

# FIRST METATARSOPHALANGEAL ARTHRODESIS WITH BONE GRAFT

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## INTRODUCTION

Arthrodesis of the first metatarsalphalangeal joint (MTPJ) is a procedure that has proven its effectiveness over time. It is a reliable surgical option for end-stage hallux limitus and has recently begun receiving increased attention in podiatric literature. There is sufficient research supporting selection of first MTPJ arthrodesis as a reasonable surgical option. Of current interest however is the use of interpositional bone graft with first MTPJ arthrodesis. Use of bone graft may be necessary, especially when the surgeon is performing a revision of a prior first MTPJ surgery.

After reviewing the podiatric and orthopedic literature, there is an obvious need for research on this procedure. There are various articles that address first MTPJ arthrodesis without the use of bone graft. Most of these articles mention the use of bone graft as an option, but it is usually brief and will include a statement regarding difficulty surrounding the procedure (1-3). While difficulty of this procedure is of particular concern, basic principles of joint fusion, resection, and bone graft application can be applied to simplify the surgical approach.

## INDICATIONS

First MTPJ arthrodesis with bone graft is an acceptable surgical option in the situation of a failed Keller or implant arthroplasty, failed arthrodesis or nonunion, failed osteotomy, avascular necrosis of the metatarsal head, or any situation where the end-stage procedure is necessary. Graft placement allows restoration of first ray length, allowing maintenance of normal first ray function.

## LITERATURE REVIEW

As previously mentioned, the literature is fairly incomplete when addressing first MTPJ arthrodesis with bone graft. Few studies in orthopedic literature completely address this procedure, while podiatric literature has completely failed to address this procedure as of yet. The most complete study on this procedure was done by Myerson in 2000 (3). This study

retrospectively looked at 24 patients all undergoing first MPJ fusion with bone graft. A total of 19 of the 24 patients (79%) had successful arthrodesis, 5 non-unions occurred, 2 were asymptomatic, and 3 were successfully revised. AOFAS scores averaged 40 preoperatively and increased to 79 postoperatively. The average length of graft was 22 mm. Eight were allografts and 16 were autografts, with 15 from the iliac crest and 1 from the distal medial tibia. Interestingly, all 5 nonunions were on patients that had autografts used. The authors concluded that first MTPJ arthrodesis with bone graft is a worthwhile procedure that adequately addresses first ray length, but it is associated with a high rate of nonunion (21%) and increased technical difficulty.

More recently Vienne et al in 2006 looked at first MPJ fusion after failed Keller arthroplasty (4). They performed 28 arthrodesis in 26 patients. Only 7 of the procedures included the use of bone grafts, while they used autograft taken from the iliac crest in all cases and graft size was not documented. AOFAS scores ranged from 44 preoperatively to 85 postoperatively. When only factoring in those patients with a bone graft, preoperative AOFAS scores averaged 48 preoperatively and 86 postoperatively. Only one of the arthrodesis performed with bone graft went on to pseudoarthrosis.

In 2000, Brodsky et al performed 12 first MTPJ arthrodesis with iliac crest autograft used in each case (5). Clinical arthrodesis was achieved in all patients and radiographic arthrodesis in 11 of the 12 patients, with one pseudo-arthrosis. AOFAS scoring was done postoperatively and averaged 70 points. Four patients had complications, which included; sesamoiditis, prominent hardware, and scar sensitivity. Two cases required flap coverage for skin necrosis. Overall the authors concluded that first MTPJ arthrodesis with iliac crest autograft is a reasonable salvage technique for a painful first MTPJ with shortening.

Hecht et al retrospectively reviewed 16 cases of first MTPJ arthrodesis with bone graft after failed silicone implant arthroplasty (6). Each fusion was fixated with either Steinmann pins or an oblique compression screw with a dorsal plate. Two patients went on to have nonunions, one was successfully revised with repeat bone graft and arthrodesis, and the other remained asymptomatic. The

authors also evaluated preoperative and postoperative subjective results using a 5-point scoring system. Overall, they concluded that while this is a technically demanding procedure it is associated with high patient satisfaction and their patients maintained a high level of function.

## PROCEDURE

### Incision and Dissection

Incision placement for first MTPJ arthrodesis with bone graft can be done through a dorsal medial approach using standard first MTPJ anatomic dissection techniques (7). Previous incision sites are often present and can be reused. The incision may need to be lengthened both distally and proximally to accommodate plate application, which also prevents aggressive retraction.

Dissection can then be carried out in layered fashion. Commonly this procedure will be revisional, so scar tissue will be present. Freeing of the superficial fascia from the deep fascia laterally should be avoided; these layers can be adequately retracted without dissection to avoid vascular compromise of the tissues. Medially, layered dissection can be carried out in standard fashion through creation of a medial pocket with the butt end of the knife handle (7).

A linear capsular/periosteal incision is then made just medial to the long extensor tendon. Periosteal dissection is best facilitated with use of a Freer. Four regions need to be addressed; proximal medial metatarsal, proximal lateral metatarsal, distal medial phalanx, and distal lateral phalanx. Sharp dissection can then be used to connect these pockets through the joint itself. The basic principle of periosteal dissection follows that reflection of the periosteum should always begin on the shaft of the long bone, these tissue pockets can then be connected through sharp dissection from the joint. Use of sharp dissection rather than a Freer may be necessary when excessive scarring is present. At this point the capsular tissue should be evaluated, especially in cases where implants have been used. The capsule will be hypertrophic and may need to be debrided. Closing hypertrophic capsule over bone graft should be avoided.

Once the first MTPJ is adequately exposed hardware removal can begin, if necessary. Preoperative planning is crucial, as additional operating room time for obtaining proper equipment will only add difficulty to what is already a technically difficult and time consuming procedure. If using iliac crest autograft, an orthopedic surgeon can retrieve the graft simultaneously as the first MTPJ is being exposed by the podiatric surgeon.

### Joint Resection

With the joint now exposed and all hardware removed, it is then appropriate to proceed with joint resection. In order for successful arthrodesis, Glissan's principles should be utilized; complete removal of all cartilage that will prevent contact of the raw bone surfaces, accurate and close fitting of the fusion sites, optimal positioning, and maintenance of this position until fusion is complete (8).

When beginning joint resection for first MTPJ arthrodesis with bone graft, Glissan's first principle is complicated due to the fact this is usually a revisional procedure and the joint may have already been resected. Regardless, the joint still needs to be prepared such that both the metatarsal head and base of the proximal phalanx are resected down to healthy bleeding bone and medullary canals where implants were previously in place need to be resected down to healthy bone as well. If an implant was removed, the medullary canal will have a fibrotic plug. This plug should be removed and the canal curetted.

Joint resection can involve either contour or planal resections. Contour resection is usually ideal as it allows maintenance of length and facilitates manual reduction of the deformity. Unfortunately contour joint resection is not a realistic option when performing first MTPJ arthrodesis with bone graft. The joint is best planal or wedge resected using a sagittal saw. The surfaces of the metatarsal head and proximal phalanx base should be resected such that accurate and close apposition between the bone and graft will be achieved satisfying the second requirement of Glissan's principles.

### Graft Placement

Once the joint has been resected it is then appropriate to prepare the graft for placement into the fusion site. First, the surgeon needs to decide if allograft or autograft should be used. Myerson's study appeared to have good success with using allograft. Regardless of his results, autograft should be considered the gold standard, especially in revisional cases. Autograft allows the necessary components of the healing process; osteoinduction, osteoconduction, and osteogenesis. Allograft that is fresh frozen possesses osteoinductive and osteoconductive properties, but lacks osteogenic properties (9).

Once the decision has been made to use autograft, the surgeon needs to decide where they are going to harvest the graft from. Either iliac crest or calcaneous are reasonable sites to harvest from. This decision needs to be made preoperatively, as iliac crest graft will require the use of an orthopedic surgeon. The size of the graft needed should dictate the harvest location. If a larger sized graft is needed,

then iliac crest is more appropriate as compared to calcaneal graft if a smaller sized graft is needed.

The graft should be placed in accordance with Glissan's second principle, allowing accurate and close fitting contact between the fusion surfaces (8). The fusion surfaces may need to be re-planned in order for this to occur. In the situation where an implant was removed, the medullary canal should be packed with bone chips. Either leftover autograft or cancellous allograft bone chips can be used for this.

### Fixation

The most important step in the fixation process is positioning. A flat plate can be used to load the foot to simulate a weight-bearing surface. The distal pulp of the hallux should be slightly off the weight bearing surface and the hallux should be parallel to the second digit. A Kirschner wire can then be introduced to temporarily fixate the fusion site. This is best done while using C-arm to confirm position.

Once the fusion site is together and the hallux is in good alignment, a locking plate should be applied. In this situation a superior form of fixation such as a locking plate is indicated. A complete discussion on plate application is beyond the scope of this paper, but there are a few simple techniques to make fixation go smoother. First, if you are having difficulty getting the plate to compress to the bone you can use a nonlocking screw as the first screw into the plate. A locking plate can function without bone to plate contact and actually functions as an internal-external fixator. This bone-to-plate contact is needed when fusing the first MTPJ so the plate will not be too prominent. Other techniques for plate application include initiating fixation proximally where the bone is more stable and using screws from the plate into the graft to help maintain stability of the graft.

Fusing the first MTPJ with a block of bone graft is unlike other fusion procedures. Keep in mind that essentially 2 fusion surfaces are created both of which will require bone graft fusing to normal bone, rather than a normal fusion

site where you have 1 fusion surface of normal bone to normal bone. Over time the graft will be completely replaced by new bone through a process called creeping substitution (9). A certain amount of overall success will then depend on internal biological processes that the surgeon cannot control.

## CONCLUSION

First MTPJ arthrodesis with bone graft is a reliable procedure when revision of the first ray is necessary. A certain amount of technical difficulty can be associated with this procedure. Using basic principles of first MTPJ dissection, joint resection, joint fusion, and plate application can help simplify this technically difficult procedure. Also understanding the process of bone graft selection is key to successfully revising the first ray.

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