THE DISTAL AKIN OSTEOTOMY: A NEW APPROACH

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The distal Akin osteotomy with internal fixation has proven to be an effective and predictable method of correcting both proximal and distal deformities of the hallux. A total of 12 patients having 17 procedures performed were reviewed. All patients except two had radiographic union by 3 months. One patient developed a nonunion and one patient a bilateral delayed union; however, these were attributed to early non-protected weightbearing at 2 weeks postoperative. Some degree of interphalangeal joint stiffness has occurred in all patients but has not proven to be clinically significant. No screws have had to be removed due to soft tissue irritation. There have been no infections and no soft tissue complications.

In 1925, Akin[1] introduced a proximal phalangeal osteotomy as an adjunctive corrective procedure for hallux valgus deformity. A medially closing wedge osteotomy was performed at the phalangeal base with correction maintained by a tongue depressor splint. The authors have found that distal oblique osteotomy provides good clinical correction for all levels of phalangeal deformity, eliminating the need for more proximal osteotomies and their associated complications.

A review of the radiographic and topographic anatomy shows that the toe sulcus of the first interdigital web space corresponds to the distal one third of the proximal phalanx. Since any lateral deviation of the hallux is not visually apparent until the first interdigital web space is reached (when the toe becomes separate from the foot), correction by an osteotomy distal to this point will clinically straighten the toe, even though the phalanx may still be skewed radiographically.

Numerous revisions and modifications have been presented in the podiatric literature, often without detailed postoperative results.[2-7] It has been the senior author's experience that the transverse Akin osteotomy is prone to delayed healing and displacement. Although nonunion has been rarely reported in the literature, delayed union is more common and often associated with pain and/or edema, resulting in restricted activities and delay in wearing fashionable shoe gear.[8] The authors believe these complications can be minimized through a proper appreciation of the osseous anatomy, engineering and biomechanical principles, and fixation techniques.

A variety of methods have been proposed to fixate the Akin osteotomy, with most authors agreeing that some form of fixation is better than none. The goals of fixations are to maintain closure of the osteotomy, provide stability for bone healing, and resist the distractive forces placed upon the osteotomy while ambulating.[2-7,9-13] In 1971, Gerbert and Melillo[5] advocated fixation of the osteotomy with stainless steel wire. Although four cortices fixation is superior to two cortices, neither produces significant compression nor stability, especially when weightbearing. Kirschner wires, particularly cross-wired, provide greater stability than stainless steel wires, but without compression. Increased stability with some compression can be effectively provided with the bone staple. Internal fixation with bone screws provides rigidity of the osteotomy, which promotes bone healing and aids in early mobilization with guarded weightbearing. When a distal Akin is performed with hallux abducto valgus surgery, rigid internal fixation allows early range of motion exercises of the metatarsophalangeal joint without the fear of displacement, less pain for the patient, and the phalanx may be grasped proximal to the osteotomy site.

OSTEOTOMY PRINCIPLES

Correct placement of the osteotomy is of significant importance in resisting the normal forces acting upon the osteotomy, during weightbearing and to promote rapid bone healing. During weightbearing, the ground reactive forces acting upon the osteotomy and hinge are directed through the proximal and distal fragments, which act as two lever arms moving about a fulcrum or axis, i.e., the hinge. Stability of the osteotomy is provided by the hinge, fixation device and post-operative supports.

Hinge failure is minimized in the distal oblique osteotomy. In the transverse osteotomy, the dorsiflexory forces are perpendicular to the osteotomy cut and the line of the progression of gait. In an oblique osteotomy, the cuts are made approximately 45 degrees to the line of progression of gait and the dorsiflexory forces are significantly dissipated.

The lever arm length is directly related to the amount of force transmitted through the hinge. The larger the lever arm, the greater the force. The lever arm begins at the point where weight is borne (i.e., the tip of the hallux) and terminates at the osteotomy. A distal oblique osteotomy has a shorter lever arm than a more proximally performed distal transverse osteotomy; therefore, less force is placed upon the hinge (Fig. 1).

The quality and quantity of bone encountered in distal oblique osteotomy also plays a major role when considering the advantages of this osteotomy over the transverse type. A distal oblique osteotomy is performed through the metaphyseal portion of the proximal phalanx, while a distal transverse osteotomy is performed through diaphyseal bone. This results in superior bone stock for bone healing. Furthermore, the longer arms of the oblique osteotomy provide a large surface area of bone to bone contact. Cross-sectional viewing of the proximal phalanx reveals the distal metaphyseal cortical bone to be thin and rectangular, while the diaphyseal aspect is thicker and circular. This results in a metaphyseal hinge that is larger, straighter, and less likely to fracture during closure of the osteotomy than the hinge of a transverse diaphyseal osteotomy (Fig. 2).

Fixation is simplified with the distal oblique osteotomy. A transverse osteotomy that has a

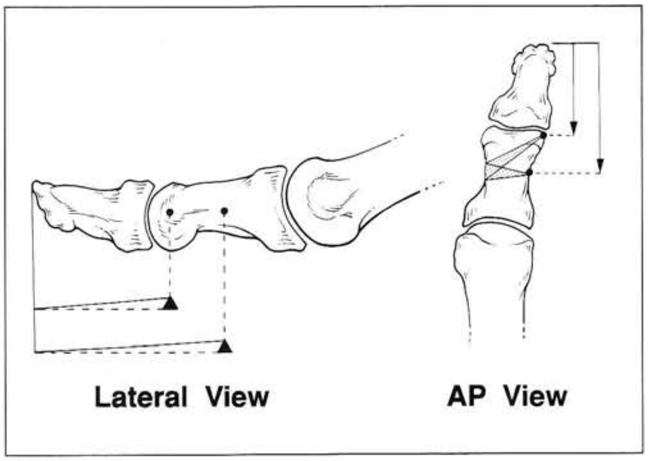

Fig. 1. Demonstrates increased lever arm length with more proximal osteotomies. The longer the lever arm, the greater the force about the fulcrum (hinge).

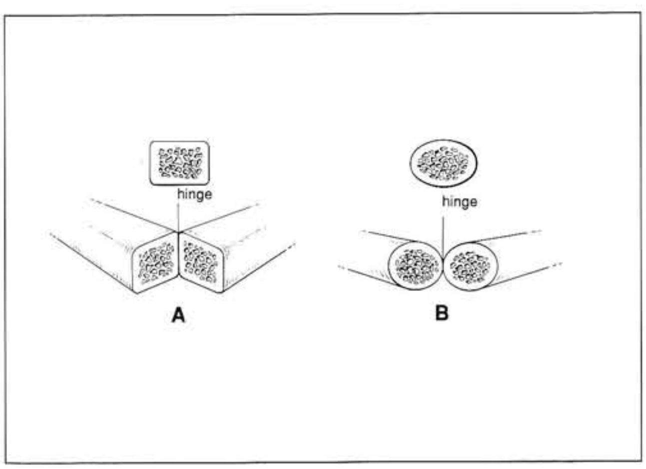

Fig. 2. Cross-section of the proximal phalanx in the distal metaphyseal region (A) and diaphysis(B).

metaphyseal hinge close to a joint surface leaves very little bone for fixation. The orientation of a distal oblique osteotomy provides large proximal and distal bone fragments for application of various fixation techniques.

PROCEDURE

To provide optimal exposure, an "L" shaped incision is utilized. The longitudinal arm of the incision is placed dorsomedially on the proximal phalanx. At its most distal aspect, the incision should be kept mostly medial to facilitate screw placement. The transverse arm is placed at a 90 degree angle to the longitudinal cut, immediately distal to the interphalangeal joint, in the transverse skin fold of the hallux (Fig. 3). The entire incision is deepened to the level of the deep fascia, and the skin flap is retracted laterally (Fig. 4). It is easiest to identify the deep fascial layer on the transverse incision as the thin retinaculum overlying the extensor hallucis longus tendon. Once this layer is identified, dissection is carried proximally and medially, maintaining the entire subcutaneous layer with the skin. This will help prevent necrosis of any part of the skin flap.

The subcutaneous layer is then separated from the periosteum on the lateral aspect of the proximal phalanx by blunt dissection. This will allow visualization for screw fixation. Next, the extensor hallucis longus is transected, immediately proximal to the interphalangeal joint. This leaves a small tag of tendon distally to facilitate repair at the procedure's end. The tendon will retract proximally less than 5 mm, due to the hood apparatus.

The periosteum is now incised along the course of the osteotomy. The osteotomy hinge will be in the distal lateral aspect over the proximal phalanx, proximal to the interphalangeal joint. Periosteum is reflected minimally, equal to the width of the osteotomy to be performed. No periosteum is reflected at the hinge. This helps provide stability should the hinge fracture (Fig. 5).

The osteotomy is now performed making the distal cut first. It is critical that the distal cut leave enough bone to accommodate the screw head. For this reason, subsequent cuts are always made proximally (Fig. 6). The osteotomy is closed and screw fixation by lag technique is accomplished. The 2.7 mm. cortical bone screw is

Fig. 3. The skin incision is outlined to provide excellent surgical exposure.

Fig. 4. Full thickness skin flap has been created and reflected exposing the long extensor tendon.

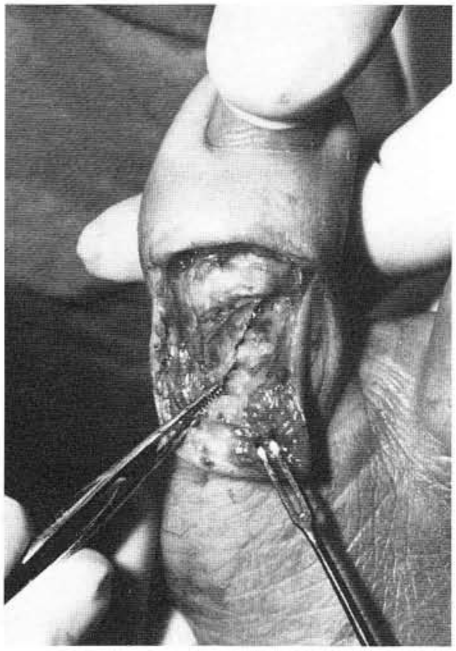

Fig. 5. Periosteum is incised along the course of the osteotomy and minimally reflected.

Fig. 6. The osteotomy is cut. The distal cut should always be performed first.

most appropriate for this task. Fixation is performed extraperiosteally (Fig. 7).

A 2.0 mm. pilot hole was placed on an angle in between perpendicular to the osteotomy and perpendicular to the cortex. The 2.7 mm. gliding hole was performed in the distal fragment. An adequate countersink must be performed to prevent fracture as the screw is tightened and to lessen the screw head prominence. The hole is measured and the screw of appropriate length is chosen. The 2.7-mm. tap follows. Finally the screw is inserted. A minimum of two threads must be seen protruding from the lateral cortex for fixation to be adequate. The periosteum is closed and the long extensor reapproximated with 4.0 absorbable suture. Postoperatively, the patient will ambulate in a surgical shoe for 4 to 6 weeks.

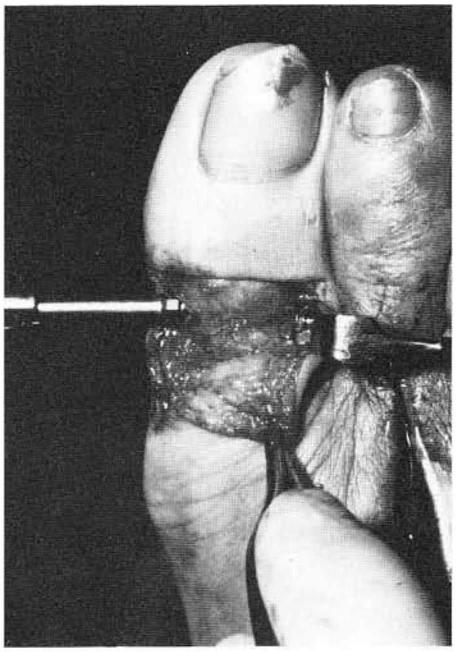

Fig. 7. The osteotomy is closed and fixation is performed extraperiosteally.

DISCUSSION

In the authors' opinion, the transverse Akin osteotomy lacks stability and often shows delayed radiographic evidence of bone healing, when the forces of weightbearing are applied.

Design modifications have been discussed, which increase osteotomy stability. Although rigid internal compression with screw fixation is preferable, adequate fixation with crossed Kirschner wires can be performed.

Rigid internal fixation, minimal periosteal reflection, and large surface area of medullary bone to bone contact will increase the rate of bone healing. Early failures in this procedure could be attributed to early weightbearing without the protection of a surgical shoe or cast. However, when proper postoperative care was followed, delayed union was not a problem.

The senior author has been performing this procedure for the last 4 years. During this time, there have been no wound healing problems. (Fig. 8, 9) the long extensor tendon function has not been lost. Stiffness of the interphalangeal joint is occasionally observed, but presents no clinical problems. Although the screw may be palpated medially and laterally, none have had to be removed for this reason.

Intraoperative problems initially encountered were related to poor osteotomy placement (Fig. 10). The initial bone cut was often too transverse, resulting in a distal fragment too small for screw placement, or so small that the bone fractured when applying bone reduction forceps. In several cases, the hinge was too distal and fractured through the joint surface. Although no painful degenerative arthritis has ensued, the possibility of such exists. Because of these complications, the importance of good exposure cannot be overemphasized. The surgical dissection described earlier provides the best visualization and exposes all elements critical to performance of this surgery.

Fig. 8. Three-month postoperative clinical appearance following Austin-Akin procedure.

Fig. 9. Postoperative radiographs left foot.

Fig. 10. Poor osteotomy placement with fracture and dislocation.

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