CHAPTER **26**

USE OF THE BIOPRO FIRST MTP JOINT IMPLANT

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Over the past 30 years, numerous joint implants have been advocated for use in the painful and arthritic 1st metatarsophalangeal (MTP) joint. The Swanson silastic® hemi implant was the first to have wide-spread clinical acceptance and use. Later, a double-stem hinged implant and then various two-component devices were offered as alternatives. These devices had their successes and their difficulties.[1] During this time period, several surgeon inventors also developed metallic versions of the hemi implant. Alfred Swanson's version was very similar to his original silicone hemi implant. Townley, also a Michigan orthopedic surgeon, developed a metallic implant but with several unique features.[2]

THE BIOPRO GREAT TOE IMPLANT

Charles Townley reported in 1994 that he had been using a metallic hemi implant in patients with an arthritic first MTP joint. Between 1952 and 1992, he implanted 312 arthritic joints with a metallic hemi-arthroplasty.[2] His implant is manufactured from machined cobalt chromium and is now available in four sizes: small, medium, medium-large, and large (Figure 1). The implant was designed to require minimal bone resection because the implant possesses a relatively thin articular base section. The articular surface of the implant is oval, wider from medial to lateral than dorsal to plantar; and slightly concave, similar to the anatomy of the 1st MTP joint. The base or articular surface possesses a thin, almost flat stem that does not require reaming like the preceeding implant designs. The implant relies upon impaction of the stem into the remaining portion of the proximal phalanx.

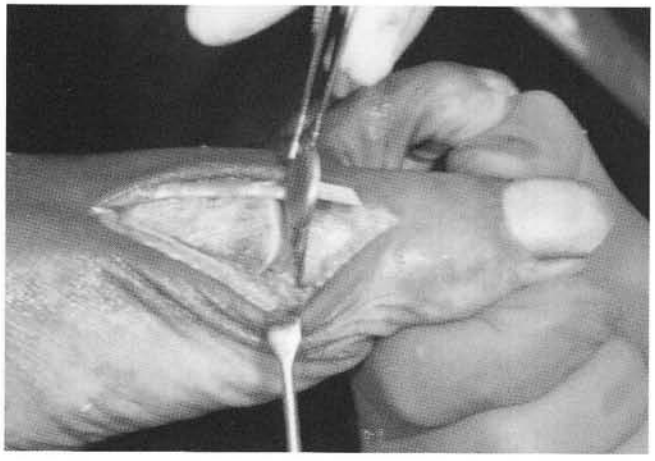

Figure 1A. The Biopro metallic hemi implant is simple in design with both a thing stem and narrow base for replacement of the great toe proximal phalangeal base articulation.

1ST MTP JOINT DYNAMICS

Sammarco has shown that the normal first metatarsophalangeal joint axis is constantly changing, but that it remains within the first metatarsal head.[3] With a hemi implant, normal joint dynamics are changed to a lesser extent than the doublestem. With the doublestem implants, the joint axis and function is significantly altered. Depending upon the degree of bone resection on either side of the joint, the joint axis will usually fall distal to the axis prior to implantation. There is also a loss of the Hick's effect[4,5] or the reciprocal motion between the phalanx and its metatarsal that also alters first metatarsal stability. These functional limitations are the result of the constrained hinge design allowing

Figure 1B.

only simple rotatory motion about the axis defined by the location of the hinge of the implant.

Both the Townley metallic hemi implant and the Swanson version are efforts to offer the functional advantages of a hemi implant yet avoid the problems of fracture and material debris seen previously with the silicone implants as well as offer functional advantages over the double-stem implants. Townley felt that the insertions of the tendons into the plantar portion of the base of the hallucal proximal phalanx could be preserved.[6] More recently, a third metallic great toe implant has been introduced, (Futura Biomedical).

AUTHOR'S EXPERIENCE

Having "grown-up", in a professional sense, in the Midwest with implant arthroplasty, I witnessed first hand the over-utilization, complications, and the successful use of 1st MTP joint implants.[7] The Townley hemi metallic implant has been used for the past 8 years. Since the time of the silicone breast implant crisis, most implants in the foot have been used on a very limited basis. This paper will review cases with the Biopro implant performed over the past 3 years.

INDICATIONS

The indications for use of 1st MTP joint implants have varied little over the past 20 years. The majority of selected patients have been cases of 1st MTP joint osteoarthritis either as a primary problem, or secondary to trauma or prior surgery. The implant has also been advocated as a revisionary procedure in cases of chronic 1st MTP joint pain. Over the past decade, hallux rigidus has been the most common clinical condition for which the author has used implant arthroplasty.

SURGICAL TECHNIQUE

Either a dorsomedial incisional approach to the 1st MTP joint or a direct medial approach will provide adequate exposure for performance of this implant procedure. This is generally simply the surgeon's preference although this author usually prefers a dorsal incisional approach. Little subcutaneous dissection is generally necessary, particularly in cases of hallux rigidus where transverse plane deformity is not usually a factor. Joint exposure is through a linear capsular incision. The dissection dorsally along the 1st MTP joint and base of the proximal phalanx is initially performed. This may then be extended plantar on either side of the phalangeal base with subsequent release of the collateral ligaments.

If the joint is tight, as in most cases of hallux rigidus, the base of the proximal phalanx may be resected next. In contradistinction to the Swanson type of great toe implants, the Biopro great toe does not require a great deal of bone resection, as the implant possesses a narrow base. The surgeon may wish to address the tight arthritic joint with decompression through bone resection yet due to the slim features of the implant, the phalangeal articular surface is resected within the cancellous portion of the base. The surgeon should leave a portion of the cancellous bone as this enables more secure placement of the implant and a larger surface area for contact with the implant base. The articular surface is resected perpendicular to the long axis of the toe.

Any remaining capsular contractures may now be released followed by liberal cheilectomy of the periarticular osteophytosis. Inspection of the sesamoids and release of the sesamoidal metatarsal attachments may be performed. The implant sizing guide is then compared to the corresponding area of the phalangeal base; a small hole in the center may be marked in the bone of the phalanx. The appropriate "sizer" is selected and inserted. The most critical aspect of the procedure is selection of the correct sized implant and its insertion in a position of neutral rotation. This is best accomplished by placing distal traction on the toe with a Backhaus or alligator bone forceps around the proximal phalanx. Distal traction and flexion of the toe allows proper positioning of the implant sizer, which is then press fit. Careful inspection for sharp overhanging bone margins is done at this time. The toe should also be placed through a range of motion looking for any potential areas of abutment that may limit movement. Range of motion should be entirely within the sagittal plane without rotation.

The sizer is removed, the wound is irrigated, and the implant is inserted by hand, (Figure 2). Further impaction may be accomplished with the supplied tamp and a mallet. Final inspection and irrigation are performed prior to closure by the surgeon's preference. Postoperatively, a surgical shoe is worn for approximately 3 weeks followed by the gradual return to walking or sports shoe.

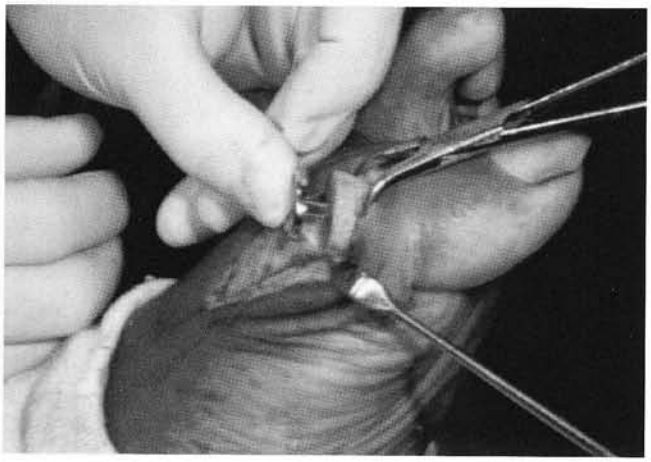

Figure 2A. The Biopro metallic hemi implant in initially press-fit then impacted. accurate implant sizing is important to avoid excessive overhand of margins of the implant base and subcutaneous prominence.

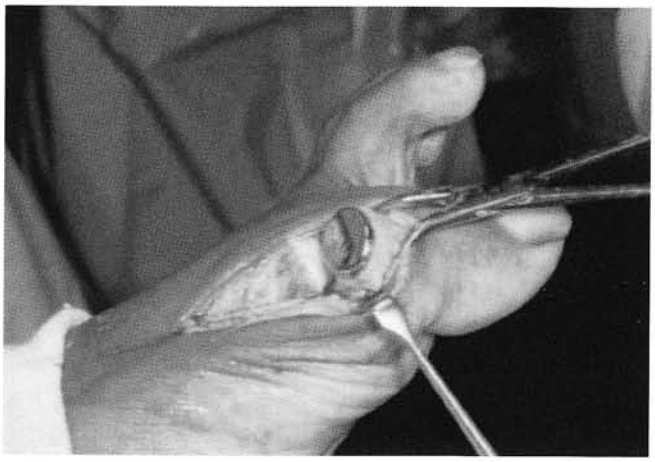

Figure 2B.

CASE STUDIES

Although, the author's use of the Biopro hemi metallic implant has been performed since the 1990s, most of these patients were lost to long-term follow-up when the author relocated. Ten Biopro implants have been implanted in nine patients, between 1998 and 2001. All patients selected for implant use presented with painful hallux rigidus, and are summarized in Table 1.

Table 1

Cases	Age	Sex	Hallux Rigidus Stage
1. JW	58	F	4
2. LD	55	F	3
3. JB	52	M	3
			4
4. SW	50	F	4
5. AF	47	F	3
6. VS	54	F	4
7. WR	62	M	4
8. DM	59	M	3
9. JG	74	M	4

CASE 1

JW is a 58-year-old white female who presented with a painful right great toe of several years duration. Prior treatment by an orthopedic surgeon consisted of injections and NSAIDs. There was pain with range of motion and crepitus. There was pain with weight-bearing and with any attempts to place weight on the great toe, there was also resultant chronic metatarsalgia. The medical history was positive for fibromyalgia and multiple musculoskeletal complaints. Radiographs showed Grade 4 hallux rigidus with almost complete loss of 1st MTP joint space and mild abduction of the great toe.

The patient underwent a bunionectomy with hemi implant arthroplasty with an unremarkable postoperative course. She progressed from a surgical shoe into a gym shoe between 3 and 4 weeks postoperative. Some residual metatarsalgia and achiness existed, but responded well to functional orthotics with complete return to preoperative activities. She had no complaints with her foot at all at one year post-surgery with a full ROM of 75° extension and 10° plantarflexion.

CASE 2

LD is a 55-year-old white female who presented with multiple foot complaints, including a painful left great toe and symptoms consistent with Morton's neuroma. Prior nonsurgical treatment yielded little improvement. She was a long-time smoker with a history of COPD, fibromyalgia, and chronic fatigue syndrome. Pain was present on ROM with crepitus. She experienced pain walking

Figure 3A. Case 2A. Preoperative AP, and B. Typical of Grade 3 hallux rigidus, C. AP 3 months postoperative.

Figure 3B.

Figure 3C.

at the 1st MTP joint as well as at the tip of the left great toe associated with hyperextension of the great toe IPJ. Radiographs showed Grade 3 hallux rigidus with flexion of the 1st MTP joint, compensatory hyperextension of the IPJ, and narrowing of the 1st MTP joint space with mild abduction of the great toe.

The patient underwent bunionectomy with Biopro hemi implant arthroplasty and Kirschner wire stabilization of the hallux IPJ. Postoperatively, she experienced periarticular swelling and achiness requiring a periarticular corticosteroid injection at 6 weeks postoperative. She continued to have low-grade complaints for more than 3 months postoperative and responded to periarticular use of topical ketoprofen gel and orthotic devices. She possessed an excellent ROM postoperatively of 75-80°. She had minor complaints at one year post-surgery mostly associated with her fibromyalgia.

CASE 3

JB is a 52-year-old white male who presented with painful feet of two years duration associated with recalcitrant plantar fasciitis and hallux rigidus. The initial management consisted of orthotic therapy and attention to heel pain. Subsequently, symptoms of pain and restricted joint movement limited his avocation as a runner. He had run about 25 miles a week for the past 20 years. The ROM was extremely limited and painful. He had significant flexion and adduction of the hallux as well adduction of the lesser toes. Radiographs showed Grade 3 hallux rigidus, right foot, Grade 4 left with joint space narrowing and irregularity, periarticular lipping and osteophytosis.

He underwent cheilectomy bunionectomy with hemi implant of first the right foot and then 6 weeks later of the left. He had an unremarkable postoperative course and returned to full activities. Initially ROM was limited but non-tender and gradually improved to 50° extension and 20° plantarflexion. His plantar fasciitis resolved until about six months postoperatively and symptoms diminished over the subsequent 6 months. He did return to athletics.

Figure 4A. Case 3. A. Preoperative AP. B. Lateral with degenerative joint changes and congenital hallux varus. C. AP view, D. Lateral postoperative view.

Figure 4C.

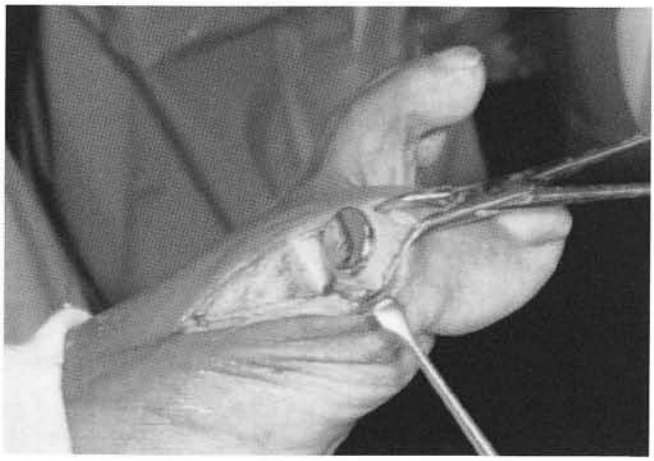

Figure 4B.

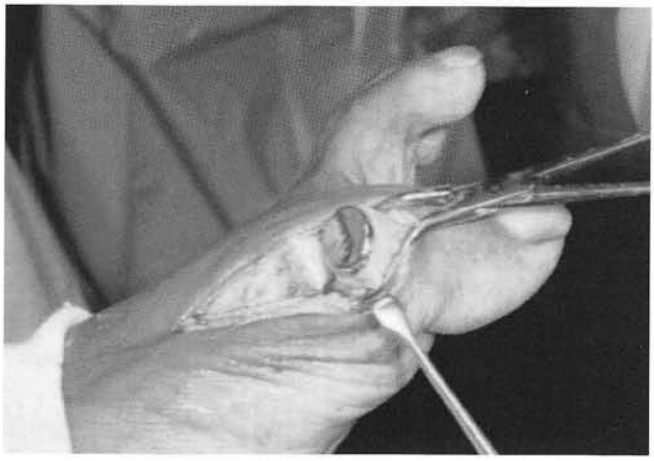

Figure 4D.

CASE 4

SW is a 50-year-old black female who presented with chronic right foot pain of several years duration. She had significant lesser metatarsalgia and plantar hyperkeratoses. The ROM was markedly limited with pain on attempts at joint movement. She was initially treated with NSAIDs but continued to have daily pain with most activities. Radiographs showed early Grade 4 hallux rigidus with joint space narrowing and periarticular proliferative changes

She underwent a bunionectomy with hemi implant arthroplasty with an unremarkable postoperative course. Initially, ROM was significantly restricted for several months but subsequently improved although it remained limited at one year postoperative. She obtained good relief of symptoms and returned to full activities in orthotics.

CASE 5

AF is a 47-year-old obese white female who presented with a painful right foot of two year's duration. Prior surgical intervention was with a Silver-type bunionectomy and for several months postoperative she was only able to tolerate a surgical shoe. She was subsequently treated with orthotic devices but has continued to have chronic pain at the 1st MTP joint. The ROM is extremely limited with pain on any attempt at joint movement. A large dorsal bunion was present with associated neuritic symptoms and hypesthesia. Radiographs showed Grade 3 hallux rigidus with joint space narrowing, periarticular lipping of the phalangeal base, and a large dorsal osteophyte.

She underwent cheilectomy bunionectomy with hemi implant arthroplasty with an unremarkable postoperative course. She obtained immediate relief of symptoms and returned to full activities. Initially ROM was limited but non-tender and gradually improved long-term postoperatively.

CASE 6

VS is a 54-year-old white female who presented with a painful right great toe which "does not bend". She complained that the hallux and 2nd toe rubbed and irritated each other. The medical history was positive for NIDDM and hypertension. Radiographs showed Grade 4 hallux rigidus with almost complete loss of 1st MTP joint space, a straight great toe, but significant adduction contracture of the 2nd MTP joint and 2nd toe.

She underwent bunionectomy with hemi implant arthroplasty and base resection of the 2nd toe. The postoperative course was unremarkable with her progressing to full activities and standard shoe wear with orthotic devices. Early on postoperative ROM was limited but continued to improve.

CASE 7

WR is a 62-year-old white male who presented with painful great toes, left greater than right, of several year's duration. He did give a positive history of trauma 40 years prior with a heavy crescent wrench falling on the top of his foot. He complained of pain in the great toe, lesser metatarsalgia, and heel pain. He had tried many different types of shoes and inlays but found that he must wear a roomy shoe with a high toe box to avoid pain at the 1st MTP joint area. Almost no motion was available at the left 1st MTP joint with 5° extension and 15° plantarflexion observed. Radiographs showed Grade 4 hallux rigidus with complete loss of 1st MTP joint space, mild abduction of the great toe and exuberant periarticular proliferative changes typical of degenerative arthrosis.

He underwent a cheilectomy bunionectomy with hemi implant. The postoperative course was unremarkable with early return to regular shoes but significant periarticular periostitis and chronic swelling and poor ROM present for a prolonged postoperative period. No evidence of infection was seen. He eventually became asymptomatic but ROM was poor.

CASE 8

DM is a 59-year-old white male who presented with painful left foot predominantly in the area of the 1st MTP joint. The ROM was markedly diminished and painful with subcutaneously bony prominences periarticular. Mild abduction of the great toe was apparent. Prior treatment consisted of orthotic devices and NSAIDs. Radiographs showed Grade 3 hallux rigidus with flattening of the articular surfaces, and narrowing of the 1st MTP joint space.

He underwent bunionectomy with hemi implant arthroplasty and base resection of the 2nd toe. The postoperative course was unremarkable with his progressing to full activities and standard shoe wear.

CASE 9

JG is a 74-year-old white male who presented with painful feet including 1st MTP joint, left foot as well as sensory disturbance associated with diabetic neuropathy. His medical history was positive for NIDDM and hypertension, hyperlipidemia, gastric reflux disease, and arthritis. Radiographs showed Grade 4 hallux rigidus with loss of 1st MTP joint space and periarticular degenerative changes.

He underwent cheilectomy bunionectomy with hemi implant. The postoperative course was unremarkable with return to full activities and standard shoe wear and an asymptomatic foot.

DISCUSSION

All patients presented with painful 1st MTP joints with a clinical diagnosis of hallux rigidus and radiographic findings of degenerative joint disease. Patients chosen for implant arthroplasty were generally older patients, with an average age of 56.7 years in this present series, range of 47-74. These 9 patients, 4 male and 5 female, underwent 10 procedures, one case being bilateral but the surgery performed in separate surgical sessions. No patients were selected with large degrees of metatarsus primus elevatus but most showed MTP joint flexion and some degree of positional radiographic and clinical elevatus. Most toes were rectus in position but some degree of adduction or abduction was not uncommon.

This series of 10 procedures were all performed on patients with grade 3 or grade 4, hallux rigidus.[8-10] One patient had prior surgery, case 5. No perioperative complications were encountered and all wounds healed uneventfully. No implants required removal. Several patients were also treated with secondary problems including lesser metatarsalgia, Morton's neuroma, and plantar fasciitis. It was not uncommon to see restricted or poor ROM initially postoperatively but this generally improved long-term in the subsequent 3 to 12 months postoperative.

The literature is replete with case studies illustrating complications of 1st MTP joint implants. Almost all case studies involved silicone implants; although the two component implants have also required revision.[11,12] Complications were particularly common in the 1970s and 1980s with a large number of implants being performed mainly for painful joints and not necessarily advanced joint disease. The use of the Townley design hemi implant minimizes the bone resection required for implant arthroplasty. Hemi metallic implant arthroplasty may be successful because of its inherent simplicity and close maintenance of normal joint dynamics. They are generally easily revised if necessary, particularly in contradistinction to the component joint replacement systems.[11,12]

CONCLUSIONS

The author's experience began with the Swanson silicone hemi implant then progressed to the Swanson design and Sutter hinge implants. Two-component joint implant has been proposed, investigated, and utilized, but few investigators have found any clinical advantages to advocate use (13). During this time, hemi metallic implants have also been in clinical use for end-stage arthrosis and joint pain. This paper demonstrates use in cases of hallux rigidus.

Over the years, the concept of joint preservation has been advanced. Today's philosophy, compared to that of 20 to 30 years ago, is that lesser cases of joint arthrosis are treated with cheilectomy and often combined with osteotomy to improve joint mechanics. First MTP joint arthrodesis is also a viable alternative for arthrosis or severe deformity. Many clinicians have been tainted by the mistakes of the past and need not condemn the judicious use of first MTP joint implants. Joint implants are still a useful clinical tool and due consideration should be given.

REFERENCES

1. Vanore J, O'Keefe RG, Pikscher I. Current status of first metatarsophalangeal joint implants. *Foot Ankle Quarterly* 1995;8:3121-34.
2. Townley CO, Taranow WS. A metallic hemiarthroplasty resurfacing prosthesis for the hallux metatarsophalangeal joint. *Foot Ankle Int* 1994;15:575-80.
3. Sammarco JG. Biomechanics of the foot, in Basic Biomechanics of the Skeletal System. 1980; New York; Lea & Febiger. p. 203.
4. Hicks JH. The mechanics of the foot. II The plantar fascia. *J Anat* 1954;88:25.
5. Hicks JH. The mechanics of the foot. I. The joints. *J Anat* 1953;87:345.
6. Townley CO. A metallic hemiarthroplasty resurfacing prosthesis for the hallux metatarsophalangeal joint. *Foot Ankle* 1994;15:575-580.
7. Vanore JV, O'Keefe RG, Pikscher I. Silastic implant arthroplasty: complications and their classification. *J Am Podiatry Assoc* 1984;74:423.
8. American College of Foot and Ankle. Surgeons, Hallux rigidus in the healthy adult, in Preferred Practice Guidelines. 1993: Park Ridge, IL.
9. Vanore JV, et al., Hallux rigidus and limitus, in Medical and Surgical Therapeutics of the Foot and Ankle, D.E. Marcinko, Editor. 1992, Williams and Wilkins: Baltimore. p. 423-465.
10. Vanore JV, Corey WV. Hallux limitus, rigidus, and metatarsophalangeal joint arthrosis. In Marcinko DE. Comprehensive Textbook of Hallux Abducto Valgus Reconstruction, Mosby-Year Book: St. Louis. 1992; p. 209-41.
11. Vanore JV. Revision of the problematic 1st MPJ implant. In *Update 2000*. Tucker, (GA): The Podiatry Institute; 2000.
12. Vanore JV. Implants. In: Banks AS, et al. McGlamry's *Comprehensive Textbook of Foot and Ankle Surgery*. Lippincottt Williams & Wilkins: Philadelphia. 20001; p. 373-417.
13. Gerbert J, Chang TJ. Clinical experience with two-component first metatarsal phalangeal joint implants. *Clin Podiatr Med Surg* 1995;12:403-13