SURGICAL MANAGEMENT OF IATROGENIC LESSER METATARSAL ELEVATUS

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INTRODUCTION

Iatrogenic lesser metatarsal iatrogenic forefoot deformities can be one of the most challenging types of deformities faced by the podiatric surgeon. These complex deformities require a rational surgical approach. Both the surgeon and the patient must have realistic expectations about the results of additional surgery. It is very important to avoid a simplistic approach which may result in further unanticipated deformity.

Historically, dorsiflexory osteotomies of adjacent metatarsals for the treatment of iatrogenic metatarsus elevatus has simply compounded the incidence of transfer lesions as the surgeon chases the painful lesion from one metatarsal head to another. A thorough understanding of the etiology and pathogenesis can prevent these undesirable results.

ETIOLOGY

Metatarsus elevatus and the associated floating toe syndrome can be caused by many factors. In some patients, a primary dermatologic condition may be the reason that the patient is prone to develop callosities or intractable plantar keratosis. In these patients the chance for formation of transfer lesions is great, making these patients poor candidates for any type of revisional metatarsal surgery. Additionally, unrecognized biomechanical or neuromuscular deformities may be a compounding factor in the development of floating toes and transfer lesions. In order to obtain the most desirable result, the management, whether surgical or non-surgical, should be directed to the primary etiology.

The importance of stabilization of the digit cannot be overemphasized. In most cases of iatrogenic metatarsus elevatus, there is an associated floating toe syndrome due to instability at the level of the metatarsophalangeal joint. Arthrodesis of the proximal phalangeal joint is usually necessary to assure stability of the forefoot.

The most common cause of iatrogenic metatarsus elevatus of the lesser metatarsal is excessive elevation of the metatarsal head at the time of surgery or during the postoperative course when the patient is ambulating. In these cases, the metatarsal head has healed in a dorsiflexed position and is no longer bearing its normal load during gait.

Generally, healing following lesser metatarsal osteotomy occurs by secondary bone healing with some shortening of the metatarsal during the healing process. Maintenance of alignment through the secondary bone healing process can be improved with excellent alignment by the use of internal or external fixation techniques. The concept of the floating metatarsal osteotomy is ill-founded and is prone to complications. Movement of bone during the healing process allows the metatarsal head to heal in any arbitrary position and is prone to a high incidence of postoperative complications including metatarsus elevatus and associated floating toe syndrome.

PATHOGENESIS

Flexor power of the metatarsophalangeal joint may be classified into two stages, active and passive power. The lumbricales and interossei muscles help to stabilize the metatarsophalangeal joint in order to establish a functional and stable joint on which the flexors of the digit may act. (Figure 1A) The goal of treatment for metatarsus elevatus with associating floating toe is directed at re-establishing the flexor stabilizing power at the level of the metatarsophalangeal joint. The passive power of the metatarsophalangeal joint is provided by the plantar fascia and plantar cap. The effect of the plantar fascia can not be overstated. The traction caused by the pull of the plantar fascia is transferred to its insertion at the base of the proximal phalanx providing stability of the MPJ. (Figure 1B) During gait, body weight must be transferred from the metatarsals to the digits during the toe-off phase to prevent the formation of plantar calluses and forefoot deformities.

The major goal of reconstructive surgery is to re-establish plantarflexory force across a stable metatarsophalangeal joint. The important factor to remember in the treatment of iatrogenic metatarsus elevatus is the loss of weight bearing from the involved metatarsal. The loss of weight bearing causes an increase of pressure to the adjacent metatarsal with the possibility of transfer lesions. Preservation of the length of the metatarsal is not as important as the preservation of the weight bearing during gait. A goal of corrective surgery in this incidence is to restore weight bearing to the metatarsal and not necessarily the length of the metatarsal. The actual procedure and technique will vary from patient to patient, depending upon individual circumstances.

CLINICAL / X-RAY EVALUATION

The type and location of the lesion is important in determining the amount of correction and choice of procedures. Clinical examination of the patient should include evaluation of the type and severity of the lesion, the presence or absence of associated digital deformity, biomechanical foot type, gait analysis and x-ray findings.

On the dorsal plantar x-ray view, it is often difficult to determine the presence of an iatrogenic metatarsus elevatus unless there is significant shortening present. (Figure 2A) The axial metatarsal view often clearly demonstrates an elevated metatarsal. (Figure 2B) The lateral view has limited benefit in determining the presence of this condition because of super-imposition of the metatarsal heads. The oblique view can be beneficial in determining shortening and elevation of the metatarsal head. (Figure 3)

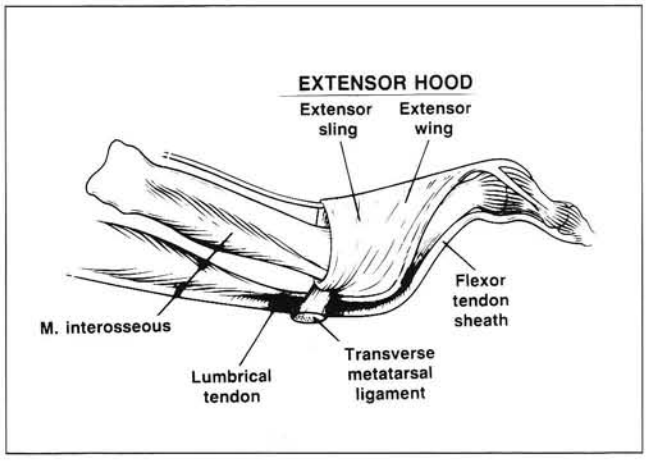

Figure 1A Orientation of intrinsic muslature.

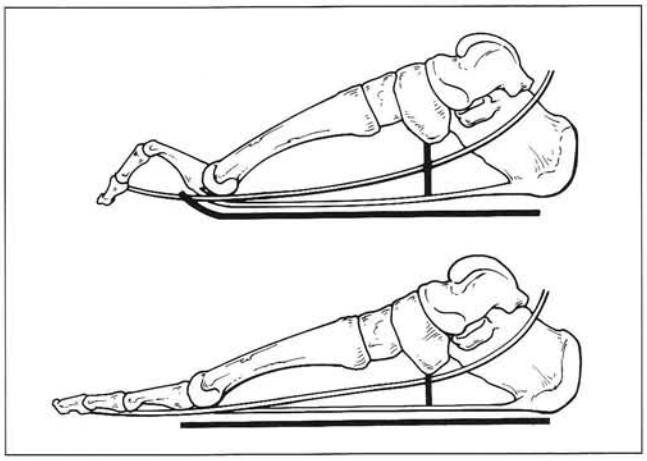

Figure 1B. Effect of plantar fascia on digital stabilization with non-weight bearing (top) and weight bearing (bottom).

Figure 2A. Difficult to determine metatarsus elevatus on dorsal plantar radiograph unless there is excessive shortening.

Figure 3. Shortening and angulation indicating metatarsus elevatus of the 4th metatarsal on the oblique view radiograph.

Figure 2B. Sesamoid axial metatarsal radiograph often demonstrates metatarsus elevatus.

SURGICAL APPROACHES

The goals of correction of metatarsus elevatus are to improve weight bearing to the metatarsal head and to decrease the load on adjacent metatarsal heads. This will help prevent the formation of the floating toe syndrome and decrease the incidence of other transfer lesions. In most cases, simply raising the adjacent metatarsal head is doomed to failure. The primary goal in all incidences of iatrogenic metatarsus elevatus is re-establishment of weight bearing to the effected metatarsal head. The secondary goal is re-establishment of length.

The individual surgical approach depends upon the etiology and severity of the deformity. The following procedures may be used as isolated procedures or in combination depending on the clinical presentation of each individual case.

Distal Plantarflexory Osteotomy

The distal plantar displacement osteotomy has limited application because of the relative narrowness of the metatarsal shaft. The procedure is technically difficult to execute and maintain because of the potential for increased instability as more plantar displacement is created. Success of the procedure requires displacement of the metatarsal head in a plantar direction, however, the surgeon is limited to approximately 50% displacement before significant instability can lead to complications in bone healing. Internal fixation with 0.045 K-wire is commonly used. In cases of significant metatarsus elevatus, dorsiflexory osteotomy of the adjacent metatarsals may be necessary to assure relief of forefoot symptoms.

The optimal goal is to re-establish weight bearing to the involved metatarsal and this may better be accomplished by an open wedge osteotomy at the base of the metatarsal.

Proximal Plantarflexory Osteotomy

A proximal opening wedge plantarflexory osteotomy of the lesser metatarsal can be a very effective procedure because of the application of a longer lever arm. The osteotomy has increased stability over distal osteotomies and utilizes a corticocancellous graft to maintain the corrected position of the distal metatarsal. The challenging point for the surgeon is to re-establish normal weight bearing of the metatarsal head without re-creating the original deformity causing a recurrence of the primary intractable plantar keratosis.

Autogenous grafts are recommended over allogenic grafts and these grafts can readily be obtained from the body of the calcaneus or other sites. The dorsal lateral aspect of the body of the calcaneus is commonly used as a donor site. The surgeon may consider insertion of an allogenic replacement graft into the donor site of the calcaneus. The opening osteotomy is usually fixated with a staple or a K-wire. Care is taken to not over-compress the bone graft site and cause absorption of the graft or recurrence of the forefoot deformity.(Figure 4A,B)

Grafting of isolated metatarsals has the potential for a more normal functional result. The procedure may be technically difficult. Internal fixation is necessary and the surgeon should be aware of the prolonged recovery which includes non-weight bearing casting for 8 to 12 weeks, physical therapy and biomechanical control of the forefoot following surgery.

Lengthening Osteotomy

Lengthening osteotomies may be used for correction of the iatrogenic metatarsus elevatus. The most common procedure involves a slide lengthening of the metatarsal combined with internal fixation from a K-wire or internal fixation screw. These procedures are prone to instability and are limited by the amount of bone available. In most cases, it is not recommended for multiple metatarsals. Postoperative recovery is usually shorter than with bone grafting, however, there is a potential for lesser MPJ limitus with lengthening of the metatarsal. The slide lengthening technique is less commonly performed at the author's Institution. (Figure 5)

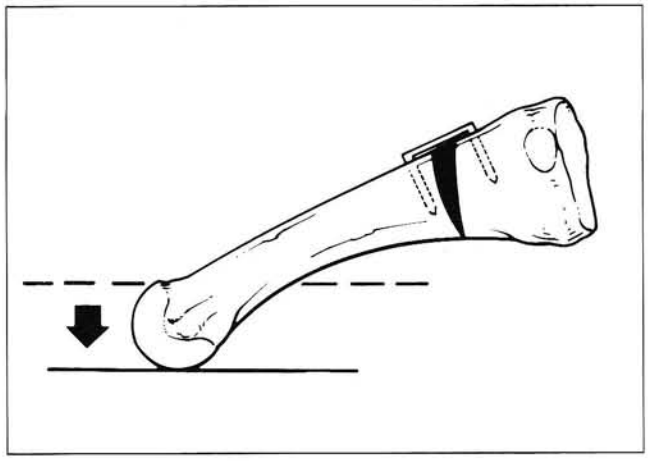

Figure 4A. Proximal plantarflexory opening wedge osteotomy with a scaphoid compression staple.

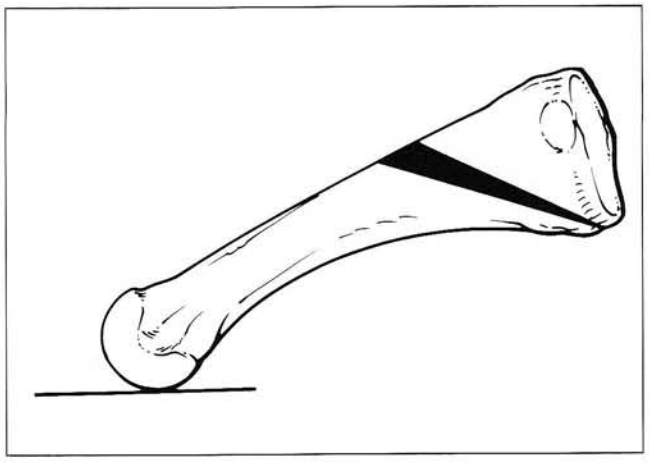

Figure 4B. Proximal plantarflexory oblique wedge osteotomy.

Figure 5. Slide lengthening with wire loop and K wire combination fixation of the third metatarsal.

Figure 6. Shortening osteotomy of second and third metatarsals combined with forefoot stabilization utilizing PIPJ arthrodesis of the second, third and forth digits.

Osteotomy

Osteotomy of the adjacent metatarsals for the treatment of iatrogenic metatarsal elevatus is a common approach. However, there has been a high incidence of recurrence or transfer lesions with this technique. The advantage of the procedure is that it can be performed on multiple metatarsals and the procedure is technically easier to perform. Minimal fixation is necessary and there is a much shorter recovery. As with any osteotomy, there is a potential for shortening of the metatarsal as well. Osteotomy of adjacent metatarsals for correction of iatrogenic metatarsus elevatus is not commonly performed at the author's Institution because of the high incidence of recurrent IPK and transfer lesions.

Shortening Metatarsal Osteotomies

A shortening osteotomy may be performed on multiple metatarsals. Many techniques are available including the Giannestras step-down osteotomy, double V osteotomy, or cylindrical wedge removal. These procedures usually have a shorter postoperative recovery than bone grafting; however, they are prone to instability and require some type of rigid fixation. Shortening osteotomies are not commonly performed or recommended for correction of this condition. (Figure 6)

Pan Metatarsal Head Resection

The pan metatarsal head resection technique is best suited for complex forefoot derangements. This procedure is very reliable and allows the patient to ambulate immediately after the surgery. The patient will usually have an apropulsive gait after surgery and logic would warrant that the forefoot symptoms and function should dictate such a surgical approach. This procedure is reserved for more severe deformities and usually for cases in which there are multiple forefoot symptoms. Arthrodesis of the proximal interphalangeal joint of the lesser digits is usually performed to provide a stable lever arm for the long flexor. Digital stability during gait is an important factor in relieving forefoot symptoms and providing stabilization of the forefoot. (Figure 7)

Implant Arthroplasty

The lesser metatarsophalangeal implants may aid in establishing a pain free range of motion in severe forefoot deformities. The implant provides minimal stability and acts primarily as a spacer and not as a structural correction. The surgeon

Figure 7. Radiograph following Pan metatarsal head resection with arthrodesis of the lesser digits, 2, 3, and 4 to provide stability of the forefoot.

cannot rely on the implant to act as a weight-bearing portion of the lesser metatarsal. Again, the primary goal of reconstructive surgery is to restore weight bearing to the involved metatarsal and decrease the excessive load on adjacent metatarsals.

Stabilization of the Digit

(Proximal Interphalangeal Joint Fusion)

Arthrodesis of the proximal interphalangeal joint produces a rigid segment necessary for the long flexor stability. Arthrodesis helps to release abnormal plantarflexory forces against the metatarsal head and prevent the retrograde effect of the digit on the metatarsal head. Re-establishing plantarflexory force across a stable metatarsophalangeal joint is a goal of the reconstruction. PIPJ fusion of the digit is commonly performed in conjunction with metatarsal surgery to re-establish weight bearing of the involved metatarsal head.

RISK MANAGEMENT

The surgeon must carefully weigh the benefits of additional surgery before attempting the surgical salvage of this condition. The patient must be made aware of the potential for recurrence of the deformity and the high incidence of recurrent lesions or transfer lesions.

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