CHAPTER 3

USE OF ABSORBABLE PIN STABILIZATION OF THE LESSER METATARSOPHALANGEAL JOINTS

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INTRODUCTION

The lesser metatarsophalangeal (MTP) joints may be affected by a variety of pathology and are often involved in transverse plane as well as sagittal plane deformities of the toes. This discussion will focus on the more severe and generally long-standing deformities where tenotomies, joint release, and plication techniques have proven inadequate. The surgical management of forefoot deformities particularly those associated with hammertoe deformities and MTP joint contractures are the focus of this discussion. Generally, hammertoe deformities involve sagittal plane contracture at the MTP joint. This may progress to a more complex deformity with luxatory multi-planar contractures. These complex deformities are generally a component of forefoot derrangements associated with hallux valgus, hallux varus, and rheumatoid foot deformities. All the lesser toes may be involved or simply isolated toes. Second toe involvement is most common and may be associated with more severe grades of hallux valgus or at times the digital and MTP joint contractures may develop with hallux varus or simply a straight great toe.

Several of these complex deformities of the lesser MTP joints will be described as their surgical management is the main focus of this discussion.

HISTORIC APPROACH TO THE HAMMERTOE AND MTP JOINT CONTRACTURE

The hammertoe deformity has historically been addressed with a post arthroplasty or head resection of the proximal phalanx with extensor digitorium tenotomies with or without MTP joint capsulotomy dependent upon the severity of deformity.[1-4] Flexible deformities have been addressed with flexor transfers in attempt to balance the toe and the MTP joints. In long-standing and more severe deformities, single or multiple PIPJ fusions are performed in combination with release of the extensor complex in each of the respective toes. This discussion is to review techniques to correct deformities where these usual techniques are inadequate.

Kelikian, in 1961 recognized the MTP joint contracture and its contribution to the deformity.[5,6] He popularized the proximal phalangeal base resection for reduction of the MTP joint contracture associated with hammertoe deformity. This has generally been considered a radical alternative due to the ablative nature of the procedure. Complications have included an unstable and shortened toe for which Kelikian himself advocated syndactyly to avoid these problems. Plantar plate repair has been proposed as an alternative to reduce MTP joint subluxation.[7]

Partial metatarsal head resection and later shortening metatarsal osteotomy have also been advocated for deformities associated with luxatory contractures and plantar metatarsal head lesions. Rheumatoid arthritis often produces severe hallux valgus associated with hammertoe deformities with lateral and dorsal luxatory lesser MTP joint deformities.[8-12] Ablative procedures such as metatarsal head resection, base resection, or both are often performed. Bone resection is performed to provide soft tissue relaxation of long-standing joint contractures. The tremendous corrective potential of bone resection and inadequacies of traditional hammertoe procedures has been appreciated by this author. It has been the basis for my investigations with alternative procedures and this preliminary report.

Experienced surgeons are often faced with very challenging deformities particularly in long-standing deformities with soft tissue contractures. These may include end-stage hallux valgus with overlapping or underlapping second toe, hallux varus with digital adductus and lesser MTP joint adductus, or divergent toes with adjacent medial and lateral transverse plane contracture. Digital adductus is often a prominent feature in patients

with congenital hallux varus, residual metatarsus adductus, or part of a post CVA syndrome.

THE MTP JOINT ARTHROPLASTY

The lesson of Kelikian is well recognized and lesser toe phalangeal base resections are still a viable option. Early surgeons generally resected an excessive amount of the proximal phalanx (upwards of half of the phalanx) leading to the previously described complications. Less radical resection generally obviates the need for syndactyly while still providing adequate soft tissue release and correction of deformity. This author's initial experience involved base resection combined with PIPJ fusion and Kirschner-wire stabilization of the ray. Recurrence may occur and this has been further modified to include absorbable pin stabilization of the toe and lesser MTP joint arthroplasty. The role of MTP joint arthroplasty will be reviewed in a variety of clinical situations. The surgical management of these challenging lesser MTP joint deformities will be illustrated.

Situation 1: Hallux Valgus with Second Hammertoe

The most common situation of dorsal and medial subluxation of the lesser MTP joint associated with hallux valgus and hammertoe deformity is demonstrated in Figure 1. This patient possessed a long-standing deformity with the second toe overlapping the hallux. The proximal phalanx was medially and dorsally subluxed with a fixed or rigid deformity. Often this severe hammertoe is responsible for the majority of the patient symptoms. The second toe sits on top of the hallux and may make shoe wear very difficult and painful.

Generally, the overlapping second toe is identified with a severe hallux valgus deformity. The hallux adductus angle is pathologic with deformities of 45 to 60°. The hallux is often rotated and the second toe rides dorsally and sits on top of the hallux. This end-stage second toe deformity develops from a simple hammertoe and progresses through MTP joint contracture and finally dorsal and medial subluxation of the proximal phalanx on the metatarsal. Hammertoe repair including PIPJ fusion and complete MTP joint release with Kirschner-wire stabilization of the second toe extending proximally and crossing the MTP joint

Figure 1A. This is an illustrative case of severe hallux valgus deformity associated overlapping second toe with adduction and dorsal subluxation of the second MTP joint.

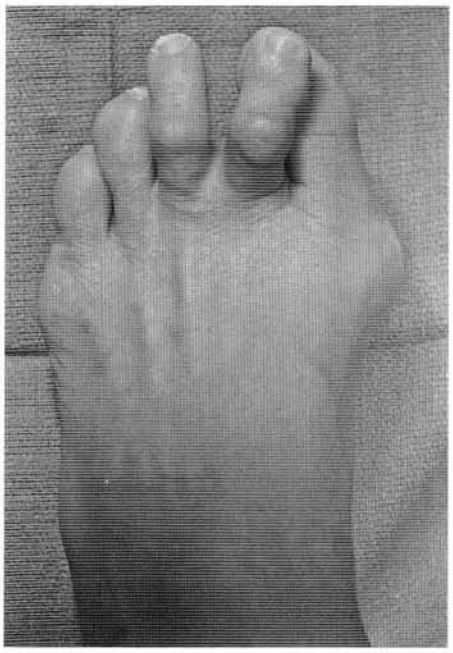

Figure 1B.

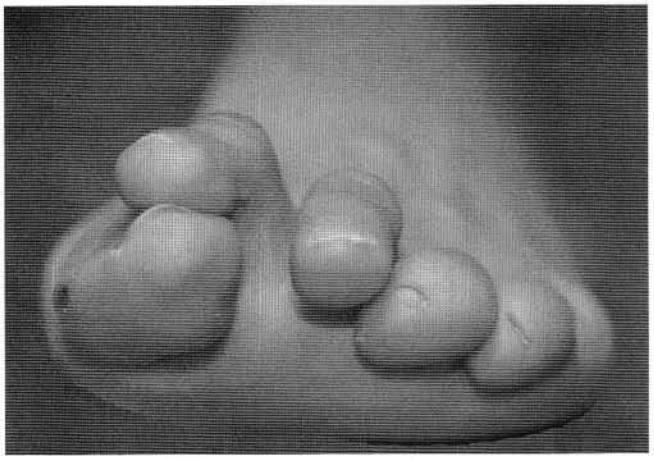

Figure 1C.

has been utilized. Initial reductions may occur but recurrence once the Kirschner-wire has been removed is common.

The author's own experience has shown that complete reduction of deformity achieved by soft tissue relaxation can only be accomplished with bone resection. My training in the late 1970s included partial metatarsal head resection as these patients often presented with plantar hyperkeratotic lesions, painful capsulitis and severe joint deformity. Kelikian's orthopedic approach included resection of the base of the proximal phalanx. This included plantar detachment of the aponeurotic insertions into the phalangeal base and provides the relaxation necessary to correct the most severe deformities. Certainly, most deformities are not that severe and should be addressed in a systematic manner with a step-wise approach with progressive soft tissue releases. Figure 1 is illustrative of the described clinical situation of severe hallux valgus and luxatory hammertoe deformities.

Situation 2: Hallux Varus with Digital Adductus

The great toe is not only the largest of our toes but it is also the dominant toe. The influence of the great toe on the lesser toes can be particularly identified in the pathology of hallux varus. Hallux varus is usually considered a complication of hallux valgus surgery wherein the hallux is overcorrected. Often this medial deviation progresses, and a very severe degree of adduction of the hallux may be observed. Over the course of time, its influence is felt by the lesser toes. The second and later the third and somewhat later the remaining toes also may be seen to medially deviate. The deformity occurs at the MTP joint with generally flexion accompanying the adduction of the proximal phalanx. Due to the natural progression of the deformity, the second toe is more severe than the third, which is usually more significant than the fourth or fifth toes.

Figure 2 is such a situation where a long standing iatrogenic hallux varus deformity is now accompanied by rigid digital contractures. This is a very difficult clinical situation and much like rheumatoid forefoot reconstructions, the entire group of deformities must be addressed surgically if correction is to be achieved and maintained.

Case 3: Rheumatoid Forefoot

The forefoot deformities noted in rheumatoid patients are classic in their description. Generally, a severe hallux valgus deformity is present with hammertoe deformities involving the second through fifth toes with fibular deviation. Radiographically, lateral and dorsal luxatory deformities at the lesser MTP joints can be appreciated. Our answer for correction of these deformities has been the forefoot arthroplasty or modifications of the Hoffmann Clayton procedures. Not only is the hallux valgus deformity corrected with some type of joint destructive procedure (Keller resection, implant arthroplasty, or arthrodesis), but this philosophy of joint relaxation and correction of soft tissue deformity through ablative resection of bone is also applied to the lesser MTP joints. Resection of the lesser metatarsal heads and or base of the proximal phalanges has been a mainstay of rheumatoid foot surgery for the past 50 years.

Last year, here in Atlanta, my presentation involved the permutation of procedures involved with forefoot arthroplasty and the rheumatoid forefoot. First MTP joint arthrodesis is generally preferable, as this provides durable reconstruction stability of the medial column of the foot. The lesser toes and MTP joint resections have traditionally been stabilized with intramedullary Kirschner-wires retrograded from the tips of the toes across the MTP joints. These are generally left in place for approximately 6 weeks post-operatively. As an alternative, the author proposed use of absorbable intramedullary pins that would not only provide the initial reduction of deformity

Figure 2A. Hallux varus is often associated with adduction contractures of the lesser toes in this case illustrates involvement of the second toe. Flexion of the greater portion of the second toe is evident with adduction contracture at the second MTP joint in this preoperative radiograph A). B) and C) show reduction of deformity following first MTP joint fusion, second toe PIPJ fusion and proximal phalangeal base resection with the second MTP joint stabilized with an absorbable pin.

Figure 2B.

Figure 2C.

and maintenance of correction during the early postoperative period, but would also achieve long-standing stabilization. Clinically, advantages may include less floppiness of the toes and less recurrence of digital deformities.

Situation 4: The Diabetic Foot

Diabetics often develop foot deformities that are not attributable to their diabetes, yet the clinical situation is somewhat unique to their diabetic condition. Diabetes is associated with a progressive loss of normal joint flexibility and has been termed loss of joint mobility by researchers.[15-17] This loss of joint mobility often plays a role in forefoot deformities and the development of diabetic foot complications such as neuropathic and ischemic ulcerations.

Rigid hammertoe deformities become fixed in nature with extension at the MTP joints, and flexion at the PIPJ and possibly DIPJs. As a fixed deformity, the hammertoe is nonreducible and subjected to shoe pressures dorsally and plantar pressures at the level of the metatarsal heads as well as tips of the toes. Often, all the toes are involved and surgical management must address release of the MTP joints as well as interphalangeal joints of the toe. Figure 3 illustrates the surgical management of a neuropathic foot with rigid joint contractures in a patient with a history of recurrent

Figure 3A. This case is illustrative of rigid deformities associated with a diabetic, AP radiograph A), and lateral view B), while the postoperative radiograph C) shows reduction of deformity is a result of proximal phalangeal base resection combined with hammertoe repair and absorbable pin stabilization of each of the respective rays.

Figure 3B.

Figure 3C.

digital ulcerations. PIPJ fusion combined with proximal phalangeal base resection is a very effective technique to correct non-reducible contractures in appropriate surgical candidates.

Situation 5: Divergent Toes

Toes may progress to many variations of deformity and including divergence between adjacent toes. This has at times been associated with a Morton's neuroma with adduction of the third toe and abduction of the fourth toe. In cases of hallux varus as described above, the second toe may follow the great toe and show significant adduction while the third toe may occasionally remain straight at least for a certain number of years.

Situation 6: Digital Amputation

Isolated lesser toe deformities or ulceration have occasionally been treated with digital amputation. This has been most often the case in patients with severe second hammertoe deformity with the second toe overlapping of the hallux. Figure 4 is an example of a patient with prior second toe amputation for just such a clinical situation. She went on to progressive adduction of the third, fourth and fifth toes. This patient was treated with proximal phalangeal base resection combined with PIPJ fusion of the third toe and absorbable pin stabilization.

MATERIALS

Absorbable fixation devices have been available and widely used clinically now for more than a decade. Some surgeons have embraced the idea of absorbable fixation while others have not appreciated its value. Absorbable pins are available in different diameters as well as lengths from several manufacturers such as Bionx, Arthrex, and Biomet. The most common sizes appropriate for use in the toes and crossing the MTP joints is either

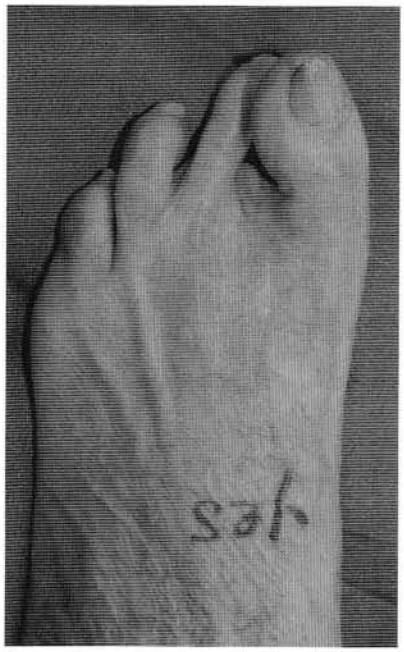

Figure 4A. This patient A) and B) had prior amputation of the second toe for overlapping second toe deformity. Following amputation, lesser toe adduction contractures continued, as seen in this AP radiograph C). This patient was treated with hammertoe repair including base resection of the third toe and absorbable pin stabilization, Intraoperative view D). Postoperative radiographs at 6 weeks E) and one year F) show good correction of deformity as well as long-term maintenance of correction.

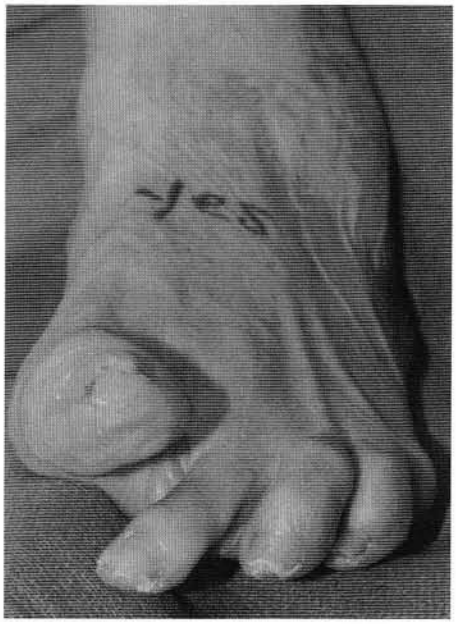

Figure 4B.

Figure 4C.

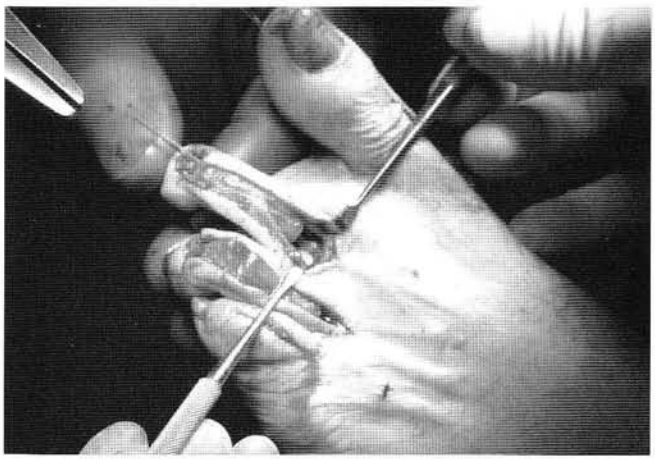

Figure 4D.

Figure 4E.

Figure 4F.

1.5 or 2 mm diameter pins. Initially, the technique for insertion of the pins included hand devices to push the pin through a hole that was previously drilled. The materials do have varying characteristics and some are designed to be inserted with power instrumentation. This does require predrilling with a designated Kirschner-wire, but allows for easier insertion in many clinical situations.

SURGICAL TECHNIQUE

Surgical exposure to the MTP joint may vary depending upon the need for PIPJ arthroplasty/fusion. The most common clinical scenario involves exposure of both the MTP joint and its respective PIPJ. This is generally accomplished through a midline digital approach extending proximally across the MTP joint. The MTP joint extensor good apparatus is easily separated from the adjacent deep tissues bluntly separating with a curved Kelly or Metzenbaum scissors. The extensor tendons may be addressed individually or simply transected as part of a dorsal MTP joint capsulotomy. The surgeon may elect to follow dorsal capsulotomy with vertical medial and lateral release or simply proceed to exposure of the phalangeal base.

A lineal midline incision down to bone is created from the MTP joint to the midpoint of the proximal phalanx. A #15 blade may be inverted at the metaphyseal flares medial and lateral with gradual proximal subperiosteal dissection. The remaining medial and lateral capsular and periosteal attachments may then be performed from dorsal plantar on either side. Location of the proximal phalangeal metaphyseal osteotomy is identified and marked. Osteotomy may then be accomplished with gentle medial and lateral deep tissue retraction using Ragnall retractors and distal traction of the toe. Following osteotomy, distal traction of the toe will allow grasping of the phalangeal base and subsequent medial and lateral dissection will provide extirpation of the base. The metaphyseal flares should still be evident. Gentle rounding of any sharp contours may be accomplished with a rotary bar. At this point, the surgeon may elect to completely deglove the metatarsal head using a McGlamry elevator.

Attention is then addressed to the PIPJ segment where surgical exposure is left to the surgeon's preference. If PIPJ fusion will be performed, the author usually prefers a lineal approach to the PIPJ. A sharp #15 blade allows for dorsal dissection at the base of the middle phalanx and soft tissue laxity at the PIPJ. The blade is inverted along the medial and subsequent lateral surfaces and dissection proceeds from distal-to-proximal. Further subperiosteal dissection of the middle phalangeal base is accomplished in a dorsal plantar manner on either side. Limited exposure of the proximal phalangeal head is necessary, and

generally only a portion of the medial and lateral collateral ligaments require dissection. Transverse osteotomy with resection of only the middle phalangeal base articular surface is performed with an oscillating bone saw followed by transverse osteotomy through the phalangeal head. A rotary bur is used to smooth any rough surfaces.

An appropriate absorbable pin system is selected and for this discussion, the technique for the Arthrex Trim-it® 1.5 mm pin will be described. Calibrated Kirschner-wires are included in the set and a intramedullary drill hole utilizing this Kirschner-wire is performed through the resected proximal phalangeal stump for approximately 2 cm. The surgeon will now drill through the middle phalanx distally at the tip of the toe. The Kirschner-wire is retrograded back across the PIPJ, through the phalangeal base at this point, the foot must be loaded to ensure proper sagittal plane positioning of the toe on the metatarsal. Attention must be given not only for sagittal plane but also transverse plane positioning. The desired position must be accomplished with a metallic Kirschner-wire before the surgeon attempts insertion of the absorbable pin. If base resections are being performed on multiple toes, then the Kirschner-wires are inserted for each of these.

One by one, generally starting with the second toe, the respective Kirschner-wires are removed followed by subsequent insertion of the absorbable pin in the same retrograde manner. The Arthrex 1.5 mm pins possess good rigidity as well as a tapered point to allow for easy insertion and handling with power equipment. The pins are 100 mm in length and allow for the surgeon to cross the MPJ placing approximately 2 to 3 cm of the absorbable pin within the metatarsal. Once all absorbable pins are inserted, they may be cut flush with the distal tip of the toe with a sharp bone forceps or pin cutter. This leaves a squared flat surface that may then be tamped subcutaneously. To limit postoperative bleeding, a small Steri-Strip may be placed on the distal tip of the toe.

CONCLUSIONS

Hammertoe deformities come in all degrees of severity. This discussion is meant to address the MTP joint subluxations and dislocations of the most severe deformities. The base resection may have been considered an archaic and radical operation, but when stabilized with absorbable intramedullary pins, a very powerful corrective procedure is born. Base resection may be performed with or without PIPJ procedure although most have been combined with PIPJ fusion. Occasionally, there are situations wherein PIPJ intervention is not necessary. The pin still may be retrograded from the tip of the toe and stabilize the DIPJ, PIPJ and MTP joint. In the past, most surgeons have had experience with broken metallic pins crossing MTP joints. Absorbable pins allow for stability yet have a certain flexibility that has proven useful in these situations of physiologic loading. Absorbable pin stabilization of the toes, and MTP joints as necessary, may be the next great innovation of hammertoe surgery.

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