CHAPTER **14**

HAMMERTOE IMPLANT OPTIONS

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INTRODUCTION

Hammertoes are referred to as a muscular imbalance that manifests in a digital deformity and affects multiple joints within the forefoot. These opposing forces on the digit cause clinical repercussions including metatarsalgia, callous formation, ulceration, osteoarthritis and acute stress fractures. The etiology of hammertoe deformity is placed into three categories, all of which have been well documented within the literature. They include flexor stabilization, flexor substitution, and extensor substitution. A discussion of each is outside the realm of this review but can be found in many of the articles available.

Hammertoes are diagnosed as rigid or flexible and noting either will distinguish procedures for optimal results. The amount of dissection is significantly increased with a rigid deformity and maintaining the anatomic layers and landmarks becomes paramount for deformity correction. It is important to note that rectification with implantation is the ultimate goal but this may not be achieved without proper tendon and capsular balancing to manipulate the distal trajectory of the digit.

Hammertoe correction has been studied and modified for well over 100 years. The fusion of the digital joints did not begin until Soule in 1910 with an end-to-end arthrodesis. This was further altered through the years, forming a spike in hole arthrodesis by Higgs in 1931. Taylor and Sheffield later embraced internal fixation in the form of a Kirschner wire (K-wire) in 1940 and since that time, numerous attempts have been made to replace the K-wire as the definitive implant for hammertoe correction (1).

IMPLANT OPTIONS

Classification of the implants can be separated in many ways, one of which is by the materials in which they are made. These components include stainless steel, titanium, nitinol, silicone, and bioabsorbable configurations. Further dissection into the available implants reveal a subgroup consisting of heat activated, non-heat activated, absorbable and traditional. While the materials for implantation have varied over time, the principles of surgery remain the same when they were described by Glissan in 1949. He stressed complete resection of the cartilaginous surface, proper positioning of the joint, bone on bone apposition, and maintenance of the position until fusion has occurred (2). While the joints in question are significantly smaller than larger procedures, it is important to remember that the principles discussed in his article should always be embraced with any arthrodesis.

Below is a discussion on many of the available options for digital arthrodesis. It is the purpose of this paper to briefly explain each system, while not endorsing any product in particular.

Traditional

K-wire fixation has been the standard form of fixation for hammertoe surgery since it was described by Higgs in 1931. Coughlin surgically corrected 118 hammertoes by proximal interphalangeal joint fusions using K-wires. He showed an 81% successful fusion rate across the arthrodesis site. While it is the "tried and true" form of fixation, the K-wire is not without its disadvantages. Complications noted by Coughlin were most commonly reported as malalignment and numbness associated with nonunion. Another study by Caterini et al accounts for futher disadvantages, including the duration of time that the wire must remain implanted, lack of compression, protection of the wire, and an inability to return to regular shoe gear sooner. Lamm et al similarly conveyed a nonunion rate of approximately 20% when intramedullary K-wires were employed (3-5). That being said, the K-wire is a form of fixation that has proven results. One only needs to be aware of the above complications and how to deal with them when they occur.

Other creative techniques using an intramedullary K-wire, cut to size, has modernized the surgical correction and allowed for optimal fixation with greater patient satisfaction. Procedures with K-wire fixation allow for a greater risk for pin tract infection, alternately a buried wire eliminates this problem and eliminates the psychological aspect of an exposed piece of hardware.

Proximal interphalangeal arthrodesis fixated with a stainless-steel wire is another option. Harris et al accomplished this method with 20 or 22 gauge wire. The wire is traversed through drill holes from medial to lateral in the transverse plane of the distal aspect of the proximal phalanx and then from lateral to medial through the base of the middle phalanx. The ends are then braided together with the digit held in a straight or slightly plantarflexed position. This procedure may also be accomplished with an adjunctive fixation device including an intramedullary wire or absorbable pin to aid in the coaxial positioning of the digit (6).

Non-Heat Activated

Digital arthrodesis across the proximal and distal interphalangeal joint has traditionally been preformed with removable K-wires, but the advantage of screw fixation is allocated when compression and resistance to bending forces are necessary. In a study by Caterini et al, 51 digital joint fusions were attempted using a 3.0 mm titanium cannulated screw. During a mean follow up of 2.6 years, 7 revisional operations were reported due to improper implantation and screw breakage at the runoff of two of the patients and five of the revisions due to persistent pain in the digit. However, the recorded AOFAS score average was 86.54 and sanctions earlier weight bearing, approximately 4 days following surgery with regular shoe gear in two weeks (4).

The MiniAcutrak screw is a fully-threaded headless screw. The headless nature and fully threaded make-up affords it a conical shape, giving it an advantage to other forms of fixation for added surface area for compression across the osteotomy site. The Acutrack screw has also been used in the hand by Brutus et al for distal interphalangeal joint fusions in 27 fingers. There were complications reported in the study where 4 patients sustained a nonunion and 2 of those 4 had infection. The screws were extracted from 3 patients, 2 due to infection and 1 for revisional surgery (7).

The Stayfuse Intramedullary titanium digital arthrodesis implant initiated by Tournier is a two-piece design. The opposite threaded configuration accommodates excellent cortical purchase of the threads within the intramedullary canal and a central snap for approximation and compression across the fusion site of the proximal interphalangeal joint. There has been some user error noted and an inability to fasten the central snap has resulted in nonunion due to arthrodiastasis of the fusion site (8).

The Protoe, introduced this year, is a product introduced by Wright Medical that has a unilateral arrow-shaped design with the opposite pole screw threads. The threaded portions of the device are implanted proximally through the intramedullary canal of the proximal phalanx while the arrow point portion is impacted into the intramedullary canal of the middle phalanx. The mechanical forces of the digit are resisted by its barbed projections at the arrowhead distal aspect and the compression provided by it proximal threaded portion. The stainless steel Protoe is available in two sizes, 13mm and 16mm, as well as 2 angulations, straight, and 10 degrees of plantarflexion (1).

The ArrowHead, a fairly new system that was introduced in early 2011, is a fixation system that acquired its name from the three-dimensional architecture of its proximal and distal portions. The stainless steel make up of the arrowhead implant and barbed design adds to its performance and compares well with previous products including pullout, bend, and rotational testing parameters, as suggested by the developers. Like other devices, the Arrow-Lok is provided in 3 sizes and 2 angulations, straight and 10 degrees of plantarflexion. The device does not require any temperature-controlled environment since the metal holds no memory components as seen with nitonol (1).

Silicone

Orthopro's Orthoflex is designed on a silicone elastomer platform for those patients that wish to avoid complete arthrodesis and maintain motion at the proximal interphalangeal joint. This system is recommended by Orthopro due to its ease of placement during the procedure provided by its double-stemmed design and its depth guide. Orthopro presents two sizes of the implant and is recommended for moderate to severe hammertoe deformities. Although there are complications including dendritic synovitis, infection, pistoning or loosening of the implant, and greater economic cost, this product is excellent for those patients with the desire to preserve the digital length (9).

Sgarlato silicone hammertoe implants also known as SHIP utilizes the standard operative technique and is allocated to all types of hammertoe deformities. The Sgarlato implants remain consistent in its deformity reduction while maintaining a high degree of motion at the arthroplasty site for an extended of period of time due to its medical grade silicone make-up. The ease of implantations is unmatched with only 2 instruments required for instillation and its minimized hinge design adds to its reputation of comfort and decreased inflammatory response. The implant is available in 3 sizes with rectangular stems for optimal "soft fusion."

Heat Activated

The Smart toe implant is prepared from a composite of nickel-titanium alloy, which reacts to its thermal environment. Rapid expansion is generated once the device is implanted into the body from a sub-zero storage container. The expansion forces the arms of the device to apply pressure to the walls of the cortex of both the proximal and distal phalanges and contributes to compression across the osteotomy site. The implants are provided in either a neutral or 10 degrees plantarfexion design. Roukis showed excellent results, where he achieved a 93% fusion rate in a study consisting of 30 toes. Other surgeons have expressed contention over the ease of the surgical procedures, describing the difficulty of implantation when the arms of the device expand prematurely. Other complications include infection, cortical wall damage, mallet toe, and medial or lateral divergence of the digit (9, 10). It is without question that there is a small learning curve when dealing with this device, but it has been suggested that when one masters the procedure, the postoperative period is much shorter and with fewer complications.

The HammerLock, also a heat-activated device, is an additional implant prepared from a composite of nickel-titanium alloy, which reacts to its thermal environment. It is of a similar one-piece design to the SmartToe but differs in its wide array of sizes consisting of small (16 mm), medium (19 mm), and large (22 mm) lengths. Alternative widths are also available for both the proximal and distal segments as well as arm length. The angulation remains straight or 10 degrees of plantarflexion. The Hammerlock implant minimizes the possible complication of cortical wall damage, contributed to a patented barb design. It has also been suggested that due to the block holding device, a certain ease of insertion exists, where one may be alotted an additional 2 minutes of insertion time if deemed necessary (1). This may be an additional advantage over the Smart-Toe system with regard to device handling.

Absorbable

Arthrex introduced bioabsorbable fixation devices implanted with the intramedullary canal. The Trim-It pin is made of poly(L-lactide) acid, which has been tested and standardized for resorption rates and reconstitution of bone following degradation. The pin is shown to have excellent strength with some flexibility for implantation. Its simple design adds to its surgical ease, which retains the original principles of intramedullary K-wire fixation (11).

The Weil-Carver Hammer toe implant introduced by Biomet sports medicine is a bioabsorbable pin composed of L-lactic acid and glycolic acid known as Lactosorb. The compound of polymers allows for consolidation of the fusion site over a 12-week period while retaining optimal rigidity for 6-8 of those 12 weeks. The implant has a barbed design at the distal aspect for capture into the intramedullary canal of the middle phalanx. If the implant is noted to be elongated and will not allow proper approximation, the distal aspect can be cut to length with standard bone cutting forceps. Biomet offers one size of the Weil-Carver implant and is accepted widely by patients due to absence of exposed hardware emanating for the digit and no complications associated with external hardware (8).

Konkel et al preformed proximal interphalangeal arthrodesis on 48 digits utilizing the depuy orthosorb poly-p-dioxanone pin. The results of the study revealed consolidated bone fusion at the PIPJ in 73% of patients with floating toes appreciated in 9 patients. Konkel et al concluded that this is a good procedure for reduction of hammertoe deformities especially when the patient is faced with a metal allergy (11).

DISCUSSION

It is obvious that many devices are available and one can quickly become overburdened with the amount of implants available. While the “tried and true” K-wire is readily accessible and much cheaper than many of the devices discussed, there are indications where a more novel approach is deemed necessary.

Each risk should be considered when choosing an implant. As is evident with any device, there are certain disadvantages that are present with absorbable fixation. Cost, risk of biological response, and decreased strength over time, are all factors to examine. In addition to cost, implant removal is an occurrence that some surgeons may face. An implanted intramedullary device makes this scenario a little more difficult and time consuming. Each device has its indication, however more research must be performed to recommend one particular fixation over another and comparative studies are needed in that regard.

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