

# USE OF INTERPOSITIONAL BONE GRAFTS FOR FIRST METARSOPHALANGEAL ARTHRODESIS: A Review of Current Literature

*Thomas A. Brosky, II, DPM*

*Cayla Conway, DPM*

### INTRODUCTION

Surgical procedures for first metatarsophalangeal joint (MPJ) arthritis have been well outlined in podiatric literature. The first MPJ fusion is a procedure that is commonly used for initial treatment of this condition or subsequent treatment, after another surgical procedure has failed. A failed arthroplasty may result in an excessively shortened first metatarsal or an overly resected proximal phalanx, which may necessitate the use of an interpositional bone-block graft to restore adequate length. The preservation of length can pose a surgical challenge, however, it is integral in preventing complications that may result from altered biomechanics, such as inadequate propulsion and lesser metatarsalgia. Although the literature on this procedure is not extensive, the first MPJ arthrodesis with bone graft is revered as a technically demanding procedure. Thoughtful presurgical planning should be given to determine the best type of graft, the appropriate size, and positioning for the patient.

### LITERATURE REVIEW

The article by Myerson et al (1) is one of the keystone articles most commonly cited in the literature on this procedure. In the study of 24 patients with bone deficit undergoing first MPJ arthrodesis, the authors used 3 types of grafts: femoral head allografts, autogenic iliac crest grafts, and autogenic distal tibia grafts. The average time of follow-up was 62.7 months. In 79.1% of the patients, fusion was achieved at a mean of 13.3 weeks postoperatively. The sizes of grafts ranged from 11 mm to 35 mm, averaging 22 mm. The graft sizes were not correlated with the complication rate in this study. The degree of lengthening was not standardized because some patients required intraoperative debridement of the first metatarsal and proximal phalanx. However, the postoperative lateral radiograph was used to measure change in length, which was recorded as an average of 13 mm. Although autogenous bone contains the osteoconductive, osteoinductive, and osteogenic properties that are ideal for bone healing, the Myerson study reported a greater

incidence of nonunion with the use of autogenic iliac crest graft (26.7%) compared to the allograft (0%).

In contrast to the Myerson study, Mankovecky et al (2) suggested a much lower rate of nonunion with the use of autogenous bone graft. In 2013, they reported a review of 6 studies, which reported a total of 42 procedures of first MPJ arthrodesis with autogenous graft as a salvage procedure for a failed Keller arthroplasty. Out of the 42 cases, there were 2 reported nonunions for a nonunion rate of 4.8%, which is significantly less than the rate reported by Myerson. One of the nonunions was revised, and the other was reported as asymptomatic. The review states the cases were highly varied in technique and fixation approach. Mankovecky et al reported a need for further research to standardize the data using various types of fixation and sources of grafts.

Regardless of the type of graft chosen, the importance of position in first MPJ arthrodesis remains a key element in the procedure. The preparation of the bone graft can play an integral role in attaining the proper position. In 2004, Machacek et al (3) described the use of a contoured bone-block interposition to replace length in an arthrodesis for a failed Keller arthroplasty. After preparation of the metatarsal and proximal phalanx, a spherical reamer was used to transform the ends of tricortical iliac crest graft into a cup shape.

Ahluwalia et al (4) described this technique in greater detail. In their case report, they affirm that contouring the graft not only increases the surface area and achieves better bony apposition for fusion, but also allows for flexibility of hallux positioning. They reported using the proximal surface of the graft to control coronal and sagittal position while the distal surface dictates rotation of the hallux. A guide wire is inserted through the center of the longitudinal axis of the graft. The graft is then contoured until bleeding of cancellous bone is noted. Although presurgical planning for bone graft size is not addressed, both articles support measuring the void preoperatively and using a dorsal plate for fixation of the graft. Yu et al (5) described the fixation in more detail. They recommended fixating the plate to the graft using 1 to 2 screws, and subsequently placing 2 to 3 screws distal to the graft and 3 to 4 screws proximally to secure the graft.

One of the most important factors postoperatively is functional outcome and patient satisfaction. Shanker et al (6) assessed 9 patients who underwent first MPJ fusion with tricortical bone block grafting with an average 15-month follow-up period. Three of these patients had additional cancellous bone grafts. All of the patients were satisfied with the procedure as quantified by a survey and only 1 patient developed a nonunion, which was not painful.

More recently, in 2011 Bhosale et al (7) followed 10 patients treated for bone loss with bone block arthrodesis as a salvage procedure for a failed Keller arthroplasty or joint replacement. The Bhosale study reported a satisfaction rate of 80% after the procedure and a 90% fusion rate with 1 patient developing a stable fibrous nonunion (7). All of the patients were treated with a tricortical autogenous iliac crest graft and fixated with a titanium plate. The surgical technique they described promotes using a saw to create flat surfaces of the first metatarsal and the proximal phalanx in preparation for the graft in order to maximize preservation of the remaining bone. A lamina spreader was used to apply traction to measure the size of the graft needed, evaluate the interphalangeal joint range of motion, and gauge any excess tension on the skin with graft placement.

Cancellous chips were used to fill any voids from the implants, and then the graft was inserted. They emphasize the importance of simulating weightbearing during intraoperative positioning. The patients had an average follow-up of 12.6 months. Four patients experienced complications, which included superficial infection and prominent hardware.

## GRAFT APPLICATION AND FIXATION

Once the joint has been prepared and a decision for interpositional graft has been made, compression of the graft and proper fixation are crucial. The medullary canals of the proximal phalanx and the metatarsal head can be packed with autogenous cancellous bone graft if needed. Autogenous bone remains the gold standard for revisional arthrodesis. The senior author has had good success with allograft interpositional grafts, however, he personally recommends grafts less than 1 centimeter in length if allograft is utilized (Figures 1, 2). The iliac crest and calcaneus provide good donor sites for autogenous bone graft (Figure 3). The iliac crest is more appropriate for grafts greater than 2 centimeters in length. Once the graft is positioned, and the hallux is in proper position, temporary fixation can be placed. Locking plate technology is the best choice for this technique (Figure 4). Bone to bone contact is crucial and should be visualized prior to final construct fixation. Most locking plates allow for fixation of the graft to the plate. This should be followed by compression of each segmental end of the graft. Final position is visualized under fluoroscopy to ensure appropriate compression of the graft ends and final overall position. The postoperative course is typically longer with interpositional grafts. The authors recommend 12 to 15 weeks non-weightbearing status. Graft incorporation can be delayed in cases where allograft is utilized. These patients should be followed radiographically for 1 year postoperatively.



Figure 1. Excessively shortened first metatarsal after failed surgery.



Figure 2. Postoperative fusion with 1 cm allograft and bone marrow aspirate.

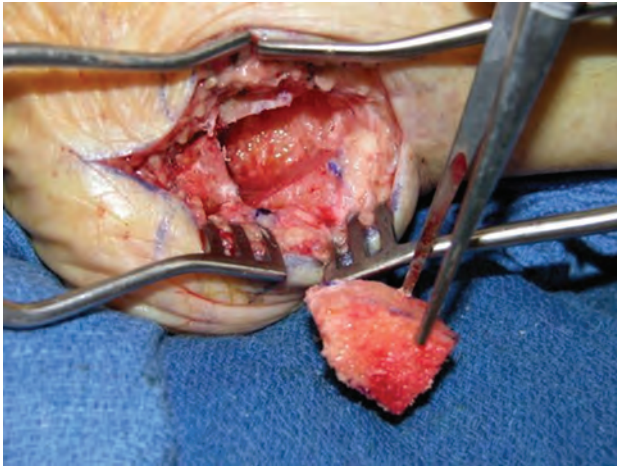


Figure 3. Sizeable autograft removed from calcaneus.

## SUMMARY

In literature, the use of an interpositional bone graft in first MPJ arthrodesis is commonly presented as a valuable salvage procedure that may be used to restore length to the important first ray. However, the technical complexity of this procedure is not minimized and careful preoperative planning is advised. The appropriate choice of bone graft is crucial and should be based on the surgeon's experience, comorbidities of the patient, and the length of graft needed. The author recommends autograft for all revisional cases, but typically uses allograft when 1 centimeter or less is needed. The postoperative course should be extended for these cases where grafts are utilized. The overall success can be influenced by the appropriate position of the graft and the proper compression of the graft-fixation construct. After extensive review, additional research is needed to thoroughly assess many important aspects of this technique, such as the parameters for the amount of lengthening, the time to fusion, and the various complications of this procedure.



Figure 4. Plate and screw fixation of graft.

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