CHAPTER **23**

ANATOMIC DISSECTION IN DIGITAL SURGERY

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INTRODUCTION

Digital deformities are one of the most commonly encountered entities treated by the podiatric physician. Hammer toe deformities occur when the normal balance of the intrinsic and extrinsic musculature is lost surrounding the metatarsophalangeal joints (Figure 1). Hammer toes can be distinguished into several categories including the classic hammer toe, claw toe, or the mallet toe. A hammer toe may occur in only one or in multiple digits, and range is severity from a mild reducible deformity to a rigid fixed deformity. The cause of these digital deformities may be attributed to 3 distinct mechanisms; flexor substitution, flexor stabilization and extensor substitution.[1] These mechanisms induce deformity at different levels of the digit. Proper evaluation is critical for long term reduction of the deformity.

FLEXOR SUBSTITUTION AND STABILIZATION

Flexor substitution occurs with a weak triceps surae muscle. The deep posterior and lateral leg muscles try to compensate for inadequate plantarflexion. The flexors gain a mechanical advantage over the interossei muscles which result in a straight contracture of the digit without adductovarus.

Flexor stabilization occurs with excessive pronation. The subtalar joint pronation allows unlocking of the midtarsal joint and hypermobility of the forefoot. The flexor muscles fire earlier and longer than normal in an attempt to stabilize the forefoot. The flexors overpower the interosseous muscles and cause digital contracture. There is often an associated adductovarus of the lateral digits.

Figure 1. Hammer toe deformity.

EXTENSOR SUBSTITUTION

The extensor muscles normally contract to dorsiflex the ankle to allow the foot to clear the ground during the swing phase of gait. In extensor substitution, the extensor muscles gain a mechanical advantage over the lumbricles causing contraction at the metatarsophalangeal joint

ANATOMY

A thorough knowledge of the functional anatomy is necessary for correction in any pathologic state, digital surgery is no exception. The digit, to include the proximal and distal interphalangeal (IPJ) and metatarsophalangeal (MPJ) joints, are a complex array of bone and soft tissues which anchor the intrinsic and extrinsic musculature of the foot and leg.[2] The MPJ and IPJs are stabilized by the collateral ligaments obliquely running on either side of the joint. The dorsal surface is covered with only a thin capsule. The plantar stability is provided by the flexor plate, a thick fibro-cartilaginous structure that prevents dorsal subluxation, especially at the MPJ.

Dorsally, the long extensor tendon has an anatomic insertion which differs from its functional attachment. The long extensor trifurcates over the digit with its central expansion attaching to the middle phalanx, and the 2 lateral slips attaching to the distal phalanx. This tendon is a weak dorsiflexor of the IPJ but a strong extensor of the MPJ. This effect is created by the extensor hood apparatus. The extensor hood is an expansion of the deep fascia with fibers than span medial and lateral around the MPJ attaching to the plantar plate region.

Plantarly, the short flexor tendons split into two slips that attach to the middle phalanx. The long flexor tendon passes through the split in the tendon and inserts into the distal phalanx. The function of the long flexor, non-weight bearing, will flex the IPJ and MPJ. During weight bearing, the long flexor tendon will pull the distal phalanx proximal, buckling the digit.

ANATOMIC DISSECTION

The approach to hammer toe correction is based on the surgical principal of anatomic dissection. The concept of anatomic dissection is the preservation of nerve and blood supply to the soft tissues.[3] This dissection technique allows for separation of tissue layers through their natural plane providing adequate exposure and full visualization of all aspects of the joint. This approach maintains the viability of surrounding soft tissues and is a primary mechanism of establishing hemostasis of the surgical wound. The primary control of bleeding throughout the surgical procedure not only maintains good visualization of anatomy, but reduced bleeding controls hematoma and edema postoperatively. The anatomic dissection technique can be applied to virtually any surgical procedure provided by the podiatric physician. For the benefit of hammer toe surgery, these techniques will be discussed in greater detail.

The skin incision is created midline over the dorsal aspect of the digit and proximal interphalangeal joint (Figure 2). The incision placement is oriented parallel to and between any critical structures. The incision can easily be extended proximally to the metatarsophalangeal joint if contracture is present. With the skin incised, the superficial fascia is identified and delicately "brushed" from the medial and lateral aspects of the proximal phalanx. The term "brushed" is a technique utilizing the 15 blade in a sweeping fashion at the natural separation of tissue layers in order to atraumaticaly separate the superficial from the deep fascia (Figure 3). This preserves the longitudinally oriented neurovascular bundles.

After adequate separation of tissue layers, the extensor tendon is transversely incised just distal to the head of the proximal phalanx (Figure 4). The medial and lateral collateral ligaments are identified and resected at the joint level, exposing the head of the proximal phalanx into the surgical site. With deformities requiring MPJ release, the extensor tendon is freed by incising the extensor hood expansion at the medial and lateral aspects of the tendon. The tendon is then reflected proximal, exposing the MPJ capsular structures. Severe deformity may require extensor tendon lengthening. This is accomplished by performing a Z-plasty lengthening between the IPJ and MPJ. The extensor hood is incised as previously described but not through its entire length. The incision stops short of the transverse incision at the phalangeal head keeping the distal portion of the Z-plasty attached to the proximal phalanx (Figure 5). The capsular tissues are incised and released as needed to allow for complete reduction at this level. A dorsal capsulotomy would be follow by a medial or lateral release (or both), depending on the transverse plane position of the deformity.

The head of the phalanx and base of the middle phalanx is resected with either power or hand instrumentation (Figure 6). Care is taken to resect the articualar cartilage and subchondral plate without excessive bone loss. A perpendicular plane must be maintained for good apposition of the arthrodesis site. The intramedullary canal

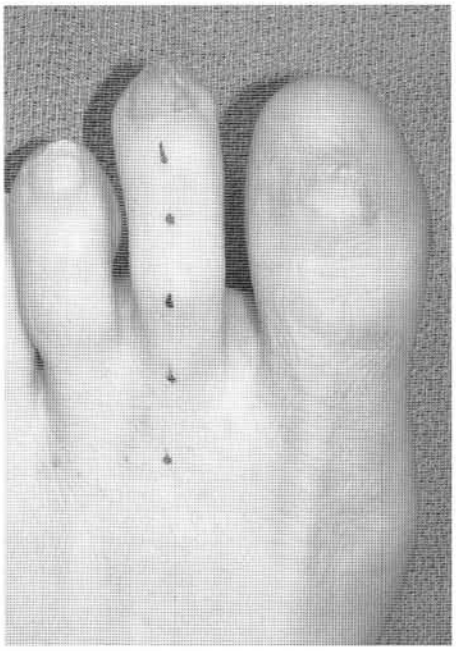

Figure 2. Proposed skin incision.

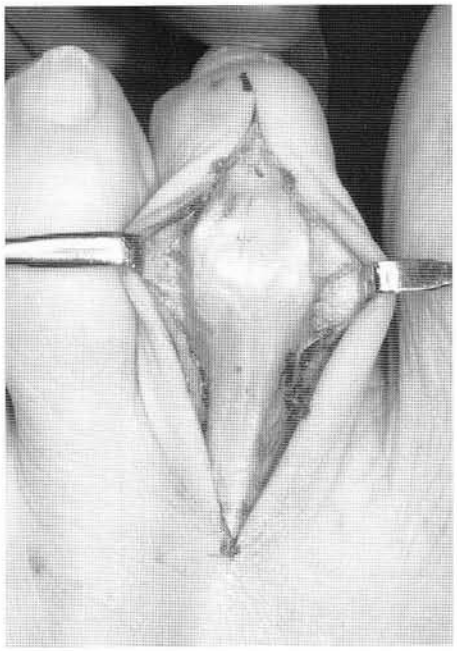

Figure 3. The superficial fascia is "brushed".

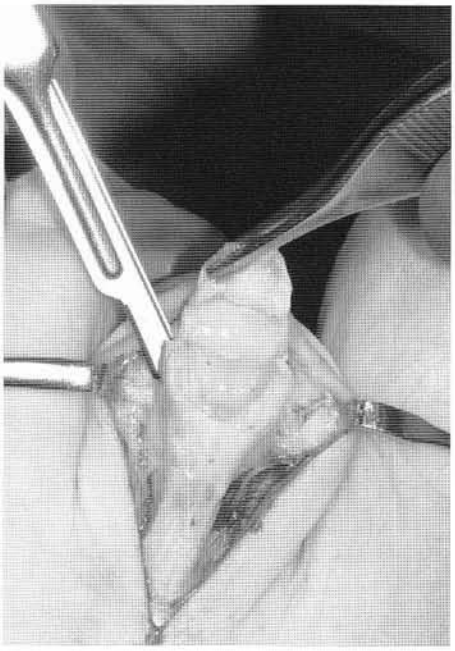

Figure 4. Extensor tendon is excised.

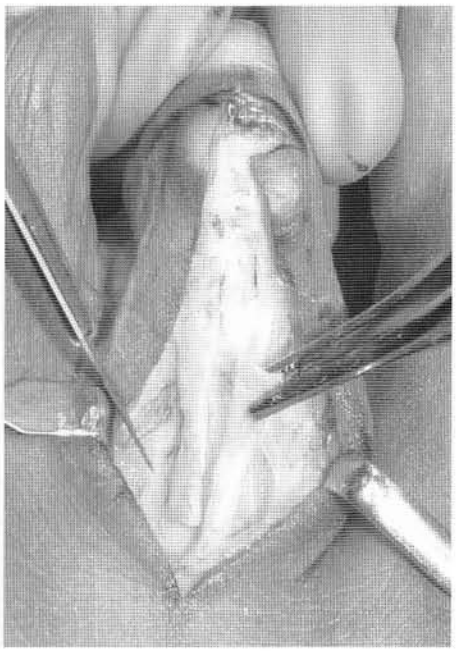

Figure 5. Distal portion of the Z-plasty stays attached to the proximal phalanx.

of the proximal phalanx is identified with a K-wire. The K-wire is then directed distally into the base of the middle phalanx at the central portion of bone (Figure 7). The distal tip of the digit is held in an extended position exiting the K-wire through the distal phalanx centrally in line with the nail plate. The wire is retrograded back into the proximal phalanx through the prepared intramedullary canal to the level of the subchondral bone plate (Figure 8). The K-wire may be advanced across the metatarsophalangeal joint if necessary. The arthrodesis site is then inspected for good bone-to-bone contact. With satisfactory bone apposition, the distal wire is bent, cut and pin cap applied.

Closure begins with the reapproximation of the extensor tendon in an end-to-end or lengthened position in a horizontal or simple interrupted technique. The medial and lateral collateral ligaments are then reapproximated in a simple interrupted fashion. This repair of the collateral ligaments maintains stability to the region especially when an arthroplasty technique was performed. Wound closure continues with the identification of the subcutaneous tissues and reapproximation with an absorbable suture in a simple or continuous running fashion. The skin is repaired with an absorbable suture using a simple or continuous intradermal technique (Figure 9).

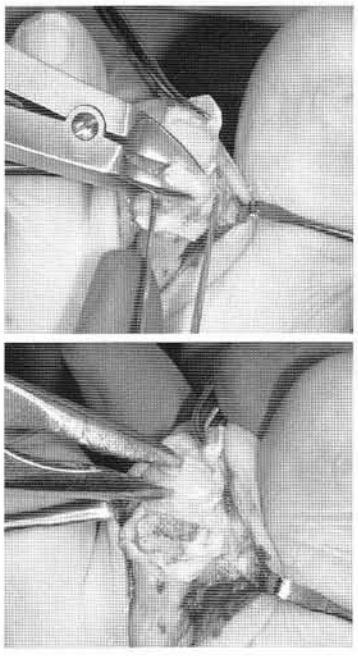

Figure 6. Head of the phalanx and base of the middle phalanx are resected.

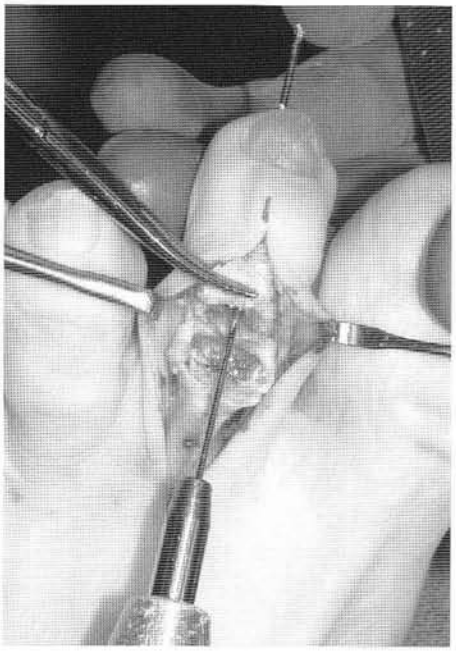

Figure 7. K-wire is directed distally into the base of the middle phalanx.

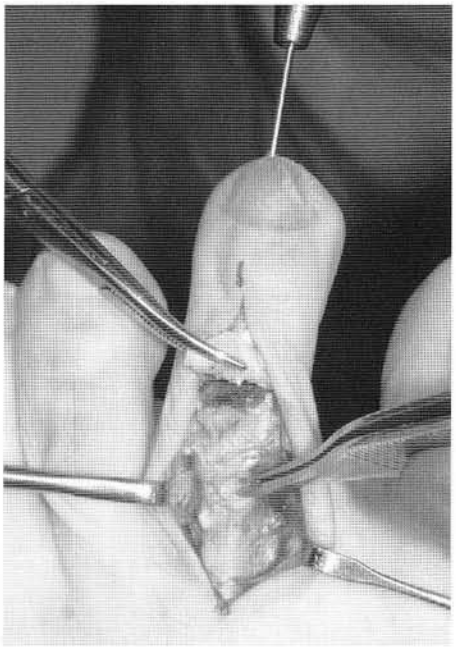

Figure 8. K-wire is retrograded back into the proximal phalanx.

CONCLUSION

The hammer toe deformity and its operative treatment is one of the most frequently performed forefoot surgical procedures.[4] The advantages of the anatomic dissection process are to provide protection to the critical neurovascular structures, establishing hemostasis, and the viability of tissues. It allows access to the surgical area for full visualization of appropriate anatomy. There are many variations in hammer toe correction to include incision placement, joint resection, fixation, and closure technique. The application of these principles and understanding of the deformity should allow the podiatric physician consistent results in hammer toe correction.

Figure 9. Skin is repaired.

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