CHAPTER **22**

HALLUX INTERPHALANGEAL ARTHRODESIS: A Simple Technical Pearl

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Arthrodesis of the interphalangeal joint of the great toe is a common procedure performed by both podiatric and orthopedic surgeons. The indications include pain, deformity, or dysfunction secondary to a variety of conditions including post-traumatic or systemic arthritis, as well as hallux malleus, hallux abductus interphalangeus, or hallux flexus deformities.

To date, a variety of surgical techniques have been described and advocated to achieve clinical and radiographic fusion of the joint. While use of small cortical or cancellous screws is extremely popular, it is well-accepted that the use of such internal fixation devices may not be successful in patients with compromised bone stock. Poor quality bone stock prevents adequate purchase of screw threads, and is commonly seen in elderly patients. In many cases, this problem can be anticipated and predicted based on the pre-operative clinical evaluation and radiographic assessment. Generalized osteopenia and poor cortical definition of the bones in the forefoot may be indicative of less than optimal quality bone stock to ensure rigid internal compression fixation. Poor quality bone stock is surpassed only by less than optimal surgical technique as a contributing factor to failure to achieve an arthrodesis when screws are employed.

The use of Kirschner-wires (K-wires) for fixation of the interphalangeal joint of the hallux was well-popularized long before the advent of screw fixation. A variety of techniques for insertion of the K-wires has been described. The use of crossing K-wires continues to be an extremely popular technique for arthrodesis of this joint. Unfortunately, it too is associated with known and predictable complications, including loosening with external migration of the K-wires prior to the desired time of removal, and pin tract irritation or infections. This is in addition to the simple nuisances of maintaining and protecting the pins from catching on environmental objects including the bandages themselves, which further compromise the effectiveness of this modality as a predictable fixation technique. If these common problems could be eliminated or minimized, then perhaps the technique would be used more frequently and with greater confidence.

The authors will describe a very simple technique which has been extremely effective in avoiding many of the common problems associated with crossing K-wire fixation for hallux interphalangeal joint arthrodesis. It is hoped that this technique will encourage surgeons to reconsider the use of K-wires as a primary technique for fusion of this joint, whenever, in the surgeon's judgment, it appears that screw fixation is likely to be met with less than optimal rigid internal compression fixation.

Although this technique does not impart the compression at the fusion site which can be achieved with the use of cancellous screws, it does provide very effective and predictable stable fixation for an indefinite period of time. Another advantage includes the ability to remove the fixation devices without the need to perform a separate surgical procedure. Also, frontal plane rotation, which is known to occur with axial compression of one screw, is eliminated altogether. Finally, in the experience of the authors, this technique is faster and less invasive than techniques employing screw fixation.

SURGICAL TECHNIQUE

Any skin incision approach that has been described for fusion of this joint can be used. The technique is successfully employed via a longitudinal linear incision, transverse semi-elliptical incision, or a curvilinear incisional approach. The procedure can be performed from both a dorsal or plantar approach, such as when performing a concomitant excision of a plantar ossicle, or nucleated lesion or ulcer.

Following execution of a dorsal incision, the extensor tendon is reflected and the interphalangeal joint is disarticulated. The articular surfaces are removed to achieve correction of frontal, sagittal, and transverse plane deformities. A variety of techniques can be employed for resection of the bone. Most of the bone should be removed from the proximal phalanx to achieve correction of planal deformities. It is usually necessary to remove only a minimum of bone from the distal phalangeal base. Angular correction is not achieved by resection of large segments of bone from the distal phalanx. Removal of an excessive amount of bone from the distal phalanx compromises fixation because of the size and configuration of the bone. The amount of bone removed from the proximal phalanx will depend upon the degree and extent of deformity.

Hand instrumentation is recommended for removal and resection of bone from the proximal phalangeal head. Although power instrumentation can be used, hand instrumentation such as rongeurs or bone cutting forceps will result in a surface which is "splintered," providing a rough surface and a quality of desirable friction between the fusion interfaces. The peripheral cortical rim of bone from the proximal phalanx, as well as the distal phalanx is smoothened with a small power bur to enhance apposition of the cancellous portion of the fusion interfaces.

The authors frequently remove only the cartilage from the base of the distal phalanx, preserving the subchondral bone. This is accomplished utilizing small bone curettes, a surgical knife and/or a power bur. A series of 1.0 mm holes are drilled through the subchondral bone surface of the base of the distal phalanx. Drilling of the proximal phalanx is neither recommended nor necessary, since resecting the head of the proximal phalanx provides excellent exposure to cancellous bone. The authors believe that the drilling of the subchondral bone surface of the distal phalanx will enhance revascularization and thus, clinical and radiographic arthrodesis. If desired, the subchondral bone of the distal phalanx can be removed.

The hallux is placed in its desired position, and apposition of the fusion surfaces confirmed. Any adjustments for additional angular or positional corrections are made. Maximum contact between the central surfaces is emphasized. Contact of the peripheral edge of the fusion interfaces is less critical than the more central portion of the fusion site.

The interphalangeal joint is then stabilized using standard retrograde technique with two 0.062 inch K-wires in a crossing fashion. The K-wires are typically driven distally through the distal phalanx, exiting the medial and lateral borders of the hallux. The K-wires' point of penetration in the base of the distal phalanx is central, with one K-wire entering slightly superiorly and the other slightly inferiorly. This is done in order to avoid collision of K-wires as they are retrograded out to the tip of the toe and back into the proximal phalanx. The authors have found that the design tip of the K-wire also plays a role in the ease and placement of the K-wires. A K-wire with a bayonet-type point is more difficult to handle than is one with a diamond-shaped point. A diamond or trocar-shaped point at the tip of the K-wire results in the most accurate and precise placement. The K-wires are then retrieved distally and retrograded so that they are flush with the distal phalangeal base surface.

Next, the distal phalanx is placed in its desired position against the proximal phalangeal surface, and the K-wires are driven proximally into the proximal phalanx. Preferably, the K-wires exit the medial and lateral cortices of the diaphyseal area of the proximal phalanx. In some cases, the K-wires have been driven more proximally into the subchondral bone area. The K-wires should not be positioned or left within the medullary canal of the proximal phalanx, as this will significantly compromise stability of the arthrodesis site. Penetration of the subchondral bone plate or the medial and lateral cortices enhances the long-term stability of the K-wires.

In some cases, the K-wires are driven in such a way as to exit the distal pulp of the toe at its medial and lateral borders, rather than exiting the toe along its medial and lateral sides. The more distal the point of exit, the more likely the K-wires will cross proximal to the interphalangeal joint fusion site. K-wires which exit the medial and lateral borders of the toe are more likely to cross each other within the fusion site itself. While the latter technique may seem to be more academically sound, it is of a moot clinical point, providing the arthrodesis site has been maintained in a compressed state as the K-wires are driven proximally. Failure to maintain proper position as

the K-wires are driven may result in the K-wires actually maintaining distraction or malalignment of the fusion site, increasing the likelihood of a bone healing complication. The specific placement of the K-wires may depend upon the nature of the deformity and the surgeon's personal preferences.

The external portions of the K-wires are now bent so as to cross transversely at the distal tuft of the toe parallel to each other. The point where the K-wires exit the hallux will determine the number of bends required in each K-wire. In cases where the K-wires exit the distal pulp of the toe at its medial and lateral borders, only one bend for each K-wire will be necessary. In cases where the K-wires have exited the medial and lateral aspect of the hallux proximal to the distal tuft, two bends will be required. The first bend will place the external portion of the K-wire parallel to the long axis of the hallux. The second bend will then be at the distal tuft of the toe. This will be a 90 degree bend, which will then place the distal aspect of the external portion of the K-wire parallel to the distal tuft of the toe (Figs. 1, 2). In order to achieve accurate bends in the K-wire, a pair of heavy, short, needle-nose pliers and a wire bender are indispensable instruments. The tip of the typical surgical suction unit may also be used to facilitate bending. The K-wires should not be bent indiscriminately. The precise placement and angle of each bend, determines the final outcome.

Finally, the excess K-wire is cut. The two K-wires, which have now been bent and positioned parallel to each other in the distal tuft of the toe, are fastened together using paper tape or wound closure strips. If applied during the surgery itself, then half-inch steri-strips are recommended. If performed after the closure and dressing of the toe, then non-sterile tape is adequate (Figs. 3A, 3B).

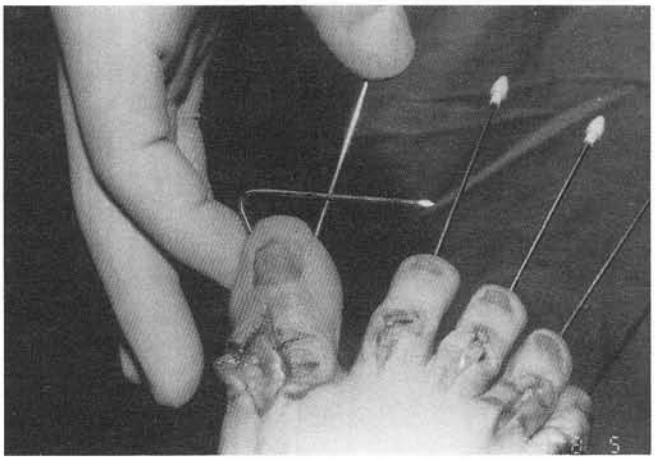

Figure 1. Intraoperative photograph showing placement of two crossing 0.062 inch K-wires for arthrodesis of the interphalangeal joint of the great toe. In this case the two K- wires exit the distal tuft of the toe. One K-wire has been bent parallel to the distal tuft.

Figure 2. Intraoperative photograph showing both K-wires bent parallel to the distal tuft of the toe. The excess K-wire will be cut and discarded, allowing the two overlapping portions to be taped together.

Figure 3A. Clinical photograph showing the K-wires being secured by use of a large wound closure strip.

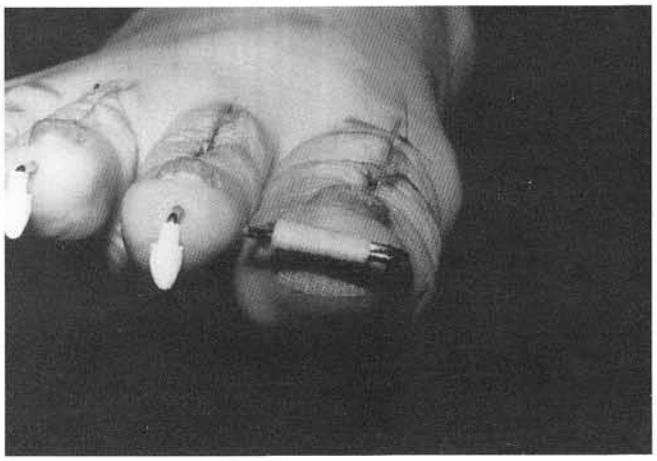

Figure 3B. Frontal view of the K-wires.

The surgical wound is irrigated with normal sterile saline and the fusion site is inspected to insure good reciprocal fit between the adjacent surfaces. Intraoperative x-rays are obtained, if necessary, to confirm alignment and position of the K-wires. It may be desirable to obtain intraoperative x-rays prior to bending the wires. Careful digital palpation will also confirm accurate placement. In some cases, the site of exit of the K-wires in the proximal phalanx can be visualized. In other cases it will be necessary to confirm their position by digital palpation. The first metatarsophalangeal joint should be placed through a range of motion to ensure that the K-wires are not penetrating or crossing this joint.

The extensor tendon is reapproximated. The subcutaneous tissues are reapproximated, as is the skin. The suture material utilized for closure will depend upon the preference of the surgeon; 4-0 absorbable multifilament synthetic sutures are typically used for deep closure. The skin is closed via a monofilament absorbable or non-absorbable synthetic suture such as polypropylene, nylon or polydioxanone.

RATIONALE FOR TECHNIQUE

The joining of the two K-wires prevents either wire from migrating inward or outward, loosening, or rotating. The two wires have now been joined together and function as a unit. External or internal migration of one or both of the K-wires is greatly reduced, if not eliminated altogether. This effectively allows the surgeon to maintain stable fixation of the arthrodesis site for an indefinite period of time. The end result is the increased likelihood of a solid clinical and radiographic fusion.

Success of the procedure does, of course, depend on close apposition of the fusion interfaces. Failure to achieve this aspect of the procedure is likely to result in a bone healing complication, as the technique will maintain distraction of the fusion interfaces. Although compression arthrodesis may be more desirable, it is not practical in all patients, especially those with compromised bone stock. In addition, rotation of the distal phalanx on the proximal phalanx is a potential complication occasionally encountered with a single axial compression screw technique. Rotation is virtually eliminated with the use of K-wires as described previously.

POSTOPERATIVE CARE

The surgical dressing is changed at 5 to 7 days postoperatively, and the surgical site inspected to identify any potential complications. A dry sterile dressing is reapplied. At two weeks postoperatively, the hallux is typically protected by the use of tube foam, which is cut just slightly longer than the external portion of the K-wires. In some cases, the K-wires are further stabilized by using paper tape or a large steri-strip which is attached to the nail dorsally and the tuft of the toe plantarly.

If swelling is a problem, it is best managed with a compression wrap of the hallux, using materials such as Coban or more commonly Halftelast. Caution should be exercised when applying such compression bandages to the hallux to avoid creating a tourniquet or restricting band that will result in increased distal edema.

Serial x-rays are obtained to confirm consolidation at the arthrodesis site at 3, 6 and 9 weeks postoperatively. A minimum of two views is recommended. When solid radiographic arthrodesis is seen, the K-wires can be removed (Figs. 4A, 4B, 5-9).

The K-wires are easily removed after separating the tips of their joined portions distally. This is accomplished by using a #15 or smaller blade to cut through the adhesive strip between the two K-wires. The wires are then rotated and easily retrieved. Pliers may be used to facilitate removal. A local anesthetic block is not necessary.

Figure 4A. Preoperative dorsoplantar radiograph of a 78-year-old patient with a severe fixed contracture of the hallux with a pre-ulcerative lesion over the dorsal aspect of the joint. Other digital contractures were completely asymptomatic and non- problematic, as was the malalignment of the first metatarsophalangeal joint itself.

Figure 4B. Preoperative lateral radiograph.

Figure 5. Postoperative dorsoplantar radiograph following fusion of the interphalangeal joint of the great toe using two 0.062-inch crossing K-wires. Note the exit of both K-wires through the diaphyseal cortex of the proximal phalanx. Also note two bends in the K-wire; the first to bend the K-wire parallel to the long axis of the toe and the second bend to allow the two K-wires to overlap each other at the distal tuft of the toe. The K-wires have been secured using a wound closure strip.

Figure 6. Clinical photograph of the same patient several weeks postoperatively. Note the adhesive binding is in place, securing the two K-wires to each other. This has prevented inadvertent inward and outward migration of the K-wires.

Figure 7. Postoperative radiograph demonstrating the use of two 0.062-inch K-wires, which are embedded into the subchondral bone plate of the proximal phalanx. In this case the K-wires exit the distal pulp of the toe rather than the medial or lateral sides, precluding the need for two bends. One bend has been performed at the distal end of the wire, placing the bent portion parallel to the pulp of the toe. The two wires are secured to each other using adhesive wound closure strip.

Figure 8. Dorsoplantar x-ray taken approximately 6 weeks postoperatively. Note the absence of any migration or rotation of the K-wires. Excellent stable fixation has been maintained in spite of the fact that the joint has not yet gone on to a solid radiographic fusion.

Figure 9. Dorsoplantar x-ray of the same patient approximately one year postoperatively. Note the excellent consolidation at the fusion site.

SUMMARY

It is hoped that this simple surgical technique, requiring minimal special instrumentation or materials, will enhance the surgical outcome of hallical arthrodesis utilizing K-wires. To date the technique has been shown to be simple, efficient and effective. It is particularly beneficial in patients with compromised bone stock in whom rigid internal compression fixation via cancellous screws is unlikely to be successful.