CHAPTER **37**

PIPJ ARTHRODESIS WITH THE SMART TOE IMPLANT

Joe T. Southerland, DPM

INTRODUCTION

Nitinol, a combination of nickel and titanium (NiTi), is a metal with memory properties. It has been used in other forms of fixation utilized in the foot and ankle, primarily in the form of staples.[1,2] Memometal, Inc. has used this property to create an implant for digital arthrodesis. The Smart Toe implant (Memometal, Memphis, TN) has both a proximal and distal expanding section to aid in the stability and compression at the proximal interphalangeal joint following arthrodesis surgery (Figures 1,2). The application of the device is relatively straightforward (Figure 3).

Figure 1. Smart Toe implant in its contracted state.

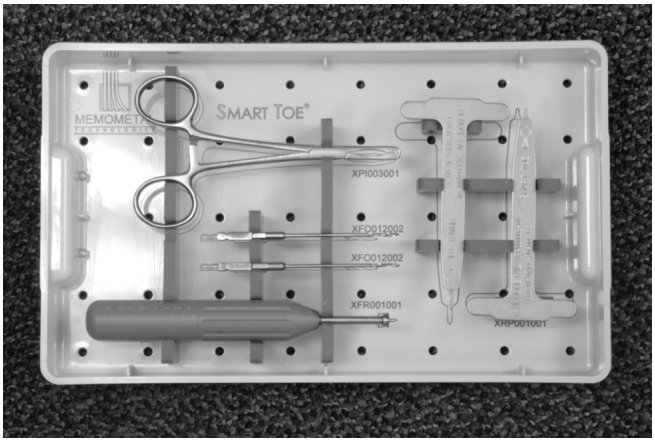

Figure 3. Smart Toe implant instrument tray.

TECHNIQUE

Exposure of the digit is the same as with any arthrodesis technique. After resection of the proximal phalanx head, the proximal surface of the middle phalanx can be left alone as the preparation of the joint for the implant denudes this cartilage.

Once the proximal head has been removed as deemed necessary, the 2-mm drill bit is used to create the canal into the remaining proximal phalanx (Figure 4). The same drill

Figure 2. Smart Toe implant in its expanded state.

Figure 4. Drilling of proximal phalanx with 2.0-mm drill bit.

Figure 5. Drilling of middle phalanx with 2.0-mm drill bit.

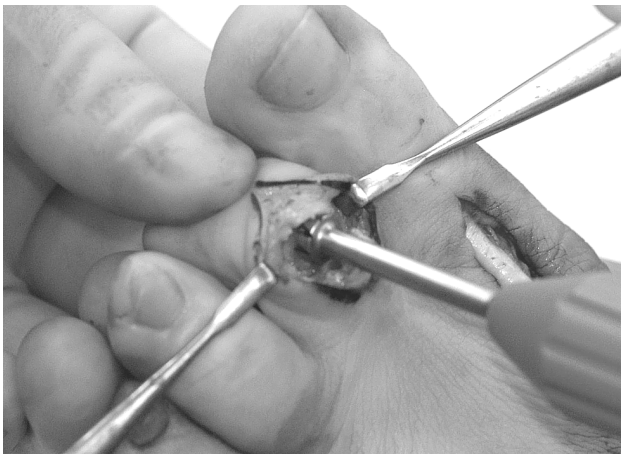

Figure 6. Preparation of middle phalanx surface with the reamer.

Figure 7. Base of middle phalanx after preparation with reamer.

Figure 8. Preparation of proximal phalanx with proximal broach.

Figure 9. Preparation of proximal phalanx with proximal broach.

Figure 10. Removal of Smart Toe implant from the storage block.

bit is then used to create a hole in the base of the middle phalanx (Figure 5). The manual drill is then introduced and rotated with hand pressure (Figure 6). This step denudes the cartilage in a smooth fashion and aids in good bone-to-bone contact at the fusion site (Figure 7). This step replaces the need to resect the base of the middle phalanx.

These two sites are further prepared with the proximal and distal carving chisels (Figures 8,9). The chisels create an opening that is wider than it is from dorsal to plantar. This helps limit rotation of the implanted device.

With both bones now set to receive the Smart Toe implant, it is removed from the freezer. In this colder state, the proximal and distal ends are in a contracted position. The implant is then grasped with the prehensile forceps at the opening in the block at the base of the distal prongs (Figure 10). Taking the implant from the block and then fitting the proximal end into the proximal phalanx is the next step (Figure 11). The middle phalanx is then distracted and pulled over the distal portion (Figure 12). The forceps are removed and the joint is pressed together and held in a rectus position for several minutes (Figure 13). As the implant begins to warm, the Nitinol strives to reach its original position. The proximal loop expands against the walls of the proximal phalanx and the distal prongs expand against the walls of the middle phalanx. It is this expansion that gives the Smart Toe implant stability. The capsule and digit are then closed in the surgeon's preferred manner (Figure 14).

Figure 11. Smart Toe implant inserted into the proximal phalanx.

Figure 12. Middle phalanx being seated over the distal prongs of the Smart Toe implant.

Figure 13. Positioning of digit while Smart Toe implant warms and expands.

Figure 14. Closure of digit following arthrodesis.

The main advantage of the implant is an obvious one; there is no external protrusion of fixation as in the traditional manner of arthrodesis with Kirschner-wires. Another advantage is the potential for continuous compression at the arthrodesis site from the Nitinol trying to reach its memory position.

The obvious disadvantage is that the implant does not cross the metatarsophalangeal joint or distal interphalangeal joint. In cases where the surgeon needs to cross the metatarsophalangeal joint, the Smart Toe implant would not be the best choice. Also, not crossing the distal interphalangeal joint could lead to distal contracture or mallet toe deformity over time that can theoretically appear. All this considered, the Smart Toe implant gives the surgeon a good stable choice for digital arthrodesis without the need for percutaneous pinning (Figures 15,16).

REFERRENCES

1. Kapanen A, Ryhanen J, Danilova A, Tuukkanen J. Effect of níkel-titanium memory metal alloy on bone formation. *Biomaterials* 2001;22:2475-80.
2. Marc A, Tristan M, Jacques P, et al. Proximal interphalangeal arthrodesis: a new approach [abstract]. Smart Toe congrès SFMCP Toulouse 2006, Equipe St Charles. Version anglaise.

Figure 15. Preoperative radiographs showing contracture of the second proximal interphalangeal joint.

Figure 16. Postoperative radiographs showing proximal interphalangeal joint arthrodesis with the Smart Toe implant.