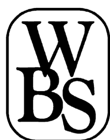

Foot Ankle Clin N Am
8 (2003) 37–48

FOOT AND
ANKLE
CLINICS

Salvage of first metatarsophalangeal joint arthroplasty complications

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There are two broad categories of surgical techniques for first metatarsophalangeal joint arthroplasty. Resection arthroplasty is a resection of the base of the proximal phalanx with or without an interposition graft of capsule or adjacent tendon (Fig. 1). The second technique involves a partial or complete joint replacement (Fig. 2). The primary indication for these procedures is first metatarsophalangeal joint pain caused by arthritic change. The salvage surgical options for failed metatarsophalangeal joint arthroplasty are directed toward decreasing or eliminating the symptoms arising from the complications of these procedures.

Resection arthroplasty

Resection arthroplasty as a treatment for bunions was originally described by Keller in 1904 [1]. Indications for the procedure have expanded to include patients with arthritis of the first metatarsophalangeal (MTP) joint. Although pain centered around the first metatarsophalangeal joint was often improved after a Keller resection arthroplasty, a number of complications were described that have made this procedure less popular over the last 10 to 15 years. Postoperative metatarsalgia is the most frequently reported complication associated with a Keller resection arthroplasty [2–4]. Additionally, preoperative metatarsalgia often persists after the Keller procedure [3,5–9]. Other reported complications that resulted from joint resection arthroplasty include excessive shortening of the hallux [2,3], narrowing of the space of the first metatarsophalangeal joint over time [10], impaired weightbearing function of the hallux with weakening of the

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PII: S1083-7515(02)00129-8

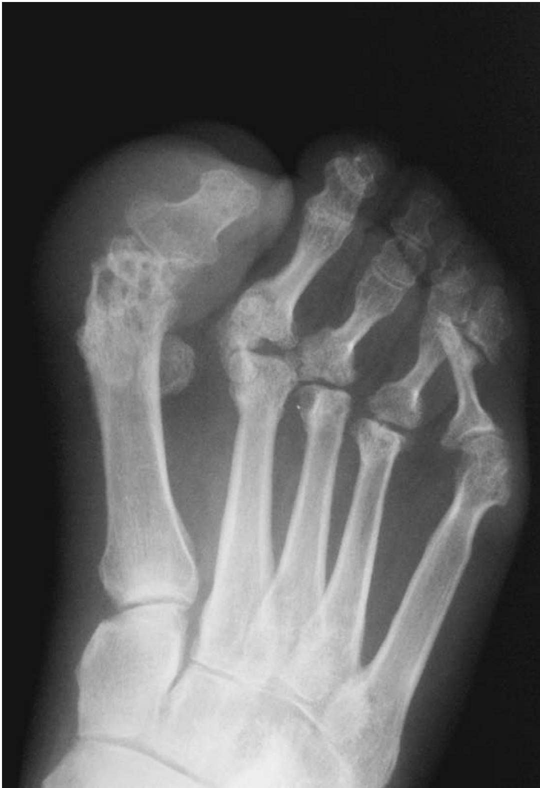

Fig. 1. A/P radiograph of a joint resection arthroplasty of the hallux.

foot or toe [4,11], claw toe or cock up toe deformity of the hallux (Fig. 3) [12], and reduced motion of the interphalangeal joint [10].

The surgical technique may be one factor that influences the rate of these complications. The recommended fraction of proximal phalanx resection is broad and ranges from one third to two thirds of the bone length [7,8,13]. The more bone that is resected, the greater the risk of destabilizing the hallux; this leads to a loss of weightbearing function and the transfer of weight to the lateral rays, termed transfer metatarsalgia [2,12,14,15]. With excessive bone resection and the development of these complications, salvage can be challenging. Recommendations for an interposition iliac crest bone graft to restore hallux length, in addition to performing a first MTP arthrodesis, was described [6]. Two factors that were reported to influence the salvage arthrodesis rates include limited motion of the interphalangeal joint and an insufficient amount of bone remaining of the proximal phalanx [6]. Compared with a primary arthrodesis of the first MTP joint with a success rate of approximately 85% to 95% [16,17], the salvage MTP arthrodesis success rate ranges from 75% to 82% [5,6,9,18–20].

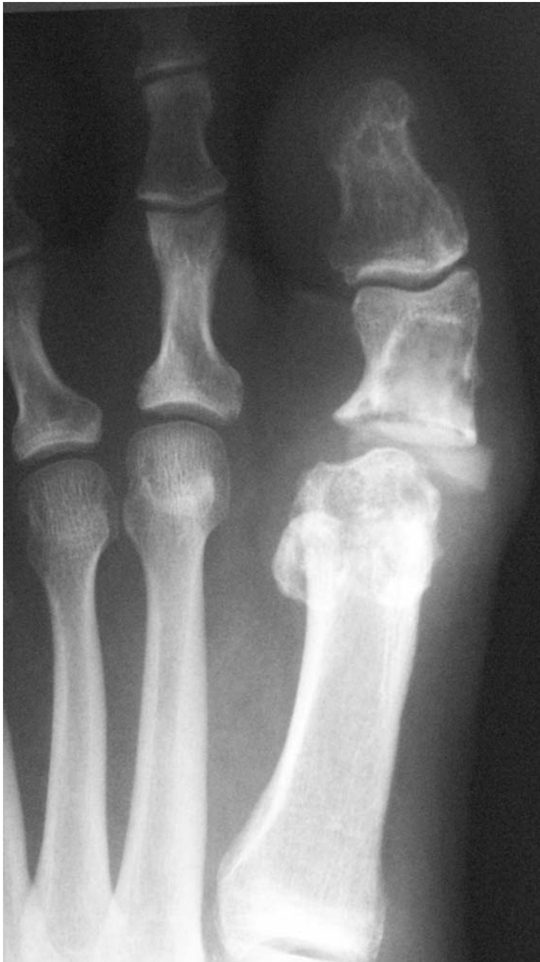

Fig. 2. A/P radiograph of a single stem silicone replacement arthroplasty of the hallux.

Literature review

There are limited data about the success rate for arthrodesis of the first metatarsophalangeal joint as a salvage for a failed Keller resection arthroplasty [5,6,9,18–20]. Coughlin and Mann [6] reported on 11 patients (16 feet) who had an arthrodesis procedure for failed Keller resection arthroplasty. The major preoperative, subjective complaint was pain at the first MTP joint. Seventy-five percent of the patients also complained of lateral metatarsalgia and 88% had intractable plantar keratosis. Ninety-four percent had a cock up toe deformity of the hallux and 25% had marked shortening of the proximal phalanx. The surgical technique varied depending upon the amount of bone that was previously

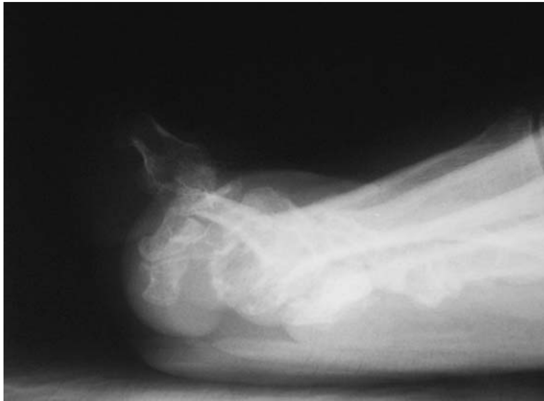

Fig. 3. Lateral radiograph illustrating a cock up deformity of the hallux.

resected and the need for iliac crest interposition bone graft (four patients). Two longitudinal, double-ended, threaded Steinmann pins were used for fixation in the patients who did not require a bone graft. These pins remained for 12 to 16 weeks postoperatively. The patients who underwent interposition bone graft had three, threaded Steinmann pins which remained for 12 to 20 weeks postoperatively. All arthrodeses healed successfully. Twelve feet were rated as excellent and four had good results. Patients had decreased pain and improved ability to walk. Only one patient had mild transfer metatarsalgia complaints after the procedure. Motion at the interphalangeal joint was not significantly different after fusion. The authors concluded that an arthrodesis of the metatarsophalangeal joint is a useful and reliable technique for salvage of a failed Keller resection arthroplasty.

An extensive literature review identified 11 additional patients in five articles in which a first MTP arthrodesis was performed for a failed Keller resection arthroplasty [5,9,18–20]. An average of an 82% success rate was achieved by using a variety of surgical techniques. Although a specific analysis of these patients was not performed, the data support the premise that a successful arthrodesis is more difficult to achieve with previous resection of bone.

First metatarsophalangeal joint replacement arthroplasty

Replacement arthroplasty of the first metatarsophalangeal joint has evolved over the past 30 to 40 years [21–34]. The advantages of the procedure include preservation or restoration of motion and excellent pain relief. The disadvantages include material failure of the implant which leads to silicone-induced synovitis and osteolysis [35–37]. The first metatarsophalangeal joint weightbearing function is altered as is the strength of the hallux because of the shortening and subluxation which occurs with joint replacement [25,35,38,39]. Patient complaints include transfer metatarsalgia, loss of motion at the first MTP joint

secondary to foreign body reaction and bone fragmentation, shortening of the toe, claw toe, or cock up toe deformity of the hallux.

A wide spectrum of design factors affect the outcome of joint replacement arthroplasty (Box 1). These design factors influence the salvage of this procedure [40]. In the late 1970s, silicone implants were commonly used for metacarpophalangeal joint replacement surgery for the hand. The implants and techniques were extended to the feet for replacement of arthritic and malaligned metatarsophalangeal joints [30,31,41]. With significantly higher biomechanical demands, including the weightbearing function of the foot and differing joint kinematics of the MTP joints, the implants failed. The failure produced an inflammatory response with cyst formation, avascular cellular stroma, multinucleated giant cells, and wear debris with fragmentation of the prosthesis (Fig. 4) [35–37]. The destructive silicone synovitis process resulted in additional bone loss that was compounded by the amount of bone that was removed initially for placement of the prosthesis.

The silicone implant design can be single- or double-hinged. The double-hinged components require that more bone is removed during initial placement. Alternative biomaterials that have been used for joint replacements include titanium with or without a polyethylene joint surface. These metal components were designed to replace the metatarsal head and proximal phalanx base or the phalanx base alone. The more bone that is resected with implant components, the greater the destabilization of the soft tissues and risk for subluxation and dislocation of the toe.

Literature review

Two techniques were suggested for salvage of a failed first metatarsophalangeal joint replacement arthroplasty. Kitaoka [42] described a technique of implant

Box 1. Design factors that affect the outcome of joint replacement arthroplasty

Silicone stem

Single
Double
Hinged

Titanium stem

Single
Double
With or without polyethylene
With or without titanium grommets

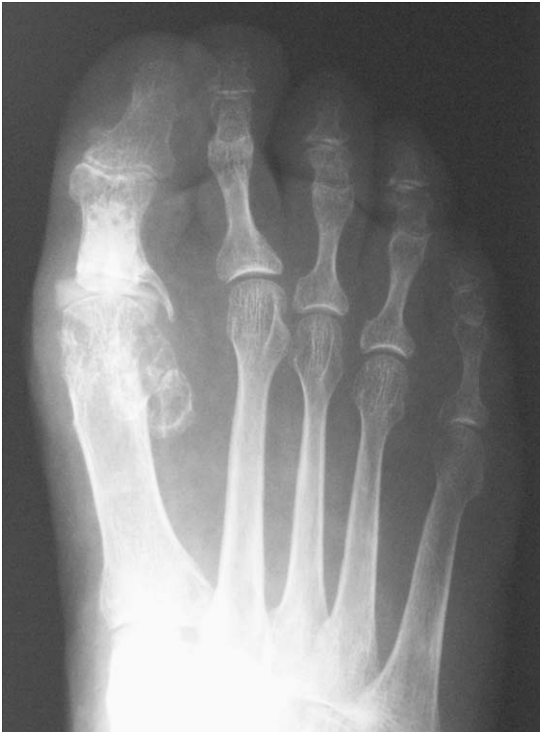

Fig. 4. A/P radiograph demonstrating first metatarsal head osteolysis, cyst formation, and proximal phalanx reactive bone spur formation secondary to silicone synovitis.

removal and synovectomy for the treatment of 14 silicone-implant arthroplasties. Revision surgery was performed at an average of 3.1 years after the arthroplasty. The average follow-up was 4.9 years in 10 patients. Clinical results were judged as excellent in seven patients, good in one patient, fair in one patient, and poor in one patient. Clinical alignment did not change after removal of the implant although a trend toward toe extension (cock up deformity) was noted. Dynamic force plate studies were performed which demonstrated unweighting of the plantar aspect of the first metatarsal head and transfer of the loading to the lateral forefoot. The great toe had less contact time during gait in the involved feet than in the control feet.

Hecht et al [43] reported on 15 feet that were treated with arthrodesis of the first metatarsophalangeal joint to salvage a failed silicone-implant arthroplasty. The average duration of follow-up was 55 months. The indication for surgery was first MTP joint pain that interfered with activities of daily living. Bone grafting was used in all cases. Eight cases had cancellous bone only and seven cases had tricortical interposition bone grafts. Two types of fixation were performed. Two intermedullary-threaded Steinmann pins were used in six cases; nine cases had an oblique compression screw technique with the application of a three- or four-hole,

one third semitubular, dorsal neutralization plate. Of the 10 patients who underwent tricortical interposition bone graft, eight cases went on to solid union on both sides of the graft. Five of six cases that were fixed internally with Steinmann pins successfully fused at an average of approximately 14 weeks. Nine of 10 cases that were fixed with compression screws and dorsal plates successfully fused at approximately 8 weeks. Clinically, there was no evidence of transfer lesions, first MTP joint tenderness, or hallux subluxation. The hallux length was well-maintained after surgery with bone grafting. Sagittal and coronal plane alignment was difficult to achieve initially intraoperatively and to maintain after treatment. Walking ability was improved and patients had less pain after surgery. The overall level of satisfaction was high. The authors concluded that arthrodesis of the first metatarsophalangeal joint that uses bone graft to salvage a failed silicone-implant arthroplasty produced acceptable subjective and radiographic results. Although technically demanding, it produces long-term stability to the hallux, restores weightbearing, and allows for maintenance of propulsive gait. The authors recommended an arthrodesis procedure instead of an excisional arthroplasty of the implant to maintain a high level of function and overall patient satisfaction.

The explanation for similar satisfactory results with both techniques may lie with the inflammatory reaction and scar formation that surround the silicone implants. This rind of tissue may impart some additional stability when removal of the implant is performed alone. Additional research is needed to support this theory. No studies are available to review the outcomes after implant removal versus arthrodesis following failed arthroplasty surgery with metal implants. The reactive scar is less impressive with metallic implants; an isolated implant removal may not impart the same level of stability to the hallux that results in less satisfactory results in this patient population.

Preferred approach

In patients with preoperative complaints of lateral ray metatarsalgia, a cock up toe deformity, or alignment issues that involve the hallux, a first MTP arthrodesis is the preferred surgical approach to stabilize the ray, while improving weightbearing function and alignment. In the elderly, more sedentary patient, an iliac crest interposition graft is not used. A medial malleolar bone graft may be obtained to fill in the metatarsal and proximal phalanx canal to facilitate fusion. Multiple, intermedullary, fully-threaded Steinmann pins are placed from the toe tip across the interphalangeal joint and metatarsophalangeal joint. They are cut short and buried beneath the skin by advancing the wire manually with a needle holder (Fig. 5). Because of the loss of length, less dorsiflexion and valgus positioning of the fusion is required. The toe is positioned in approximately 5° of dorsiflexion and 3° to 5° degrees of valgus. Careful preoperative assessment that specifically looks for osteoporosis is performed. A bone density evaluation is obtained if it is believed to be necessary. After bone graft harvesting, a stress fracture of the distal tibial metaphysis can occur in osteoporotic patients with

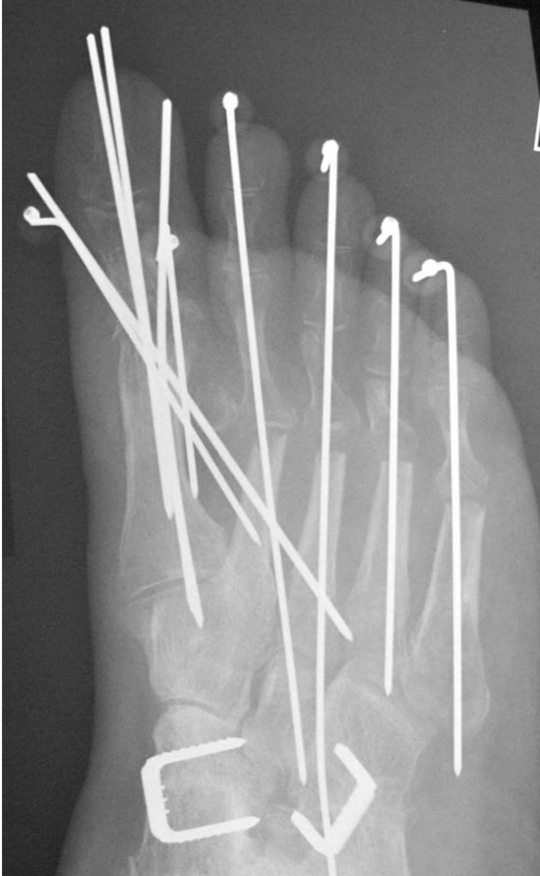

Fig. 5. A/P radiograph of a first metatarsophalangeal arthrodesis using retrograde threaded Steinmann pins. Metatarsal head resections have been performed of the lesser toes stabilized with longitudinal smooth Kirshner wires.

advancement to weightbearing, despite the use of a small, oval, cortical window. A common complication is prominent hardware. The Steinmann pins may become exposed at the toe tip in the future, which necessitates that pin's removal.

The younger, more active patient with significant bone loss may be a candidate for an iliac crest interposition bone graft to re-establish length and weightbearing function. Preoperative education of the patient is important. A nonunion at one side of the bone graft occurs frequently and may require a second bone grafting procedure with cancellous bone to obtain a solid fusion (Figs. 6, 7). The hallux is positioned in 10° to 15° of dorsiflexion in relationship to the floor and 5° to 10° of valgus or adjacent to the second toe. A dorsal six- or seven-hole plate placed with compression-plating technique is used for stabilization.

The postoperative protocol for either arthrodesis technique requires the patient to be nonweightbearing for 3 weeks. Elevation of the extremity is emphasized to

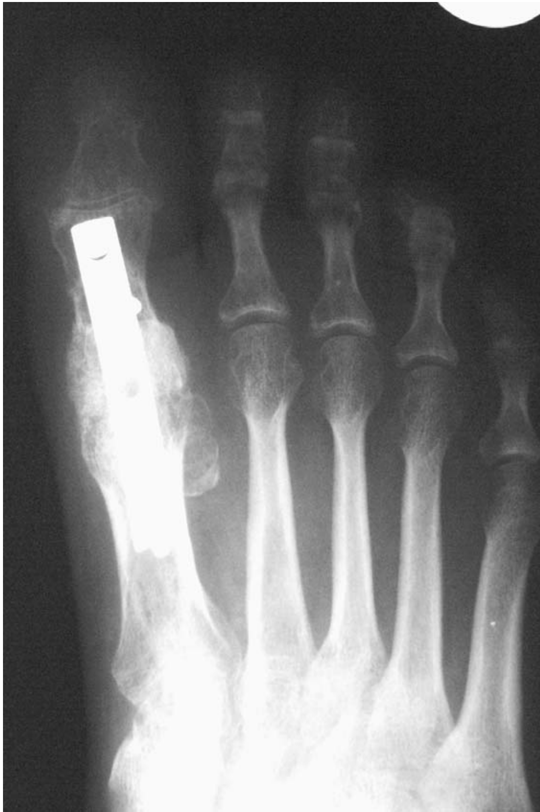

Fig. 6. A/P and lateral foot radiographs depicting a first MTP arthrodesis with interposition iliac crest bone graft and stabilized with dorsal compressive plating technique.

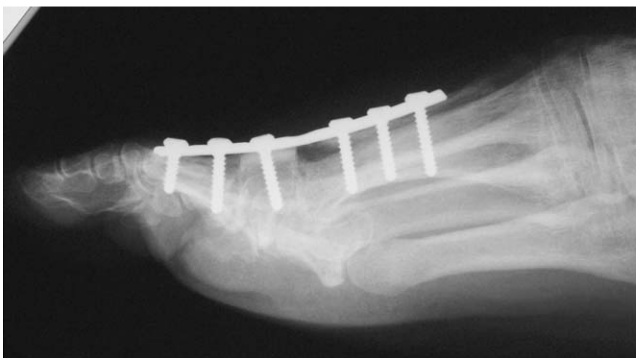

Fig. 7. A/P and lateral foot radiographs depicting a first MTP arthrodesis with interposition iliac crest bone graft and stabilized with dorsal compressive plating technique.

aid in wound healing during this time. The patient is then placed in a short-leg walking cast for 5 additional weeks and radiographs are obtained at 8 weeks. If progressive bone healing is seen on radiographs and the patient is not tender at the MTP joint, the patient is placed in a stiff-soled, postoperative shoe and allowed to transition into a sneaker when swelling and comfort allow. This may take several weeks and the patient should be made aware of this preoperatively. Follow-up films are obtained 3 months after surgery.

Isolated joint replacement removal is performed in the patient without lateral transfer lesions or in the patient with multiple medical problems that preclude arthrodesis. For the first 3 weeks after surgery, the patient is encouraged to keep the limb elevated and minimize the amount of walking in a postoperative shoe. After the wounds have healed, the patient may wear a regular shoe. A toe spacer between the great and second toes is used for 3 months to discourage molding of the great toe laterally or drifting into valgus.

A multitude of shoe and orthotic modifications may aid in modifying weightbearing and can be used in the patient with transfer metatarsalgia, hallux instability, and joint pain. They include a custom metatarsal pad added just proximal to the painful metatarsal head to unweight the area. Shoe stretching or a high toe box shoe may be used to avoid rubbing of the hallux on the shoe. These alterations can be performed preoperatively or postoperatively to decrease the patient’s symptoms.

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