CHAPTER 19

Anatomic Dissection For The Austin: Preservation And Recovery Of Range Of Motion

John A. Ruch, D.P.M.

No discussion of hallux valgus surgery would be complete without an overview of the principles and integral components of anatomic dissection of the first metatarsophalangeal joint. This paper will review the stepwise approach to hallux valgus surgery and pay particular attention to the techniques of arthrotomy of the first metatarsophalangeal joint, where significant modifications are extremely important in preservation of motion of the first metatarsophalangeal joint.

The specific components of hallux valgus surgery include:

1. Anatomic (tissue plane) Dissection
2. Plantar Lateral Release (1st MPJ)
3. Arthrotomy/Capsular and Periosteal Reflection (1st MPJ)
4. Exostectomy (bunionectomy)
5. Muscle-Tendon balance (adductor tendon transfer)
6. Postoperative Rehabilitation (range of motion/Dyna Splint).

ANATOMIC (TISSUE PLANE) DISSECTION

The fundamental principle of anatomic dissection focuses on separation of the superficial fascia from the deep fascia in the area of surgical execution (Fig.1). This basic surgical concept is the key to preservation of vital structures and creation of hemostasis throughout the surgical technique.

Incision placement is critical in all areas of surgery. The universal dorsal-medial incision has been routine, and is used for direct access to the medial and lateral aspects of the first metatarsophalangeal joint. The incision is placed just medial to the extensor hallucis tendon and avoids direct violation of the dorsal-medial neurovascular structures.

Dissection is carried through the incision to the level of the deep fascia where undermining is performed. Any superficial veins which cross the incision are dealt with appropriately. Standard techniques of dissection are then used to undermine or separate the superficial fascia from the deep fascia, over the medial aspect of the first metatarsophalangeal joint, and down into the interspace along the lateral capsular margins. This dissection technique elevates the primary neural and vascular structures within the superficial fascia, and protects them from direct surgical violation. It is this technique which creates hemostasis by protecting the specific arteries and veins. This specific surgical manipulation obviates the need for tourniquet hemostasis in most hallux valgus and other forefoot surgeries.

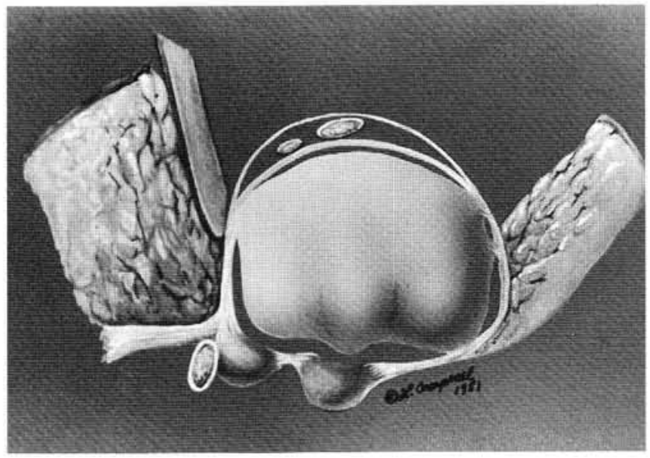


Figure 1. Fundamental illustration depicting separation of the superficial fascia or subcutaneous layer from the deep fascia which encircles the first metatarsophalangeal joint. This basic dissection principle preserves primary blood supply and nerve structures which lie within the subcutaneous layer. Surgical techniques performed within the collar of the deep fascia can then be performed with no violation of the critical neurovascular structures.

While epinephrine is used routinely in forefoot surgery, its primary purpose of controlling capillary bleeding is relatively short-lived. Green et al. have described the effects of epinephrine as lasting only 45-60 minutes during the surgical procedure. It is the primary surgical technique of tissue plane dissection and the body's own hemostatic capabilities which produce a relatively dry surgical field. The caution for the use of epinephrine includes avoidance in patients with known vascular compromise, vasospasticity, or other vascular disorders.

PLANTAR LATERAL RELEASE

Dissection of the first intermetatarsal space has been described in detail by members of the Podiatry Institute. The primary objective of this dissection is the release of contracture of specific soft tissue components which produce valgus deviation of the great toe. This altered motion of the hallux has previously been attributed to lateral deviation of the articular surface of the metatarsal head or PASA (Proximal Articular Set Angle). In the majority of cases, however, this altered motion is actually due to the position and function of the fibular sesamoid. Contracture of the plantar-lateral soft tissue structures of the first intermetatarsal space occurs insidiously and progressively as the deformity of hallux abducto valgus matures. This progressive contracture of soft tissue components and altered dynamic function of the fibular sesamoid is responsible for the previously described "track bound" motion of the first metatarsophalangeal joint.

Almost all of the critical soft tissue structures include direct attachment to the fibular sesamoid. The fibular sesamoid has been historically associated with the pathomechanics of the hallux valgus deformity, and it is through these specific soft tissue structures that abnormal position and function of the sesamoid influence the range of motion of the first metatarsophalangeal joint.

A systematic release of these plantar-lateral structures can significantly decrease the abnormal influence of the fibular sesamoid and restore a normal sagittal plane motion of the hallux at the metatarsophalangeal joint. Caution must be exercised to avoid excessive release of the plantar-lateral structures of the interspace, so that surgically-induced lateral weakness will not lead to hallux varus deformity.

The sequential plantar-lateral release includes the following structures:

1. The conjoined adductor tendon
2. Fibular sesamoidal ligament
3. Tendon of the lateral head of the flexor hallucis brevis
4. Fibular sesamoid
5. Lateral collateral ligament of the metatarsophalangeal joint
6. Other fascial and septal attachments

The conjoined head of the adductor tendon is released from its primary insertion into the proximal phalanx (Fig. 2). The tendon is then freed proximally into the interspace along with its secondary attachments to the lateral surface of the fibular sesamoid. The tendon is fully released back to its proximal muscle body without transection of the muscle tendon component. Usually, in this dissection, the transverse head of the adductor is released. This mobile muscle tendon unit is then preserved for later transfer at the conclusion of the surgical procedure, for muscle tendon balance of the metatarsophalangeal joint.

The next maneuver in sequence includes transection of the fibular sesamoidal ligament and a longitudinal plantar capsulotomy. This incision at

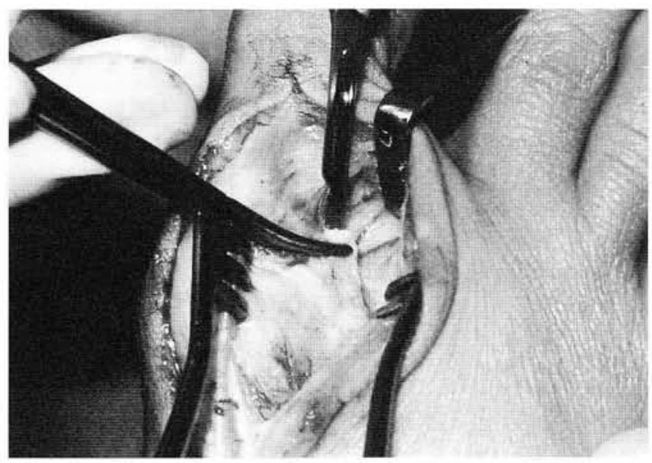


Figure 2. Detachment of the adductor tendon from its primary insertion into the base of the proximal phalanx.

the superior edge of the fibular sesamoid is carried from behind the metatarsal condyle, distally to the base of the proximal phalanx. Capsulotomy and release of the fibular sesamoidal ligament will allow medial transposition of the sesamoid apparatus, with the realignment of periarticular structures around the metatarsophalangeal joint (Figs.3A, 3B).

At this point in the surgical dissection, specific evaluation of motion of the metatarsophalangeal joint is performed before continuing any further release of structures at the plantar-lateral aspect of the joint. The hallux is held in a rectus alignment while the intermetatarsal angle is artificially reduced and loaded. If the hallux moves freely in

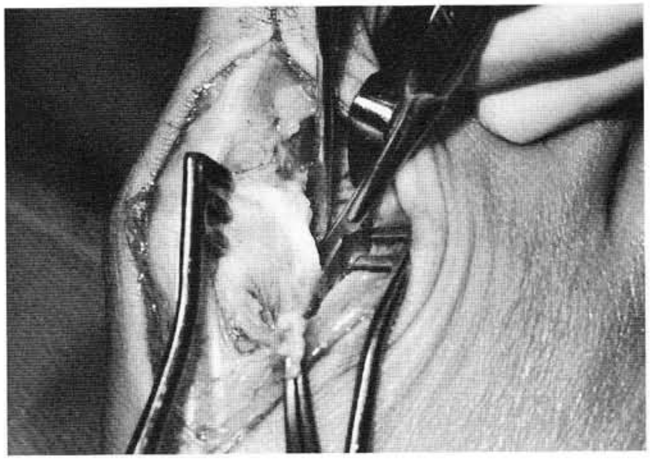


Figure 3A. Incision of the lateral joint capsule including the fibular sesamoidal ligament.

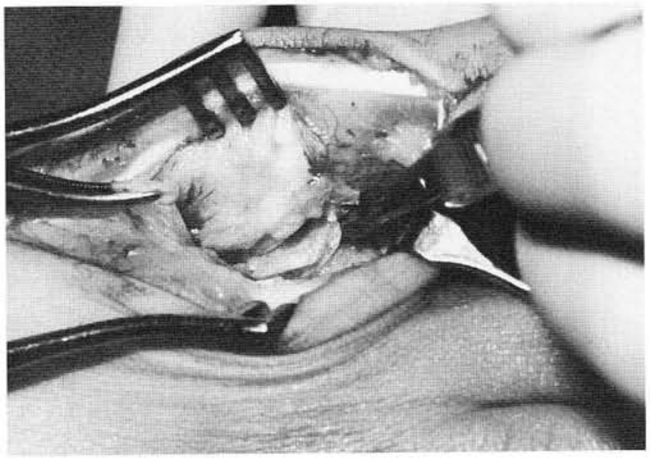


Figure 4. Transection of the ligament between the anterior edge of the fibular sesamoid and its attachment into the base of the proximal phalanx, effectively performing a tenotomy of the lateral head of the flexor hallucis brevis.

the sagittal plane, no further release of plantar lateral structures is performed. If there is significant lateral deviation of the hallux with dorsiflexion, then plantar lateral release is continued.

The next structure to be sequentially released is the ligament which runs from the anterior aspect of the fibular sesamoid to its insertion in the base of the proximal phalanx. This effects a tenotomy of the lateral head of the flexor hallucis brevis. This tenotomy may be partial or complete, depending on the degree of contracture (Fig. 4). Caution must be taken in execution of this technique to avoid severing the flexor hallucis longus tendon, which courses between the fibular and the tibial sesamoids.

The next structure to be sequentially addressed, if contracture remained, would be the fibular sesamoid itself. The sesamoid is removed if

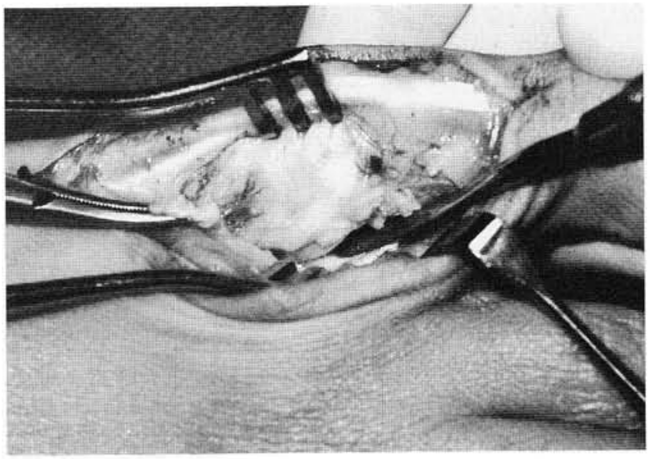


Figure 3B. Reflection of the fibular sesamoidal ligament to expose the plantar lateral condyle of the metatarsal head.

it can not function effectively beneath the metatarsal head. This is usually quite rare, however, it can occur in cases where significant adaptation of articular surfaces has occurred with loss of the lateral condyle and/or crista. Hypertrophy of the sesamoid from arthritic adaptation is also a primary reason for removal of the fibular sesamoid, and elimination of its abnormal influence on metatarsophalangeal joint motion.

With removal of the fibular sesamoid, caution must be exercised in the subsequent realignment of structures around the metatarsophalangeal joint. Removal of the fibular sesamoid creates significant lateral weakness, and predisposes the joint to hallux varus if excessive medial tension is created with closure.

A complete lateral release of the metatarsophalangeal joint has historically been performed by simple medial dislocation of the hallux and rupture of the lateral collateral ligament. In many instances, this was a routine manipulation, however, in today's surgical realignment of the metatarsophalangeal joint, this manipulation has been all but eliminated. Preservation of the lateral collateral ligament and lateral joint tissues is recommended in all but the most severe contractures of hallux valgus.

In an extremely severe deformity, there may be other soft tissues in the interspace which will influence position and motion of the hallux. There can be specific intermetatarsal or interphalangeal fibers (which have attachment to the plantar fascia and other interspace tissue planes) that can attach into the proximal phalanx and influence its range of motion. In a severe deformity where continued impendance of motion of the great toe is identified, meticulous dissection and identification of these fibers may improve the end range of motion of the metatarsophalangeal joint.

ARTHROTOMY

Arthrotomy of the first metatarsophalangeal joint to expose the head of the metatarsal in hallux valgus surgery has historically been an indication of a surgeon's speed, efficiency, and artistic capabilities. From a more practical point of view, the technique for exposure of the metatarsal head, however, can have a direct influence on the end range of motion of the first metatarsophalangeal joint following hallux valgus surgery.

With the advent of the metaphyseal osteotomy, preservation of blood supply to the metatarsal head has been of increasing importance, as the incidence of osteonecrosis or aseptic necrosis of the metatarsal head has been identified. Most surgeons advocate minimal reflection of capsular tissues for preservation of periosteal blood supply to the metatarsal head when employing metaphyseal osteotomies such as the Austin or Chevron technique.

The initial capsular incision is longitudinal and placed just medial to the extensor hallucis longus tendon (Fig. 5). At the joint line, the incision must penetrate through three tissue layers. These layers include the deep fascia, joint capsule, and synovium. At the metaphyseal level or neck of the metatarsal the three tissue layers include the deep

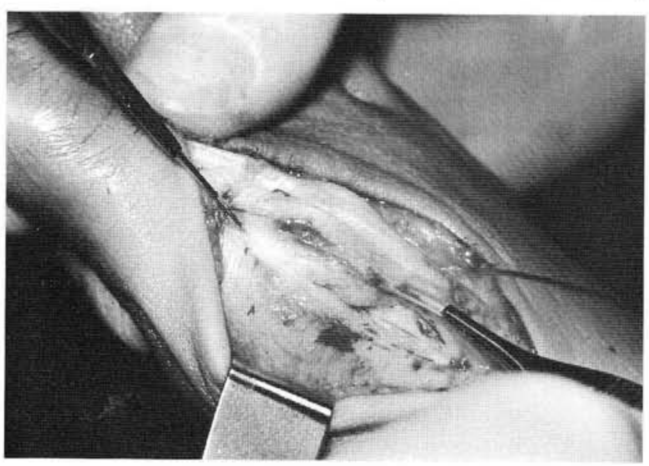
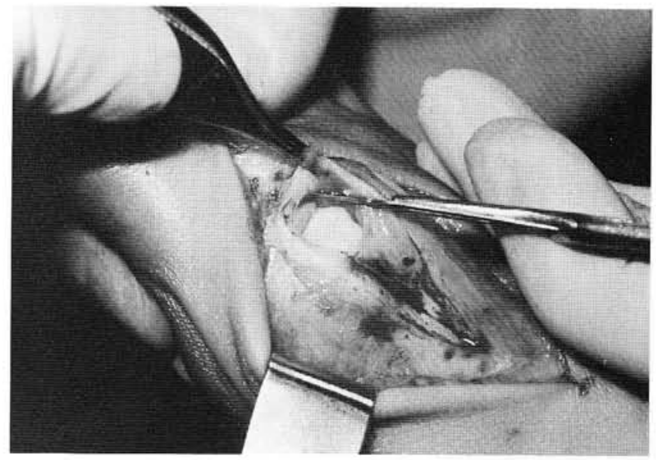


Figure 5. Initial longitudinal capsulotomy demonstrating three tissue layers at two different levels. At the joint line, the three tissue layers include deep fascia, capsule, and synovium. At the neck of the metatarsal, the tissue layers include deep fascia, capsule, and periosteum.

fascia, joint capsule, and periosteum over the shaft of the metatarsal.

Increased visualization of the metatarsophalangeal joint, including the contour of the metatarsal head and the base of the proximal phalanx, can be accomplished by extending the longitudinal capsular incision cleanly out to the attachments over the base of the proximal phalanx (Figs.6A, 6B). Elevation of the dorsal capsular layer, including the synovium, will then give direct visualization of the dorsal contour of the metatarsophalangeal joint. In effect, no soft tissue reflection is necessary for this maneuver.



Figures 6A & B. Elevation of the dorsal capsular pouch revealing contours of the metatarsal head and base of the proximal phalanx.

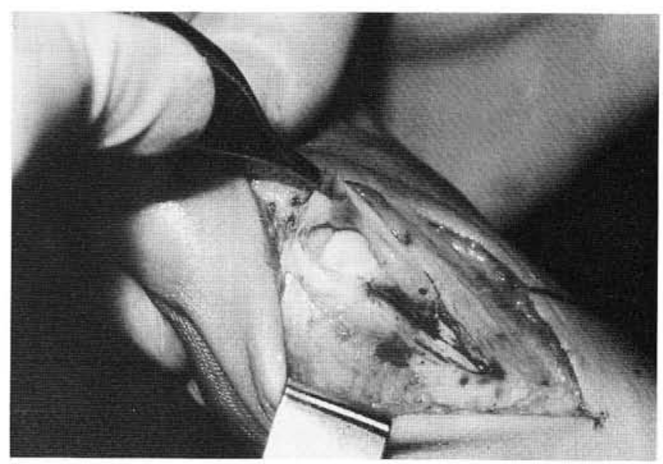


Figure 6B.

Minimal capsular and periosteal tissue is dissected from the dorsal-medial surface of the epicondyle of the metatarsal head (Fig. 7). This tissue is reflected for visualization and exostectomy of the dorsal-medial corner of the metatarsal head. At this point, it is not necessary to reflect the entire

Figure 7. Minimal reflection of attachments over the dorsal medial aspect of the metatarsal head or dorsal surface of the epicondyle.

soft tissue layer from the dorsal aspect of the metatarsal head and neck.

With the use of the Chevron osteotomy technique, soft tissue is reflected from the dorsal surface of the metatarsal neck by a subperiosteal dissection technique, just proximal to the capsular attachments over the metatarsal head. This technique is performed with a Freer elevator and is executed approximately 2 cm proximal to the joint line. The elevator delicately separates periosteum from the shaft of the metatarsal and leaves the primary dorsal capsular and periosteal tissues attached to the head of the metatarsal.

Examination of the dorsal soft tissue reflection then identifies two distinct pockets or areas of reflection (Fig. 8). The first region is the intact dorsal capsular fold over the head of the metatarsal and base of the proximal phalanx. The synovial

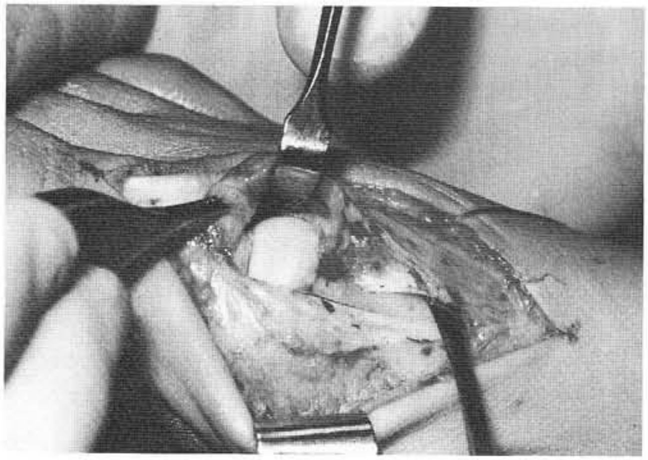


Figure 8. Dorsal subperiosteal dissection across the neck of metatarsal to provide an exit for the dorsal arm of the Chevron osteotomy, and preserve periosteal attachments to the head of the metatarsal.

and capsular tissues remain intact and preserve their blood supply to the capital fragment. Minimal disruption of the dorsal synovial pouch also minimizes intra-articular adhesion and loss of motion after surgery.

The second area of soft tissue reflection is over the neck of the metatarsal, and provides an exit for the dorsal arm of the Chevron osteotomy while preserving soft tissue attachments over the dorsal surface of the head of the metatarsal.

The next region of reflection includes capsule and soft tissue from the medial aspect of the metatarsal head. This technique is traditionally initiated by a vertical incision through the joint capsule at the joint line. This incision will transect the medial capsule and medial collateral ligament of the metatarsophalangeal joint. The proximal medial capsular flap is routinely reflected from the medial aspect of the metatarsal head, and proximally onto the shaft. This technique can be facilitated by using a Freer periosteal elevator (Fig. 9) to reflect the periosteum and superficial capsular tissues at the level of the metatarsal neck, prior to reflection of the medial capsular flap from the head of the metatarsal. This sub-periosteal technique is performed at the metatarsal neck, in the same region as the dorsal sub-periosteal technique used to reflect the soft tissue for the dorsal

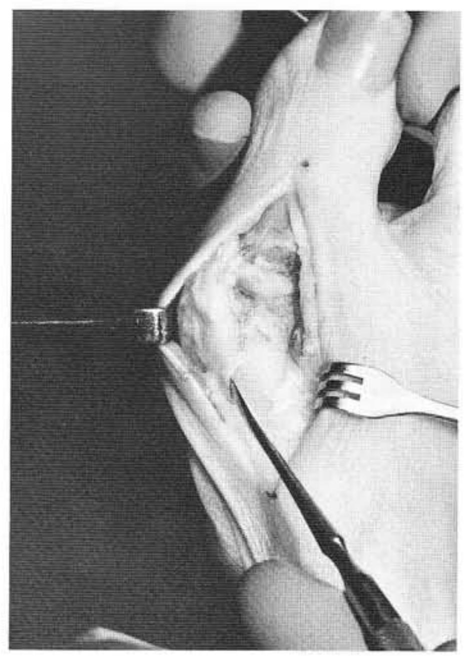


Figure 9. Medial subperiosteal reflection identifying continuity of the medial capsular flap with proximal periosteum.

arm of the Chevron cut. This simple modification in technique will clearly identify the continuity of the medial capsular tissues, and minimize shredding of the medial capsular tissues or "button-holing" of the medial capsule. The medial capsular flap is then reflected meticulously from the medial surface of the metatarsal head and its primary attachments into the epicondular region of the metatarsal head. Reflection of the medial capsular flap is followed proximally onto the shaft of the metatarsal.

The next capsular manipulation is a third area of sub-periosteal dissection, across the plantar or inferior surface of the neck of the metatarsal (Fig. 10). This sub-periosteal dissection preserves the plantar attachments of capsule and soft tissue in the region just behind the plantar condyle of the metatarsal head. This plantar pocket also creates an exit for the inferior arm of the Chevron osteotomy. Preservation of the capsular attachments on the plantar surface of the metatarsal head preserves the intimacy of the sesamoid articulation and blood supply (via plantar attachments of soft tissue) to the metatarsal head.

At this point, a final sub-periosteal reflection is performed along the lateral surface of the neck of the metatarsal. This in effect creates an entire sub-periosteal reflection of soft tissue from the surgical neck of the metatarsal. Soft tissue attachments remain intact to the dorsal, lateral, and inferior aspects of the metatarsal head. This soft tissue technique preserves optimal blood supply to the head of the metatarsal while providing adequate exposure for the metaphyseal osteotomy.

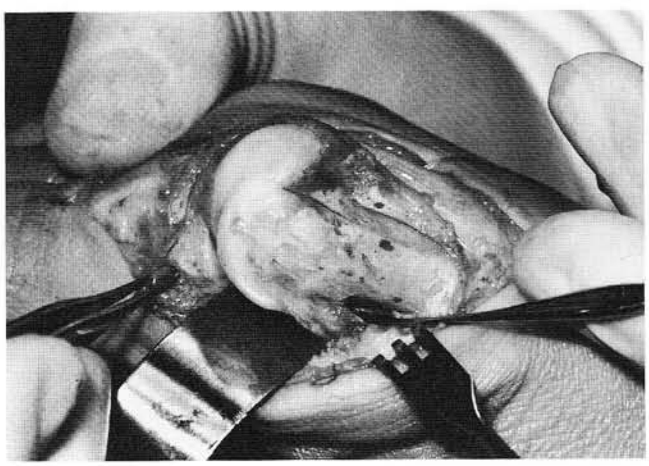


Figure 10. Plantar subperiosteal dissection across the inferior aspect of the neck of the metatarsal, providing a plantar exit for the Chevron osteotomy, and preservation of the plantar capsular attachments.

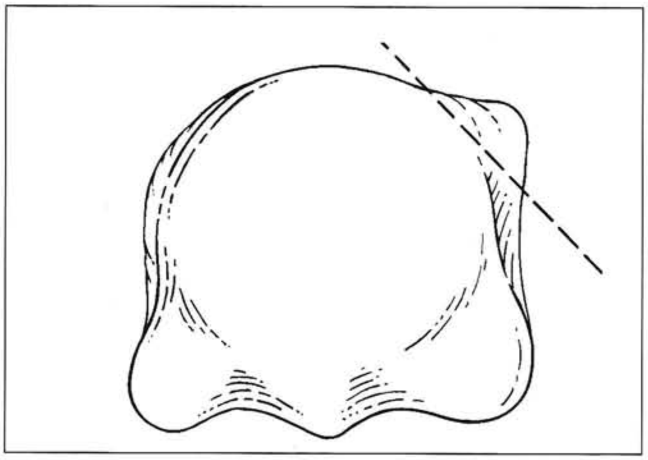
Preservation of soft tissue attachments accomplishes two significant goals. The first goal is preservation of blood supply to the capital fragment, and the second goal is preservation of delicate periarticular attachments and tissues to the margins of the metatarsophalangeal joint. Preservation of these tissues will minimize postoperative adhesions and fibrosis and have a direct influence on rapid recovery of metatarsophalangeal joint motion.

EXOSTECTOMY (BUNIONECTOMY)

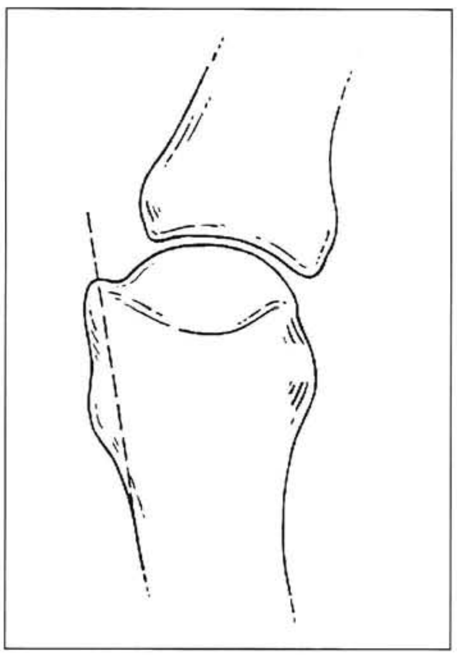
Removal of prominent bone from the dorsal medial aspect of the first metatarsal head has historically been described as the bunionectomy. Modern techniques caution against excessive removal of bone from the metatarsal head to avoid staking of the metatarsal head, or destruction of normal anatomic contours which would facilitate medial luxation of the tibial sesamoid and other periarticular structures, and lead to the deformity of hallux varus.

The key relationships which must be kept in mind while performing resection of bone from the metatarsal head include the articulation of the medial rim of the proximal phalanx in the sagittal groove of the metatarsal head, and the articulation of the tibial sesamoid in the plantar sesamoidal groove. A dorsal-medial ostectomy is recommended to preserve the primary contours of the sagittal groove, as well as the medial condyle and sesamoidal groove in their entirety (Figs. 11A, 11B). A second landmark for resection of bone from the medial aspect of the metatarsal head includes a line which converges on the medial shaft of the metatarsal (Figs. 12A, 12B). Extension of this line will preserve the sagittal groove of the metatarsal head, as long as the resection is performed at the dorsal medial corner of the metatarsal head.

The primary goal for resection of bone from the metatarsal head includes adequate removal of bone, preservation of the normal anatomic contours, and a stable seat of the metatarsophalangeal joint. When the joint is aligned congruously in its most stable position, the medial rim of the proximal phalanx seats in the sagittal grove of the metatarsal head (Figs. 13A, 13B). At this point, if an adequate plantar lateral release has been performed, the hallux will move freely in the sagittal plane on the metatarsal head.



Figures 11A & B. Dorsal medial orientation of the primary exostectomy of the metatarsal head, to preserve the sagittal groove and plantar medial condyle of the metatarsal head.



Figures 12A & B. Longitudinal orientation of the primary ostectomy for preservation of the sagittal groove.

It is at this point in the surgical procedure that a proper evaluation of PASA and other structural variations can be adequately performed. In many instances, deviations within the proximal phalanx (DASA) may actually be the cause of residual hallux abductus. Evaluation of first metatarsal deviation will also be addressed by a variety of metatarsal osteotomy techniques.

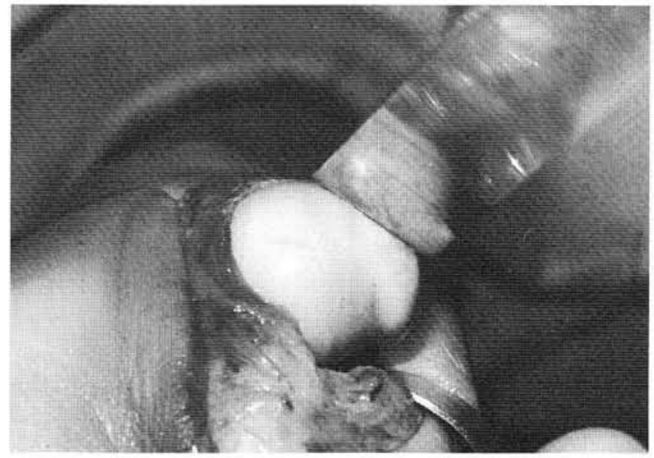


Figure 11B.

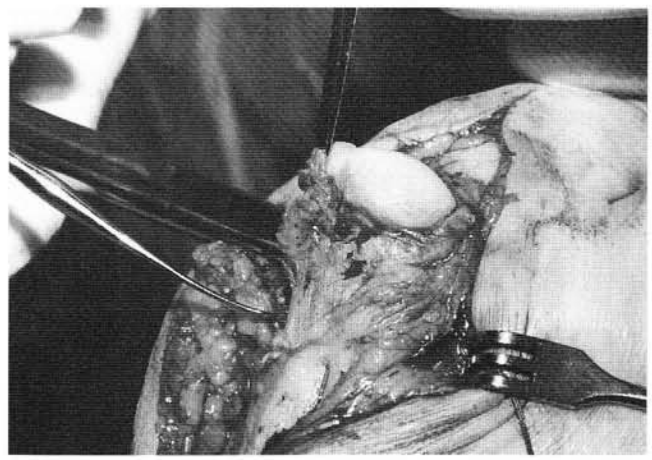
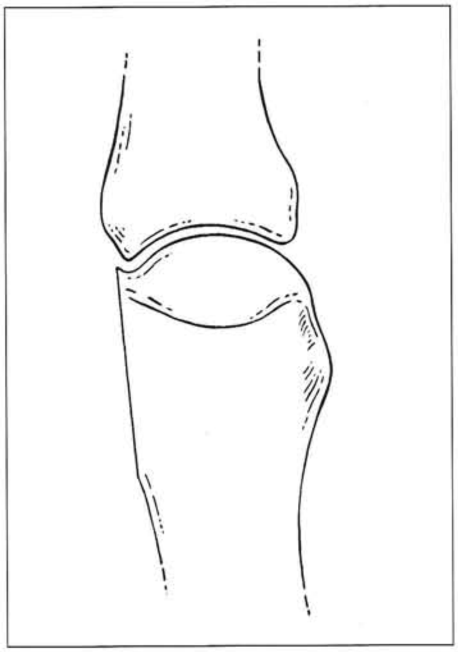


Figure 12B.

MUSCLE TENDON BALANCE (ADDUCTOR TENDON TRANSFER)

With the execution of an appropriate metatarsal osteotomy or other manipulations around the metatarsophalangeal joint, the procedure is completed by closure of capsular and other soft tissues. Meticulous detail must be observed when closing the periarticular structures to create a normal balance of the medial and lateral stabilizing structures of the metatarsophalangeal joint.

The adductor tendon transfer has been promoted as a primary technique for muscle-tendon balance. Release of the adductor tendon removes a deforming force on the metatarsophalangeal joint. The isolated adductor tendon can then be transferred dorsally across the neck of the metatarsal, and used as an anchor to help derotate the capsular tissues and draw the sesamoid apparatus into a more normal position or alignment. The adductor transfer also serves to help derotate the hallux and reduce the intermetatarsal angle. Care must be



Figures 13A & B. Ultimate congruous articulation of the base of the proximal phalanx with the head of the metatarsal, identifying the medial rim of the proximal phalanx articulating within the sagittal grove of the metatarsal head.

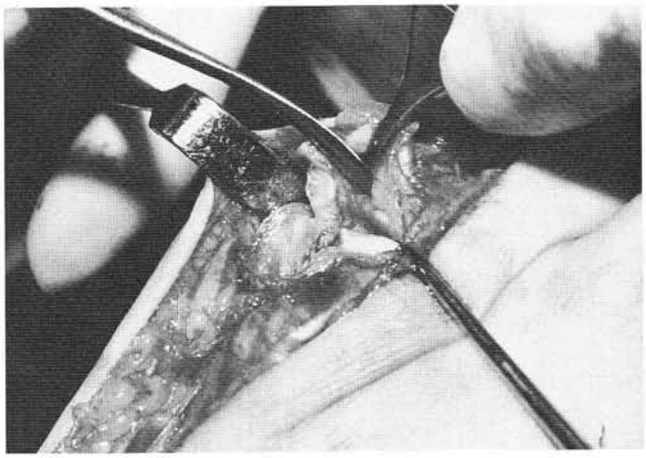


Figure 13B.

taken not to over-tighten this transfer and produce medial luxation of the tibial sesamoid, with the resultant deformity of hallux varus.

CONCLUSION

The overall scheme for surgical dissection of the first metatarsophalangeal joint, when performing an Austin bunionectomy, is focused around minimal trauma and preservation of vital periarticular structures. A subperiosteal dissection collar is created around the neck of the metatarsal, and provides exit for the Chevron osteotomy, as well as preservation of the periarticular capsular attachments to the dorsal lateral and plantar aspects of the metatarsal head. Preservation of the intimate articular synovial and capsular attachments will minimize intra-articular fibrosis and adhesion, and preserve periosteal blood supply to the capital fragment of the metatarsal head.

Ultimate recovery of motion of the first metatarsophalangeal joint is dependent upon stretching and reorganization of the capsular tissues. While normal patient activity and various modalities of physical therapy have been used in the past, restriction of motion following an Austin bunionectomy is common.

A relatively new approach to postoperative joint rehabilitation is the Constant Passive Motion (CPM), which creates continuous movement of an operative joint. This postoperative splint applies a constant pressure of dorsiflexion to the metatarsophalangeal joint. The splint is initially applied as the patient retires for the evening, and the patient will wear it as long as possible. Early findings indicates that patient can tolerate the device for a few hours during the first few days before they have to remove it, but as the joint begins to stretch and loosen, patients are able to wear the device all night. As the patient becomes more tolerant to the device, the range of dorsiflexion is gradually increased.

Early results with experimental models have indicated rapid recovery of dorsiflexion from 40-50 degrees, to the normal 80-90 degrees of dorsiflexion seen at the first metatarsophalangeal joint. These results have been obtained in patients who are from six months to one year postoperative, and have been used to recover range of motion at the metatarsophalangeal joint.