CHAPTER **13**

SURGICAL TIPS AND TRICKS WHEN CORRECTING HAMMERTOE DEFORMITIES UTILIZING AN INTRAMEDULLARY DEVICE FOR PROXIMAL INTERPHALANGEAL FUSION

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INTRODUCTION

The most common fixation for proximal interphalangeal (PIP) fusion is provided by smooth 1.1 mm (0.045") or 1.6mm (0.062") Kirschner wires (K-wires) placed in an antegrade manner through the middle and distal phalanges while PIP joint extension and distraction are maintained. It is then placed in retrograde fashion into the proximal phalanx. Pin fixation is necessary for four to six weeks after surgery (1). The pins are capped to prevent the sharp ends of the pins from catching on objects such as the patient's bed sheets. Although percutaneous K-wires are effective, nonunions can be quite common. Other treatment challenges associated with K-wire fixation include migration and loss of fixation (2). Issues such as pin tract infections as well as difficult postoperative management by patients make alternative fixation methods desirable (3).

Having used percutaneous K-wires to provide fixation to the resected proximal interphalangeal joint, surgeons seek a means of providing fixation that is more stable than a K-wire as well as to mitigate the difficult postoperative management required by patients receiving this type of fixation.

A novel intramedullary device is now available to treat hammertoe deformities. While most surgeons are very comfortable with the surgical technique to treat hammertoes using K-wires, the insertion technique for an intramedullary device although similar to that for a K-wire requires specific techniques to take advantage of the implant's design features. This article offers operative techniques observed by the designing surgeon and other highly experienced users that facilitate the use of this implant and help ensure the most positive clinical outcomes possible.

IMPLANT DESIGN

The ARROW-LOK Digital Fusion System (Arrowhead Medical Device Technologies, Collierville, TN) is the specific implant (Figure 1) used in the development of this article. The ARROW-LOK was designed to improve upon the performance of the K-wire, the accepted standard for fixation of osteotomies, arthrodeses, and reconstruction in the lesser toes following corrective procedures. The ARROW-LOK device provides more stable fixation than the K-wire and reduces the incidence of complications that can be caused by pin tract infections. Since the ARROW-LOK is intended to be permanently implanted, the surgeon avoids having to remove the device.

Figure 1. ARROW-LOK Digital Fusion System Implant (19 mm).

Machined from a single piece of 316L stainless steel, the ARROW-LOK is a solid, 1.5 mm (0.059") diameter shaft with a three-dimensional arrow shape at each end. The implants are available in several lengths to fit the lesser toes of a wide range of patients. It also comes in two different angles: one with a neutral orientation, the other with a 10° plantar grade angle.

OPERATIVE TIPS AND TRICKS

There is a learning curve. Commit to trying ARROW-LOK on at least five patients while closely following the recommended technique. As simple as the ARROW-LOK is and uncomplicated the operative technique may be, please expect to take at least five to ten cases to become comfortable with the product, the operative technique and how the design interacts with the anatomy. A minimum of five cases may offer the surgeon the opportunity to experience the simplicity of the ARROW-LOK system on patients with varying bone quality and assorted anatomical variations.

Preoperative Planning Helps Determine the Correct Size Implant

Review the preoperative radiographs and the patient examination. Utilize the ARROW-LOK radiographic template to evaluate if the size of the intramedullary canal can fit a 3.5 mm diameter arrowhead (Figure 2).

Anticipate the soft tissue releases.

Get an estimate of the size and shape of the intramedullary canal.

Predict the implant length.

Consider that the removal of bone from the ends of the proximal and intermediate phalanges will result in 3-5 mm less length for the implant.

Notice where the width of the intramedullary canal is less than the 3.5 mm diameter of the ARROW-LOK implant. Measure to ensure there is enough length to accept an implant, considering that the length of the implant includes the 3 mm length of the arrowhead tip.

Expect the unexpected. Be prepared.

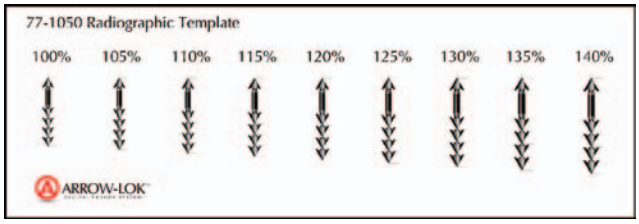

Figure 2. ARROW-LOK radiographic template aids in preoperative planning.

Ream Down the Center of the IM Canal

Aim the reamer 1-2mm plantar of the geometric center of the intramedullary canal (Figure 3). Placing the reamer in this orientation will help ensure that the pilot hole will be as close to the center of the intramedullary canal as possible. Why is this important? Some surgeons have a tendency to ream too dorsal because that is the technique they use when implanting K-wires. Reaming too dorsal can cause the implant to catch on the cortex upon insertion, preventing it from smoothly advancing down the broached cavity.

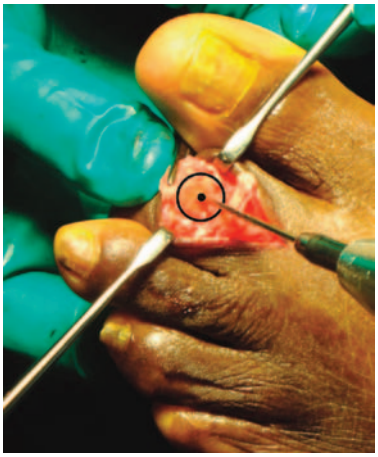

Figure 3. Reaming down the center of the intramedullary canal provides a proper-placed pilot hole for the subsequent step of broaching.

Broach Straight In and Straight Out and Avoid Wiggling the Broach

Advance the broach carefully into the pilot hole. Avoid wiggling the broach when inserting. Doing this will enlarge the broached cavity, reducing the amount of interference fit provided by the arrowhead tip (Figure 4).

Likewise, remove the broach by pulling straight out. Avoid wiggling the broach when removing to avoid inadvertently widening the broached cavity. Remember the main objective is to create an accurately-sized cavity that provides a degree of press-fit with the arrowhead.

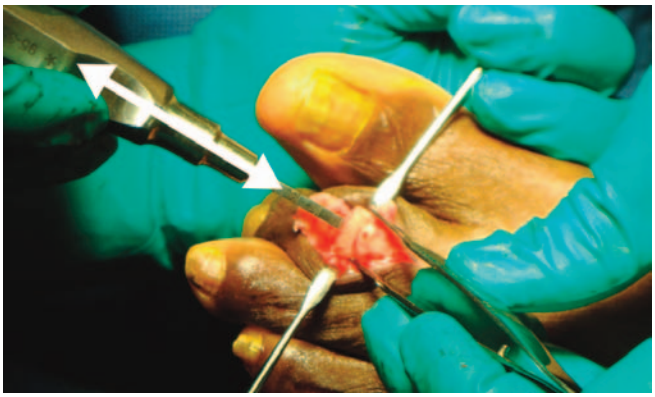

Figure 4. Create an accurately sized channel for the implant by broaching straight in and straight out. Avoid wiggling the broach in the medial/lateral directions to "work it in" the IM canal.

If the Broach Does Not Freely Advance, Tap it Gently With a Small Mallet

In harder bone, the broach may be difficult to insert by hand. In instances like this, use a small mallet to advance the broach. Remember the broach must go straight in and straight out. DO NOT wiggle the broach.

Gently tap the broach straight on. If the broach stops advancing and/or the tone created by the hammering changes, STOP HAMMERING to ensure that the bone will not fracture. Consider shooting a picture with your C-arm to evaluate the location of the broach in the intramedullary canal.

Broach in 5mm Increments, Remove, and Repeat

When broaching in hard bone, advance it carefully in 5mm increments (Figure 5). Remove the broach to allow the bone to "relax" prior to continuing the broaching process.

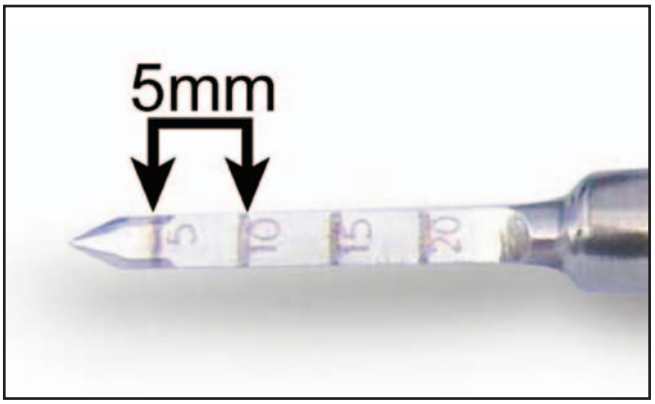

Figure 5. The tip of the ARROW-LOK broach is graduated in 5mm increments.

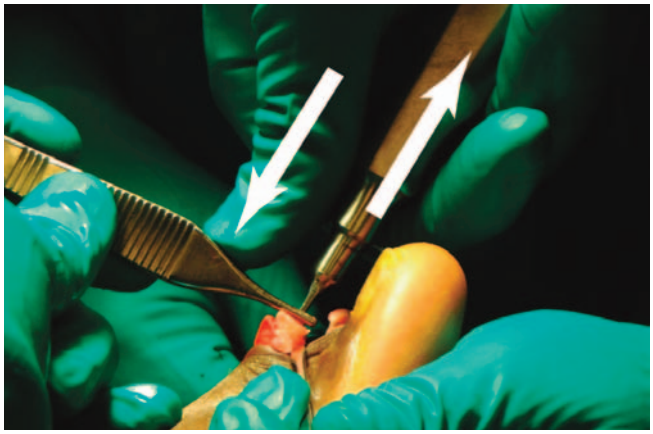

Figure 6. Remove a "stuck" broach by placing a pick-up against the bone, exerting a pushing force with your thumb.

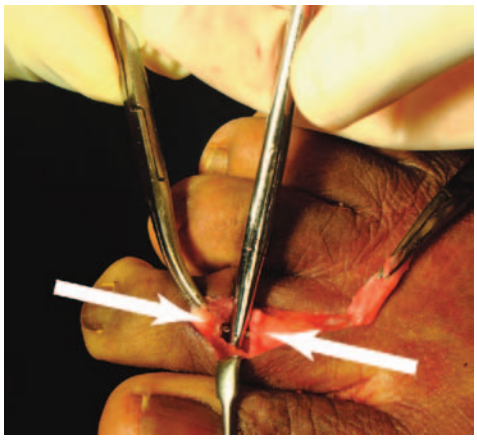

Figure 7. Keep the insertion forceps engaged until the proximal and middle phalanges are touching it securely.

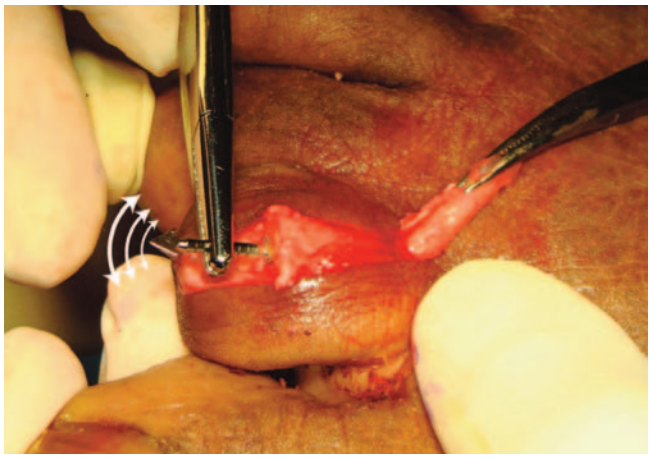

Figure 8. A small plantar/dorsal wiggle of the implant may be all that a "stuck" implant needs to dislodge it and enable it to progress down the broached cavity.

Remove a Broach That May Be Difficult to Extract By Pressing Your Thumb Against a Pick-Up

Place a pick-up on either side of broach, held against the bone in which the broach has entered. Place the thumb of the hand holding the broach against the forceps and push (Figure 6). This will place the force of removing the broach against the bone itself, sparing the toe from any strain on the soft tissue.

Keep the Insertion Forceps Engaged on the Implant Until Both Segments are Compressed Against It

The insertion forceps serves as a positive stop for the implant (Figure 7), preventing it from advancing further into the proximal phalanx when compressing the intermediate phalanx on the distal end of the implant.

If the Implant is Not Advancing and Seems Stuck

Gently wiggle the implant in the plantar direction.

Try gently wiggling the implant in the plantar direction to ensure it is progressing centrally down the broached cavity (Figure 8). Users have occasionally experienced difficulty during insertion when the implant on the insertion forceps is aimed slightly too dorsal and catches on the cortical bone.

Lightly strike the insertion forceps with a small mallet as close to the implant as possible.

Should the implant not advance after the technique described above it may be hung up on a piece of cancellous bone, use a small mallet to lightly strike the insertion forceps at a spot on the instrument as close to the implant as possible. Striking the forceps at this location will direct the implant in a direction straight down the broached cavity.

"Walk" the arrow down the broached cavity by rocking the implant medially and laterally while exerting pressure.

Rocking the implant medially and laterally while exerting pressure on the insertion forceps can advance the implant by engaging one side of the arrow in the broached cavity then pivoting the implant as far as possible to engage the opposite side.

Once the Implant is Inserted, Resist the Urge to Grab the Toe and Exert a Pull-Out or Rotational Force to Test the Stability of the Implant

Once the ARROW-LOK is implanted, resist the urge to tug on or twist the toe to evaluate the stability of the implant. This should be considered destructive testing and may compromise the fixation of the implant.

Close the Extensor Tendons to Help Ensure Stable Fixation

Close the extensor digitorum longus and brevis tendons and reapproximate the medial and lateral collateral ligaments (Figure 9) to help further stabilize the proximal interphalangeal joint that has just been fixated with the ARROW-LOK implant. The more stable a fusion site is, the faster union takes place.

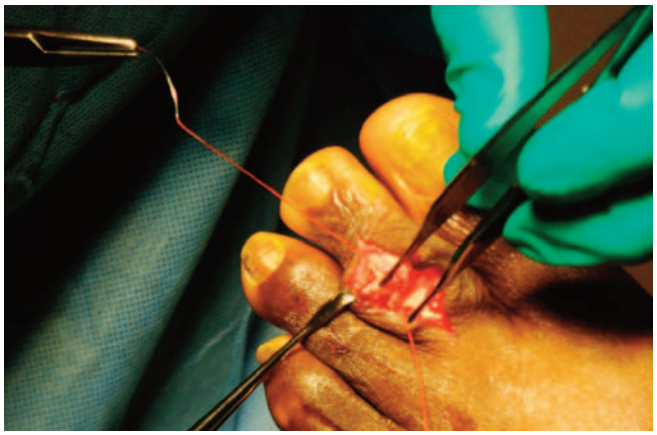

Figure 9. Closing the extensor tendons, reapproximating the collateral ligaments, and closing the capsule all help to ensure the soft tissue contributes to fusion site stability.

What Happens if the Implant Does Not Fit Regardless of What I Do?

An absolute last alternative backup is to use a 1.6 mm K-wire and fixate in the traditional manner. The authors experienced isolated instances in which in spite of pre-operative planning that suggested the intramedullary canal would accept an implant, the intramedullary canal was too narrow to accommodate the 3.5 mm diameter of the ARROW-LOK implant.

CONCLUSION

The most common fixation for proximal interphalangeal fusion is provided by a smooth K-wire. Although percutaneous K-wires have been used extensively for years, complications are well-documented. Surgeons have attempted to overcome the shortcomings of K-wires with a variety of surgical techniques, designs and materials, each presenting its own compromises and trade offs. After considering the key objectives of proximal interphalangeal fixation, surgeons developed an implant combining the benefits of K-wires with a design offering more stable fixation. The ARROW-LOK Digital Fusion System exhibits the potential to offer surgeons an alternative solution to proximal interphalangeal fixation that will provide patients a more effective clinical outcome than current treatment alternatives.

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