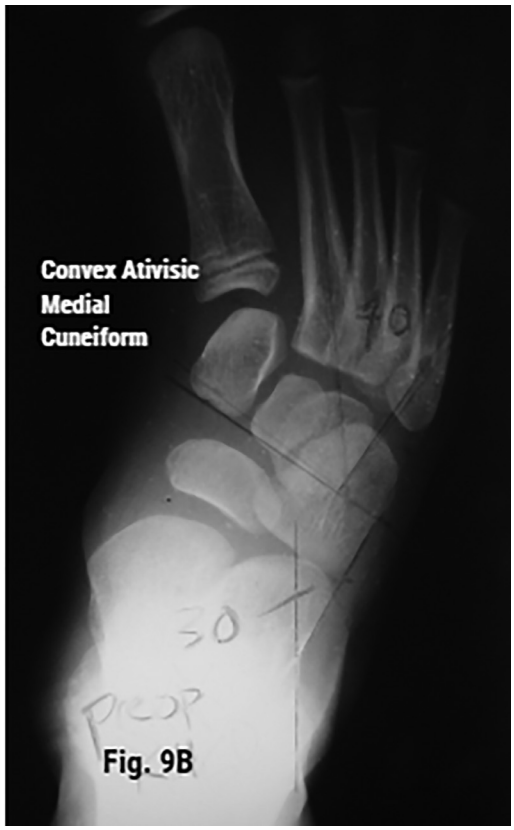


Fig. 9. Dorsoplantar radiographs used to assess the midfoot. The medial cuneiform may be abnormally shaped or atavistic with a short medial border and a long lateral border (*A*) versus a hypoplastic, concave shape that drives the MTA and or hallux valgus deformity (*B*).

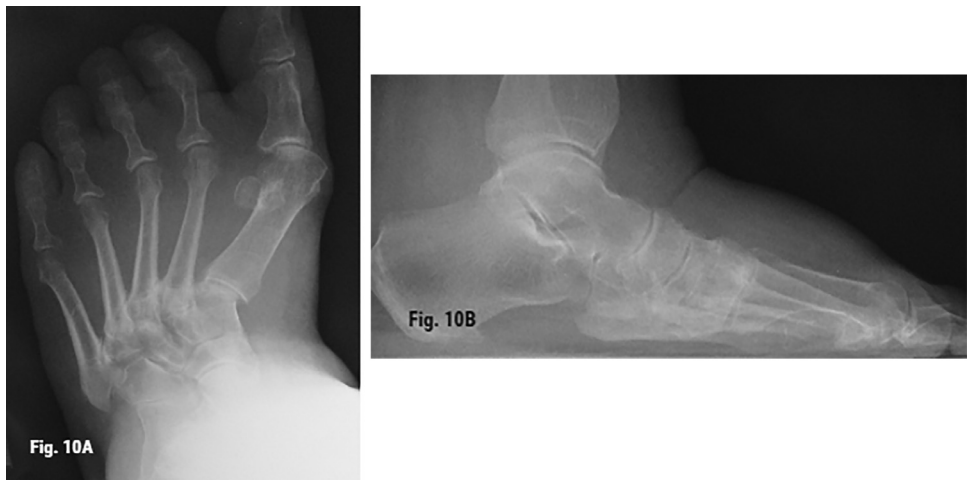


Fig. 10. (*A* and *B*) Neglected metatarsus adductus commonly causes pain with shoegear from hallux valgus, hammertoes, irritation of the prominent styloid process of the fifth metatarsal, and pes planus.

The most common complication with the modified Lepird procedure is a stress riser. There is very little landscape on the surface of the dorsal cortex available between the screw head and the dorsal-distal aspect of the osteotomy. If the dorsal cortex is not adequately countersunk, the osteotomy is performed too close to the guide hole, or care is not taken to prevent overtightening of the screw, stress risers and loss of stable fixation can occur.

In conclusion, the modified Lepird procedure allows the foot and ankle surgeon to dial in the exact amount of deformity correction thereby minimizing the risk of over- or undercorrection. The author recommends this procedure when pan-metatarsal base osteotomies are required for correction of MTA and associated deformities.

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