CHAPTER 9

FIRST METATARSOPHALANGEAL JOINT FUSION CONSIDERATIONS

Thomas A. Brosky, II, DPM
Nicholas A. Giovinco, DPM
Joshua J. Mann, DPM

First metatarsophalangeal joint (MPJ) fusion is a time-tested procedure that produces reliable outcomes. A first MPJ fusion is utilized for the painful arthritic joint, end-stage hallux valgus deformity, and it can produce reliable outcomes for reconstruction and salvage procedures. The authors would like to discuss some common questions pertaining to the evaluation and technique when performing a first MPJ arthrodesis. These questions include: Are there any potential biomechanical risk factors that can cause hallux limitus/rigidus? What is the appropriate position for fusion of the first MPJ? Does it matter which type of graft (autograft versus allograft) is used when performing salvage arthrodesis? What is the most appropriate fixation for the first MPJ fusion? Can early weightbearing affect the fusion rate?

BIOMECHANICAL RISK FACTORS

Historically, there have been several biomechanical risk factors that may lead to hallux limitus. Root et al (1) described several reasons including: hypermobility, immobilization, an elongated first metatarsal, metatarsus primus elevatus (MPE), osteoarthritis, acute trauma, osteochondritis dissecans, gout, and rheumatoid arthritis. Nilsonne (2) hypothesized that an elongated first metatarsal would restrict plantar flexion and would increase compression of the first MPJ. The concept of MPE was first described by Lambrinudi in 1938, and was determined by the clinical presentation of a single patient (3). Some of these views have been challenged in the recent literature.

MPE

There is controversy as to whether or not MPE is associated with hallux rigidus. Roukis et al (4) demonstrated that dorsal motion of the first MPJ decreased by 19% and 35% as the first metatarsal was elevated 4 mm dorsally and 8 mm dorsally from weightbearing resting position, respectively. In another study performed by Roukis, there was a statistically significant difference between radiographic measurements of first metatarsal elevation in patients with hallux rigidus compared with those presenting with hallux valgus, plantar fasciitis, and Morton's neuroma (5). In 2010, Espinosa et al (6) concluded that an MPE of greater than 5 mm could be a predictive value in the presence of hallux rigidus. Shurnas and Coughlin (7) believed that elevatus was a secondary change, and noted that a change in MPE correlated with the advancing grade of hallux rigidus. A radiographic study by Myerson and colleagues (8) noted that mean values for first ray elevation were similar in both the study and control groups. No study to date has concluded why MPE could cause hallux rigidus, but one possible reason would be that over time this could lead to an increase in joint reaction force due to diminished excursion of the flexor hallucis longus tendon, which has been shown to occur by Sharkey et al (9) and Dunn et al (10).

HALLUX EQUINUS

Plantar flexion of the proximal phalanx of the hallux in relation to the first metatarsal with limited dorsiflexion has been described as hallux equinus (11). An uncompensated varus or pes planovalgus are two biomechanical reasons that have been noted to lead to this (11-13). The medial column does not contact the ground when an uncompensated varus is present. The hallux will compensate for the elevated medial column by plantar flexing to contact the ground. This provides stability during weightbearing. During pes planovalgus, the medial structures do not fully support the medial longitudinal arch. The plantar flexors of the hallux can cause flexion of the hallux at the metatarsophalangeal joint level to attempt to stabilize the medial column. Hallux equinus has been noted to lead to retrograde force of the first metatarsal therefore causing MPE (3, 13).

Elongated First Ray

In more recent literature, contradictory findings have been noted in regard to an elongated first metatarsal being a risk factor for hallux limitus. Ribbans et al (14) noted after reviewing 180 radiographs with hallux rigidus that only 37% involved a longer (>1 mm) first metatarsal than the second metatarsal. According to Shurnas and Coughlin

(15) the incidence of a long first metatarsal was not noted to be significant in their study population. Singer et al (16) also did not note a significant difference in their study population when comparing patients with normal, hallux valgus, or hallux limitus feet radiographically.

FUSION POSITION

The literature demonstrates numerous fusion angles. The most accepted proper positioning for first MPJ fusion utilized is neutral rotation of the hallux, 10-15 degrees of valgus, and 20-30 degrees of dorsiflexion in reference to the axis of the first metatarsal (17, 18). However, when performing an arthrodesis of the first MPJ we do not believe that there is a "one size fits all" position. The surgeon needs to take into consideration the foot structure and function of each individual patient. Our general rule for proper positioning of the hallux is as follows: the hallux nail should face upward with no frontal plane rotation, in alignment with the second digit transversely, and just off of the weight-bearing surface of a loading plate in the sagittal plane. There are certain consequences that can occur if appropriate positioning is not performed. Too much plantar flexion can cause an increase in stress to the hallux interphalangeal joint, and too much dorsiflexion can make shoe fitting a challenge as well as cause less hallux purchase during gait until late propulsion. Incorrect positioning in the transverse plane could lead to second digit irritation laterally or shoe irritation medially, and frontal plane deviation can cause pain due to overloading of the interphalangeal joint condyles.

FIXATION

Various types of fixation have been described for first MPJ arthrodesis, and high success rates have been shown regardless of the fixation used. Biomechanical studies show that there is increased strength noted in newer forms of fixation available, but studies comparing patient satisfaction with newer forms of fixation have not shown the outcomes to be statistically significant. Kay et al (19) noted that a combination of a single screw and a dorsal neutralization plate was almost twice as strong as two crossed screws. Denolf and colleagues (20) showed there was no significant difference when comparing time to union, rates of union, positioning, complications, and patient satisfaction between a compression screw or a screw and one-quarter tubular plate. The literature is insufficient when describing the use of locking plates for first MPJ fusions. In 2011, Jones et al (21) compared the fusion rates of locking plates to nonlocking plates for first MTPJ arthrodesis, and found a trend of higher fusion rates with the use of the nonlocking plates. Their fusion rate for locking plates in patients without rheumatoid arthritis was low at 79.8%. Swiatek et al (22) compared 4 plate constructs. They reported no significant difference in time to fusion or fusion rates between static and locked plates, with or without a compression screw. More research to compare and determine whether locked plate technology is useful in first MPJ arthrodesis is needed.

AUTOGRAFT VERSUS ALLOGRAFT IN REVISIONAL SURGERY

Revisional bone-block arthrodesis has been described and recommended as the procedure of choice in the medically fit, and active patient presenting with a failed fusion (18). Using bone graft in first MPJ fusions can be useful after a failed Keller or implant arthroplasty, failed arthrodesis or osteotomy, or when avascular necrosis is present in the first metatarsal head. Oznur et al (23) in 2000 reported on the use of bone graft with first MPJ fusions. Eight allografts and 16 autografts were used in this study. Interestingly, all the nonunions that were reported (5) were autografts. Zingg et al (24) in 2006 performed 28 fusions in 26 patients after failed Keller arthroplasties. Seven of these fusions required bone graft, and all were autografts. Only one of these went on to a pseudoarthrosis with the rest successfully healing. Morris et al (25) performed 12 first MPJ fusions with iliac crest autograft. Clinical arthrodesis was achieved in all patients; and radiographic studies showed that 11 of 12 had successful fusion with one being a pseudoarthrosis. Fusion in this type of setting occurs at two interfaces where, anatomically, small vessels are providing perfusion. The calcaneus is a good source if the graft size required is no larger than 1 cm in width (26). However, bone graft from the iliac crest should be considered in revisional first MPJ fusions requiring anything over 1-1.5 cm in length. It is imperative to assess the preoperative radiographs for proper planning in these situations, and resect down to healthy bone before retrieving bone graft intraoperatively.

WEIGHTBEARING

Non-weightbearing has historically been employed from 4-8 weeks following first MPJ fusions. Recent literature has challenged this, and several studies have shown an acceptable rate of success when early weightbearing has been employed (22, 27, 28) The author's preferred postoperative regimen is as follows: initially a Jones compression dressing with a posterior splint is applied and the patient is non-weightbearing for the first week. The patient is then

transitioned to a light dressing with heel weightbearing in a pneumatic cam-walker until forefoot walking is tolerated. Most patients will transition to full weightbearing within 2-3 weeks without difficulty.

CONCLUSION

The success of first MPJ fusion is directly proportional to several factors that include proper dissection techniques and appropriate positional alignment. Dissection should include all cartilaginous tissue along with adequate resection of the subchondral bone to ensure good bone-to-bone contact. The literature has demonstrated much success with numerous fixation techniques from Kirschner wires to plates and screws. When these techniques are followed and the position is in optimal alignment, successful fusion can be achieved.

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