

TECHNIQUE

First Metatarsophalangeal Fusion with Ball-and-Socket Bone Preparation and a Dorsal Plate Fixation

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ABSTRACT

The first metatarsophalangeal joint fusion is an accepted technique for hallux rigidus, severe hallux valgus deformity, and revision for failed hallux valgus surgery. In this article, the use of reamers for congruent convex concave surfaces is described. Together with a dorsal plate and an interfragmentary compression screw, this combination of the ball-and-socket bone preparation has operative advantages over other metatarsophalangeal fusion techniques. It is, on the one hand, technically simple to achieve congruent joint surfaces which is a requirement for good bone healing, and on the other hand, the prebent plate limits the risk for major malalignment of arthrodesis.

Keywords: fusion, hallux, hallux rigidus, revision hallux valgus surgery, osteosynthesis

Arthrodesis of the hallux metatarsophalangeal (MTP) joint is most frequently performed for painful and arthritic joints. Success rates are reported to range from 77% to 100%.[1–5] Clutton[6] was credited for this procedure in 1884. McKeever's article in 1952[7] popularized the arthrodesis of the hallux MTP joint. It may be performed for patients with advanced hallux rigidus or joint destruction caused by rheumatoid arthritis or in patients with hallux valgus and secondary degenerative arthrosis. One of the major indications for an arthrodesis of the first MTP joint is a failed Keller arthroplasty.[8,9]

Several methods for preparing the articular surfaces of the metatarsal head and the base of the proximal phalanx have been described. These include flat surfaces, "tongue and trough" technique conical surfaces prepared manually with a burr, or a reamer system. Flat surfaces can be achieved by using an oscillating saw. A disadvantage of this method is that one has to achieve optimum position of the cuts at the first attempt. Repositioning would lead to further bone loss.

Other options for preparing the arthrodesis site are to shape the head and base of the proximal phalanx into a congruent cone-cup surface or into spherical surfaces. There are several sets of instruments commercially available which shape the head and the base of the proximal phalanx.[4,10,11] Concave and convex surfaces for apposition may be achieved by using a burr, although it is not possible to achieve the same degree of congruency of the 2 articular surfaces as when reamers are used for this purpose.[12]

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INDICATIONS AND CONTRAINDICATIONS

The major indication for first MTP arthrodesis is revision surgery with instability of the MTP joint (cock-up deformity and floppy toe) or recurrent hallux valgus deformity. Additional indications are severe degenerative changes of the MTP joint, rheumatoid arthritis with hallux valgus deformity, and severe hallux valgus deformity.

Contraindications are severe vascular disease, severe osteoporosis, infections around the foot, and polyneuropathy.

TECHNIQUE

Preparations

For preoperative planning, standardized anteroposterior and lateral standing radiographs have to be obtained. With the patient in supine position, the procedure is generally performed under regional anesthesia (ankle block with xylocaine 1% and bupivacaine 0.5%). The use of a fluoroscope is recommended to monitor alignment and fixation. Usually, we perform all forefoot surgeries without a tourniquet. It is our feeling that, together with a postoperative dressing saline-soaked sponges, the postoperative swelling is reduced compared with the situation when a tourniquet was used.

FIGURE 1. A dorsal skin incision is made.

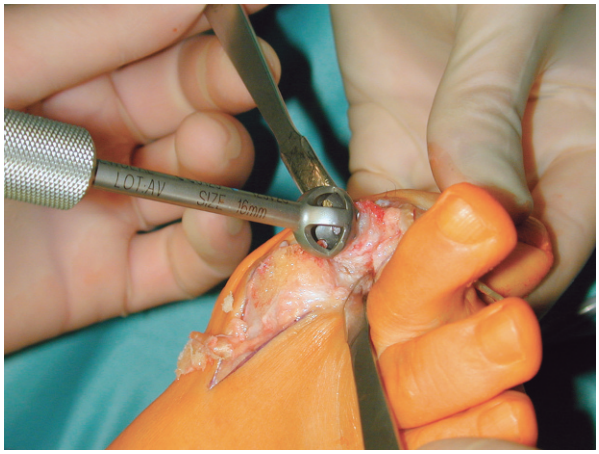

FIGURE 2. Exposure and reaming of the base of the proximal phalanx.

Skin Incision/Approach

A standard dorsal approach is recommended regardless of existing scars (Fig. 1). The skin incision starts approximately 4 cm proximal to the MTP joint and extends to the interphalangeal joint.

The tendon of the extensor hallucis longus muscle is usually dissected in a z-shaped fashion to facilitate exposure of the MTP joint. In cases of revision surgery for a cock-up deformity, lengthening of the tendon is necessary.

The joint capsule and the soft tissue coverage of the metatarsal and the phalanx are incised longitudinally straight down to the bone and then opened as an envelope. A subperiostal preparation is mandatory to assure sufficient release from the lateral soft tissue and adhesions. The plantar soft tissues attached to bone are left intact to protect the blood vessels supplying both bones. After inspection of the articular surfaces, osteophytes and debris are removed with a rongeur, whereby special attention should be paid again to the plantar aspect of the joint to avoid laceration of the flexor tendon.

Preparation of the Joint Surfaces

In the next step, the base of the proximal phalanx and the metatarsal head are prepared. While the toe is brought into maximum plantar flexion, the joint surface of the base of the proximal phalanx is exposed by 2 Hohmann retractors. Care is also taken to protect the long flexor tendon. The aim is to remove the remaining cartilage and sclerotic bone down to bleeding cancellous bone.

Several techniques have been described for the bone preparation. We prefer the ball-and-socket technique. The advantage of this technique, compared with plane cuts or a conical preparation, is the minimal bone loss and the ability to alter the position of the toe after the preparation has been performed.

This anatomical preparation can be done with a small spherical reamer, chisels, or a rongeur. The disadvantage of this method is the inaccuracy in attaining a spherical surface, resulting in a reduced area of bone contact. Special power-driven reamers (Hallu-Reamer, Newdeal Inc. Vienne, France) facilitate this step (Fig. 2).

A 1.6 Kirschner wire is placed into the center of the phalanx as a guide wire for the reamer set. The adequately sized "male" convex reamer then removes the sclerotic bone down to the cancellous bleeding bone. The preparation of the surface of the metatarsal head follows in the same manner with the "female" concave counterpart (Fig. 3). On the metatarsal head, after reaming, the medial eminence is prominent. This will now be resected in line with the distal reamed aspect of the metatarsal head. The sesamoids are generally not addressed. According to our experience, even if there was preoperative pain in the sesamoid region, this is resolved after the arthrodesis.

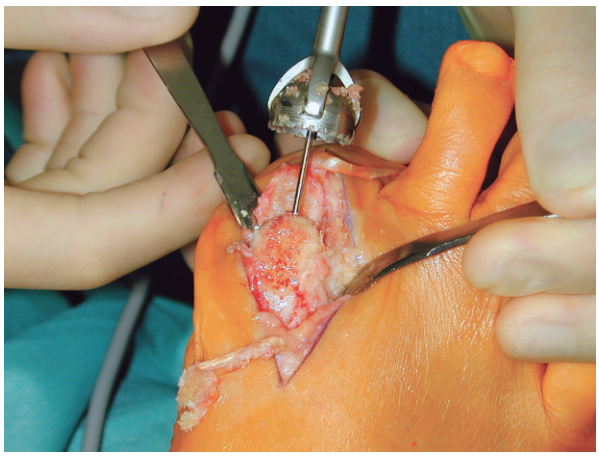

FIGURE 3. Exposure and reaming of the first metatarsal head.

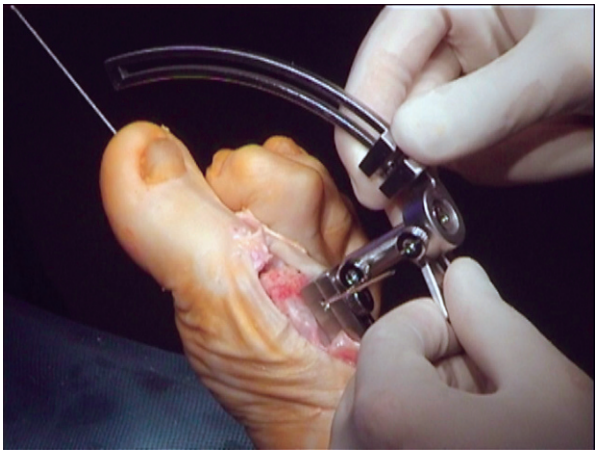

FIGURE 4. The Hallu guide for positioning of the arthrodesis.

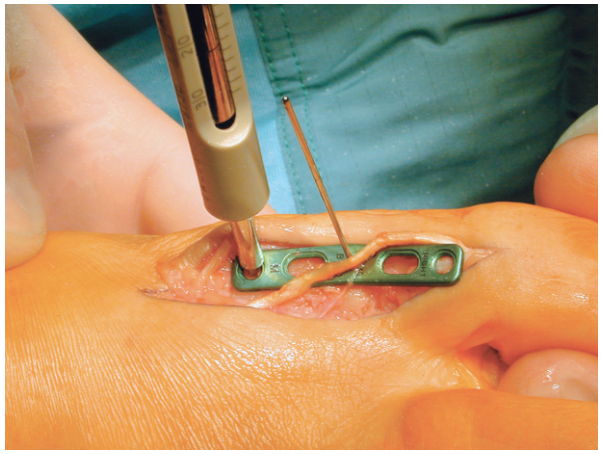

FIGURE 5. Fixation of the dorsal plate with the most proximal screw.

Position

The position of the fusion is crucial. A hallux valgus angle of 15 degrees is recommended, but the correct position has to be determined for the individual patient. Both impingent of the second toe (caused by excessive valgus) and shoe conflict of the medial aspect of the hallux (caused by insufficient valgus) must be avoided. Neutral pronation/supination is recommended.

Positioning may be facilitated by using a phalangeal guiding device. The baseplate for the phalangeal guide is fixed on the dorsal aspect of the first metatarsal after preparation of the bone surfaces. Attached to the baseplate is a kind of goniometer to set extension and flexion as well as varus and valgus (Fig. 4).

The dorsal extension can be referenced to the first metatarsal or the plantar plane of the foot. The correct position is achieved when the tip of the toe is able to exert pressure on the ground while standing. At the same time, insufficient dorsal extension must be avoided to prevent overload of the toe and the interphalangeal joint during walking. In the operation room, it is difficult to simulate the situation during weight bearing, and therefore, the use of the metatarsal as a bony reference point may be helpful. In general, a range of 15 to 20 degrees is recommended for the dorsal angle between the metatarsal and the phalanx, but the metatarsal inclination angle of the individual patient has to be considered. A preoperative weight-bearing lateral radiograph gives an impression of the inclination of the first metatarsal relative to the floor and helps positioning the fusion in the sagittal plane.

The rotation of the toe should be neutral in any case.

Fixation

The fixation of the arthrodesis is usually performed with a dorsal plate (Hallu-C plate, Newdeal Inc.) with an oblique 3.0 compression screw (Synthes Inc. Vienne, France) (Fig. 6). In revision cases of bone block fusions, we use the (Hallu-S plate, Newdeal Inc). The arthrodesis should now be placed in 10 degrees of dorsiflexion and 10 degrees of valgus. If a flexion contracture is present, the arthrodesis is placed in more dorsiflexion. A good clinical test for the optimum extension is to place the cover of the instruments set under the foot. It should be now possible to place just one finger between the toe and the cover.

After the desired position is achieved, the plate is dorsally applied and fixed with a temporary pin. Now, the most proximal screw is placed (Fig. 5). A guide wire for the 3.0 cannulated AO screws is driven from the medial aspect of the distal first metatarsal aiming at the lateral cortex of the proximal phalanx or from the medial aspect of the proximal phalanx aiming at the lateral cortex of the first metatarsal (Fig. 6). After checking the position with the C-arm, the screw is inserted and

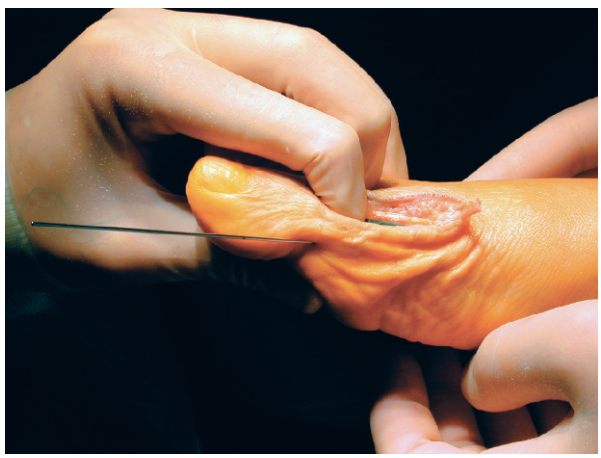

FIGURE 6. Guide wire for the 3.0 AO interfragmentary compression screw.

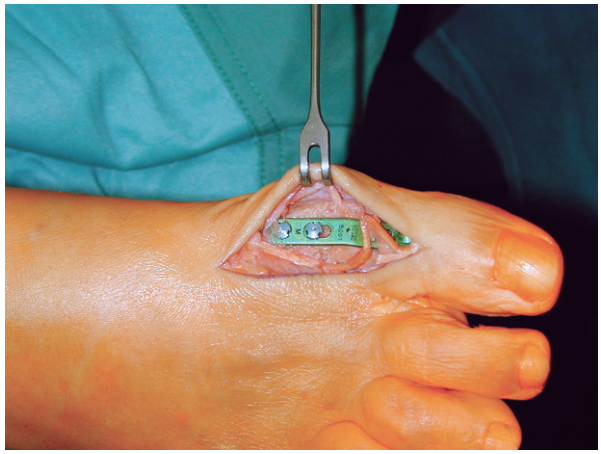

FIGURE 7. Dorsal view of the Hallu-C plate.

tightened. Finally, the plate is fixed by the remaining 3 screws (Fig. 7). The screws for the fixation of the Hallu plates (Hallu-S plate + Hallu-C plate, Newdeal Inc.) are usually from a 2.7-mm diameter. In the situation of a poor bone stock, a 3.0-mm screw is available.

■ POSTOPERATIVE CARE

Immobilization is usually provided by compression dressing in a postoperative hallux valgus shoe (Rathgeber Vienne, France; Fig. 8), and patients are allowed weight bearing to tolerance starting on the day of surgery. In the situation of poor bone quality, an OrthoWedge Vienne, France shoe is used. Only in revision cases, severe osteopenic bone, or interposition bone block fusions a below-knee cast is used (Figs. 9 and 10).

Depending on the type of fixation, it may be difficult to determine when arthrodesis has been

FIGURE 8. Postoperative shoe.

FIGURE 9. A, A 59-year-old woman with hallux valgus et rigidus. B, After first MTP fusion.

achieved. Despite early evidence of fusion, the internal fixation device should not be removed prematurely.

The hardware is usually not removed. Only if a prominence is present and painful, we remove the hardware.

■ COMPLICATIONS

The incidence of postoperative nonunion has been indicated to be between 0% and 13% and may vary with the fixation method used. Approximately 3% to

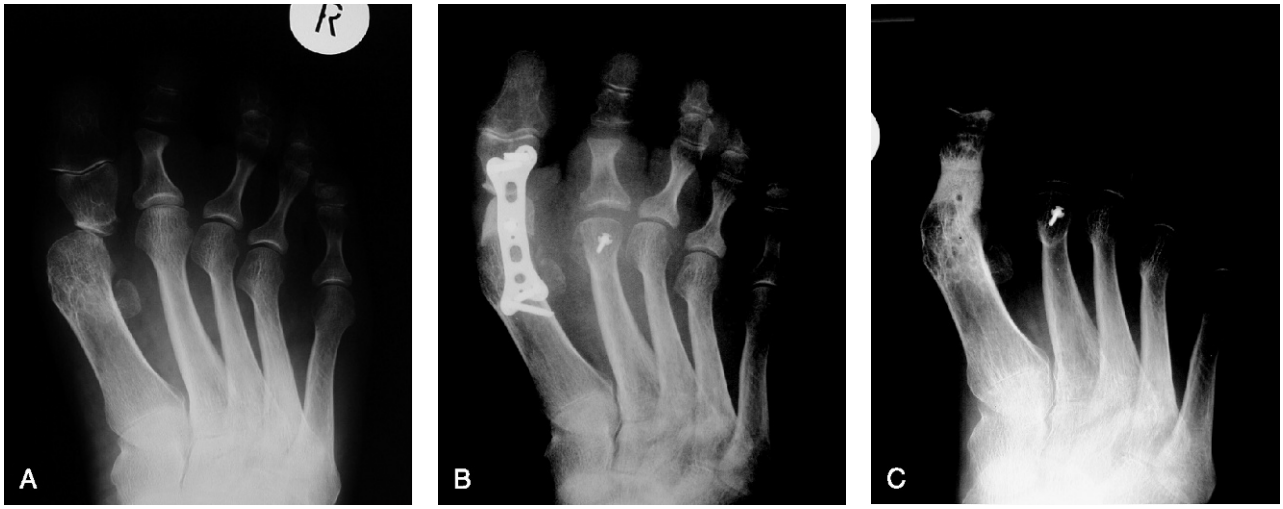

FIGURE 10. A, A 45-year-old woman after Keller-Brandes arthroplasty. B, Postoperative picture of the first MTP bone block fusion. C, Two-year follow-up after hardware removal.

5'% must be expected, even if stable internal fixation can be achieved. The incidence is significantly higher if bone graft interposition is used. Postoperative pseudoarthrosis may remain asymptomatic and not require revision.[10] Delayed wound healing may be a problem. This is more frequent with bone graft interposition or dorsal plate fixation. Secondary degenerative changes at the interphalangeal joint were observed in approximately 10% of patients on long-term follow-up, but most cause only minor symptoms or are asymptomatic.

RESULTS

Coughlin and Abdo[4] presented a series of 47 patients (58 feet) who underwent first MTP joint fusion with a small Vitallium plate. Congruous joint surfaces were prepared with either cone-shaped or cup-shaped reamers. At an average follow-up of 19.2 months, 98% (57 feet) were successfully fused. Ninety-three percent (54 feet) noted good or excellent results. Plate removal was necessary in only 7% (4 feet) of cases. Complications included nonunion with plate breakage and delayed union in 1 foot each.

Flavin and Stephens[13] reviewed 12 patients with a low-profile contoured titanium plate. At a mean follow-up of 18 months, they noted a statistically significant increase in the American Orthopaedic Foot and Ankle Society (AOFAS) hallux score and the SF-36 score. Bone union on radiographs was demonstrated at an average of 6 weeks. There were no complications, and all radiographs showed good alignments of the hallux relative to the first and second metatarsals. This was attributed to the fact that the plate is prebent, and major malalignments of the arthrodesis should not occur.

CONCLUSION

The combination of the ball-and-socket bone preparation and the fixation with dorsal prebent plate has operative advantages over other MTP fusion techniques. It is, on the one hand, technically simple to achieve congruent joint surfaces which is a requirement for good bone healing, and on the other hand, the prebent plate limits the risk of major malalignment of the arthrodesis.

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