HALLUX VARUS

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INTRODUCTION

Hallux varus is a deformity of the first metatarsophalangeal joint which can be acquired or of congenital origin. Classically, the deformity consists of a deviated or luxated 1st MPJ where the hallux is adducted, and can include a varus rotation and extensus component. Severity of the triplane components may vary, with a pure adduction deformity occasionally occurring. (Fig. 1) Etiological factors and approach to treatment are similar for all variations of the deformity, therefore both triplane and uniplane deformities will be referred to as hallux varus throughout this paper.

Congenital hallux varus is rare and is usually associated with other anomalies such as supernumary digits.[1] Thomson describes congenital hallux varus as primary or secondary.[2] Primary congenital hallux varus is present as an isolated finding. There is generally progression of the deformity with age and according to Joseph[3] it is more common with unshod populations such as in rural India. Secondary congenital hallux varus is found in combination with medial deviation of the metatarsal as seen with metatarsus adductus and talipes equinovarus.

Acquired hallux varus is the more common, but still relatively rare presentation of the deformity. Acquired hallux varus is frequently iatrogenic in nature secondary to hallux abducto valgus surgery. With over-correction, a structural and/or soft tissue imbalance can be created around the 1st MPJ resulting in hallux varus. Acquired hallux varus may also be a result of trauma or chronic arthritis.[3]

The primary focus of this paper will address iatrogenic hallux varus. The authors will examine etiological factors associated with its development and present a systematic approach for its treatment. Knowledge of the material presented can then be applied to all types of hallux varus.

Fig. 1A. Classic hallux varus with triplane components.

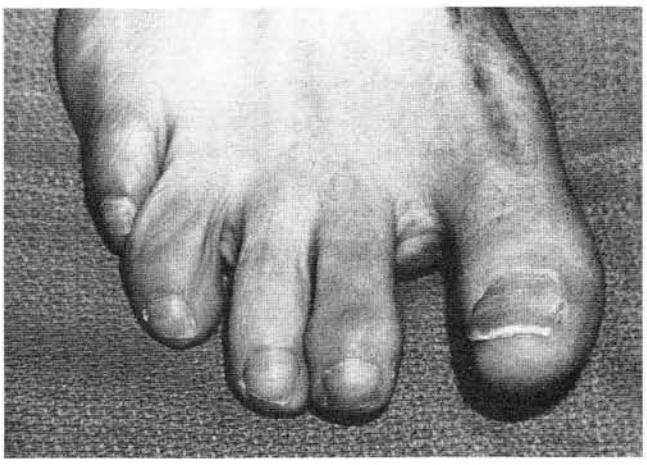

Fig. 1B. Hallux varus with primarily adductus component (hallux adductus).

ETIOLOGY

The natural anatomical relationship of soft tissue structures around the 1st MPJ create a balanced dynamic force in the normal foot. (Fig. 2) If this balance of forces is disturbed, major deformities may develop. In a well-aligned foot there is a functional balance of forces between the medial and lateral heads of the flexor hallucis brevis. The extensor and flexor muscles create dorsiflexion and plantarflexion of the 1st MPJ. The abductor hallucis and adductor hallucis muscles act as stabilizing forces medial and lateral respectively. Deviation of this natural balance will create deforming forces and subsequent deformity of the joint.

Hawkins classified hallux varus deformities into static and dynamic types.[4] The static deformity follows over-correction of hallux valgus deformity with either joint destructive procedures or metatarsal shaft osteotomies without disruption of the muscle-tendon balance around the joint. Hawkins feels that gradual re-alignment may be anticipated as long as no muscle-tendon balancing procedure was performed.

The dynamic acquired hallux varus deformity occurs because of muscle imbalance about the joint. A number of hallux abducto valgus procedures are designed to weaken the lateral structures (adductor hallucis and lateral head of flexor hallucis brevis muscles.) This approach can precipitate overpowering or imbalance of the medial head of FHB and of abductor hallucis muscles. An imbalance of the flexors and extensors may also play a role in the development of hallux varus. With an excised fibular sesamoid and a medially deviated tibial sesamoid, the entire flexor hallucis brevis force is weakened. The EHL can now overpower the short flexor and create a malleus component in the classic hallux varus. If the fibular sesamoid and lateral head of FHB remain intact, partial plantarflexory strength of FHB will be present. Less imbalance will be created in the sagittal plane and a more transverse hallux varus may occur. The dynamic hallux varus will progress with time.

Excision of the fibular sesamoid and adductor tendon transfer in the McBride type bunionectomy has frequently been implicated for the development of hallux varus.[5] However, Banks et al.,[6] noted that several factors are usually necessary for development of an aberrant position of the 1st MPJ. To prevent iatrogenic hallux varus and to be able to plan an appropriate surgical approach to hallux varus correction, the surgeon must have a thorough understanding of each of the possible contributing factors. (Table 1)

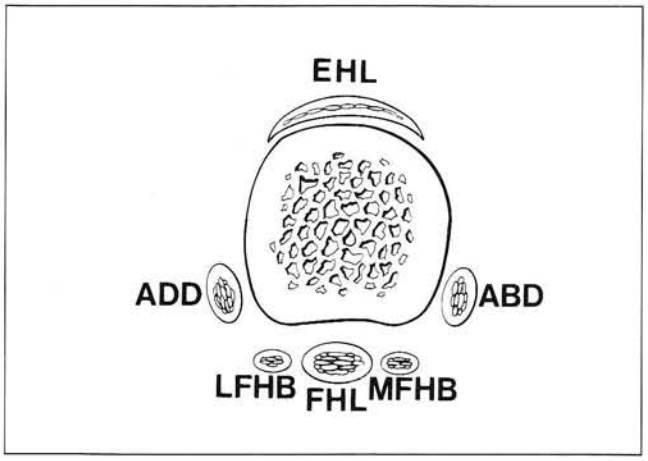

Fig. 2. Cross section of 1st metatarsal head showing normal muscular relationship creating dynamic balance around the 1st MPJ. EHL - extensor hallucis longus, ABD - abductor hallucis, MFHB - medial head of flexor hallucis brevis, FHL - flexor hallucis longus, LFHB - lateral head of flexor hallucis brevis, ADD - adductor hallucis

Plantar Lateral Release

An integral part of restoration of joint balance in hallux abducto valgus surgery is the sequential release of lateral joint contractures. This release is performed systematically, beginning with the adductor tendon and continuing in a step-wise approach with transection of the fibular sesamoidal ligament, transection of the lateral head of the flexor hallucis brevis, fibular sesamoidectomy and lateral capsulotomy. With each step, an opposing force to the medial structure is lost which enhances a medial muscular imbalance. An overly aggressive lateral release in combination with additional osseous or soft tissue procedures may progress to hallux varus. According to Hawkins,[4] release of both the adductor hallucis tendon and of the lateral head of flexor hallucis brevis is the critical factor in developing a medially imbalanced 1st MPJ.

Medial Imbalance

Medial displacement of the tibial sesamoid will create a strong medial imbalance with great potential for hallux varus. As the sesamoid appa-

Table 1

CONTRIBUTING FACTORS OF HALLUX VARUS DEFORMITY

I. Excessive Plantar-lateral release
   A. Resection and/or repositioning of adductor tendon
   B. Resection of lateral head of FHB
   C. Excision of fibular sesamoid
   D. Lateral capsulotomy
II. Medial Imbalance
   A. Medially displaced tibial sesamoid/aggressive adductor tendon transfer
   B. Medial displaced EHL
   C. Excessive medial capsulorrhaphy
   D. Aggressive post-operative bandaging and splinting
III. Excessive Osseous correction
   A. Overzealous medial exostectomy
   B. Negative intermetatarsal angle
   C. Negative PASA

ratus is displaced medially, the vector of force from the medial head of flexor hallucis brevis is deviated from its normal position. Less plantarflexory force is present and a greater adductory force is created. Also, as medial deviation of the apparatus occurs, the medial deforming force of the abductor hallucis muscle is enhanced. The medial displacement of the tibial sesamoid can be the result of a combination of factors including excision of the fibular sesamoid and transfer of the adductor tendon.

In hallux valgus surgery, the laterally deviated sesamoid apparatus is repositioned by transferring the adductor tendon beneath the EHL and attaching it to the medial capsule. (Fig. 3) An overly aggressive transfer may create medial subluxation of the sesamoid apparatus and subsequent medial imbalance. Several technical components may contribute to an overzealous transfer. Due to pliability of the medial capsule, a transfer that is attached to the plantar medial portion can create greater force than the transfer attached to the dorsomedial edge. (Fig. 4) Also, if a short adductor tendon is transferred, excess tension may be applied to the medial capsule.

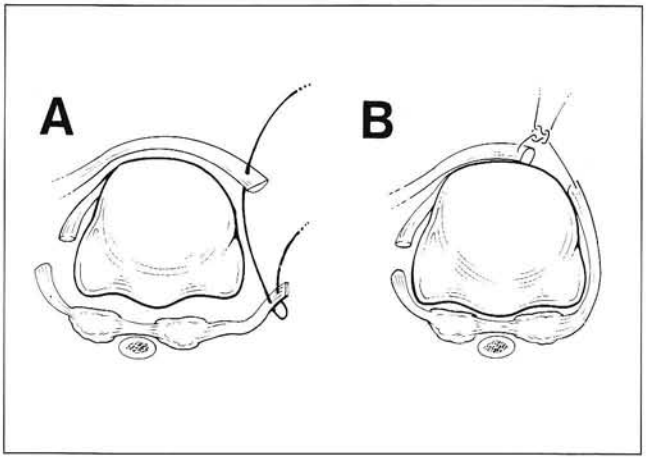

Fig. 3A. Laterally deviated sesamoids prior to tying adductor tendon transfer. Notice adductor tendon being sutured to dorsal medial edge of medial capsule. **B.** Re-positioned sesamoids after transfer with adequate tension.

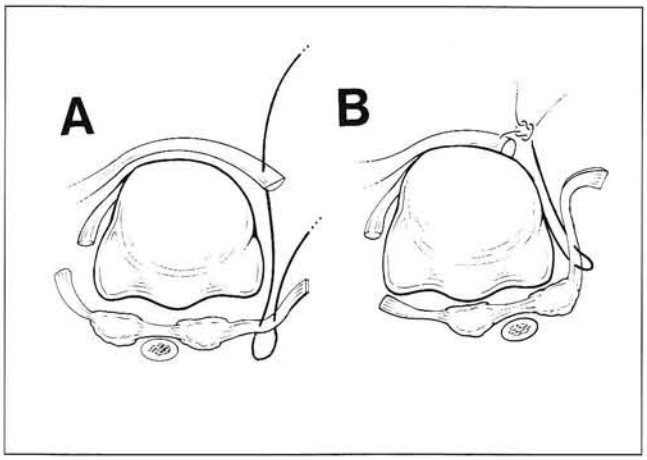

Fig. 4A. As adductor tendon is sutured further plantar medial, greater tension is created. With less capsular tissue between suture and sesamoid, there is less forgiveness of the capsule and tension will not be lost. **B.** Over-corrected position of sesamoid apparatus due to excessive tension from modified suture technique.

The vector of force for a normally positioned EHL tendon has both abductory and dorsiflexory components. (Fig. 5A) As the hallux displaces medially during early hallux varus development, the EHL tendon will bowstring medially. The normal EHL force is now directed medial to the 1st MPJ axis and the abductory component is converted to an adductory component.[7] This force contributes to further progression of the deformity. (Fig. 5B)

Joint balance may be altered with excessive tension of a medial capsulorrhaphy. Solely, this will not create a hallux varus, but in conjunction with other contributing factors it may initiate the medial displacement of the 1st MPJ.

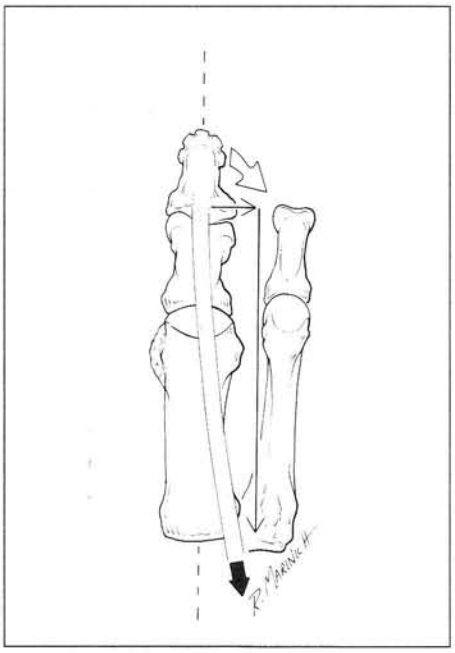

Fig. 5A. Line of pull of EHL with rectus hallux. Notice a slight lateral deviation of EHL with normal anatomy. This creates a small abductory component to its vector of force.

Fig. 5B. As the hallux subluxes medial, the direction of force from EHL moves medial to the 1st metatarsal axis and creates an additional adductory force to the toe. Also notice the retrograde abductory force created to 1st metatarsal head.

Fig. 6A. Preoperative radiograph of a patient with moderate hallux abducto valgus deformity.

Fig. 6B. Immediate post-op radiograph. Notice the medial incongruency of the 1st MPJ. An unrecognized hallux valgus interphalangeus can contribute to over-correction of the 1st MPJ (Reproduced with permission from DiNapoli DR, Jimenez AL: Hallux Varus. In McGlamry ED (ed):*Reconstructive Surgery of the Foot and Leg, Update '88*. Tucker GA, Podiatry Institute Publishing Co, 1988, pp 129-135).

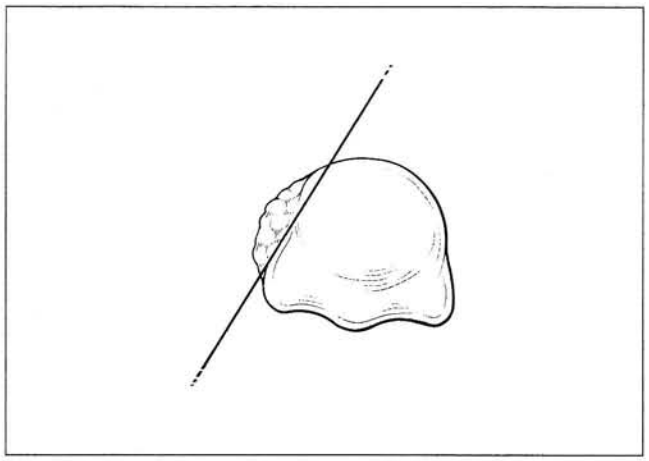

Fig. 7A. Frontal plane view of 1st metatarsal head demonstrating the appropriate orientation of the dorsomedial exostectomy.

Occasionally, excessive tightening of the capsule is performed as the surgeon attempts to create a rectus toe in a foot with an abductory deformity within the hallux. The joint may originally be congruous, but as the toe is adducted to a straight position the joint will deviate medially. (Fig. 6)

An aggressive postoperative dressing may also maintain the 1st MPJ in a medially deviated position. Fibrosis and adhesion in a medially deviated position may be an initial factor in the development of hallux varus.

Excessive Osseous Resection

Medial Exostectomy

Overzealous resection ("staking") of the first metatarsal head in bunion surgery may lead to hallux varus. The plantar medial condyle of the first metatarsal serves as a medial buttress for the tibial sesamoid, and the sagittal groove of the distal metatarsal head serves as a stable articulation for the base of the proximal phalanx. Excessive resection of bone from the medial aspect of the metatarsal head including the sagittal groove and the plantar condyle may result in medial displacement of the tibial sesamoid and base of the proximal phalanx. To help prevent medial muscular imbalance, appropriate resection of the hypertrophic eminence should be performed. An osteotome or power saw blade is angulated so as to remove the dorsomedial portion of the prominence and maintain the sagittal groove.[6] (Fig. 7)

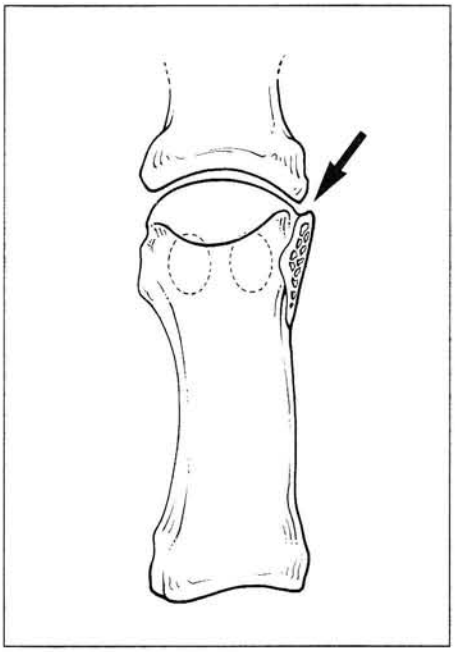

Fig. 7B. Dorsoplantar reconstruction of the 1st M demonstrating the sagittal groove (arrow) intact after resection. The groove continues to serve as a buttress for base of proximal phalanx.

Negative Intermetatarsal Angle

With the variety of first metatarsal osteotomies, overcorrection of the first intermetatarsal angle may be created. Without other contributing factors, a mild negative IM angle may not precipitate a hallux varus and may only create a structural (static) hallux varus. With increasingly negative IM angles and other contributing factors, a dynamic hallux varus will occur with medial muscular imbalance. High negative IM angles can increase the medial vector of force just as high positive IM angles increase the lateral vector of force in hallux abducto valgus deformity.

Negative PASA

An aggressive Reverdin osteotomy may produce a negative proximal articular set angle (PASA) of the 1st metatarsal head. In a predisposed foot this may contribute to hallux varus deformity by two methods. The resulting retrograde buckling effect can create a negative IM angle and development of hallux varus as described above. Secondly, with medial angulation of the articular surface, the hallux of the congruous joint is directed

medial which enhances the progression of medial muscle imbalance.

TREATMENT

As in many pathological deformities of the foot, there is no one specific method of treatment for hallux varus. Two general approaches may be taken: conservative and/or surgical. A number of factors are considered in each individual case to determine the most appropriate course of action. These factors include the severity of the deformity, the duration, the flexibility and the joint integrity.

Conservative Approach

The success of conservative care for hallux varus is dependent upon early recognition and initiation of treatment. As the duration of the deformity increases, soft tissue adaptation may progress to osseous adaptation and require a more aggressive approach.[7] Ideally, conservative treatment should begin immediately post-op.

Conservative treatment consists of maintaining the toe in an abducted and valgus position during healing of the capsular structures. This helps reestablish length of tight medial structures and allows lateral structures to fibrose in a contracted position. Maintaining the appropriate position may be accomplished with a variety of bandaging techniques. As the wound heals and the bandages are discontinued, splints, taping and/or shoe padding may be utilized to maintain the corrected position.

Without noted improvement, the conservative treatment of hallux varus is only indicated for a short period of time. Surgical action should be taken, as delaying correction will only allow for more degenerative changes to occur within the joint.

Surgical Technique

The literature is replete with a variety of isolated procedures for correction of hallux varus, but the authors feel that isolated procedures are usually inadequate for correction of the deformity. Generally, a combination of etiological factors create the deformity and subsequently a combination of procedures are necessary for its correction. With complete understanding of the pathophysiology of hallux varus, a logical surgical approach can be undertaken, with deforming forces released in a step-wise fashion.

The systematic approach described initially by Banks et al.[6] is commonly utilized at Northlake Regional Medical Center and will be reviewed. (Table 2)

By initially releasing soft tissue structures around the joint, accurate assessment and determination of necessary procedures can be performed. Due to the unique nature of each hallux varus presentation, assessment prior to release may be inaccurate resulting in the need for unanticipated surgical procedures.

Skin Incision

Prior to skin incision, one needs to determine whether the previous scar is contributing to the deformity. If contracture is present, a lengthening skin plasty is necessary. Also, if hypertrophic, the previous scar may require excision.

The deformity is entered through the line of the original incision. The incision may be extended slightly for additional exposure. The increased length gives better exposure and allows identification of normal tissue layers prior to entering the fibrotic tissue.

Table 2

STEP-WISE SURGICAL APPROACH

I. Soft Tissue Release
   - A. Skin incision
   - B. Medial capsulotomy
   - C. Lateral release/transection of intermetatarsal ligament
   - D. Total intracapsular release/deglove 1st metatarsal

II. Correction of Structural Deformity
   - A. Negative intermetatarsal angle
   - B. Negative proximal articular set angle

III. Tendon Release/Transfer
   - A. Adductor hallucis
   - B. Abductor hallucis
   - C. EHL

IV. Tibial sesamoidectomy

V. Joint destructive procedures
   - A. Implant Arthroplasty
   - B. Keller Arthroplasty
   - C. 1st MPJ Arthrodesis

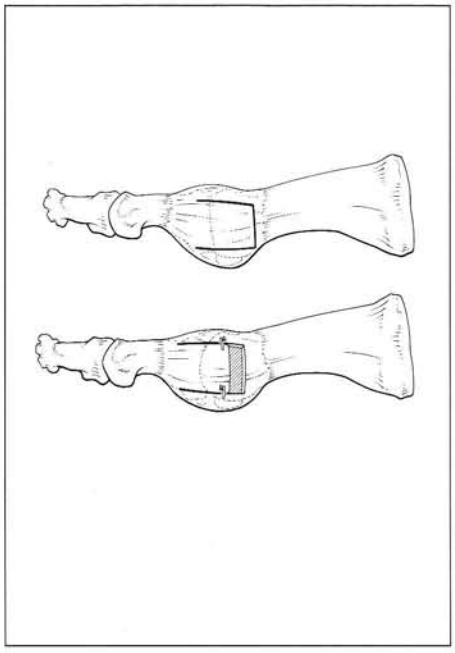

Fig. 8A. U shaped medial capsulotomy. Upon closure in a lengthened position the joint is covered.

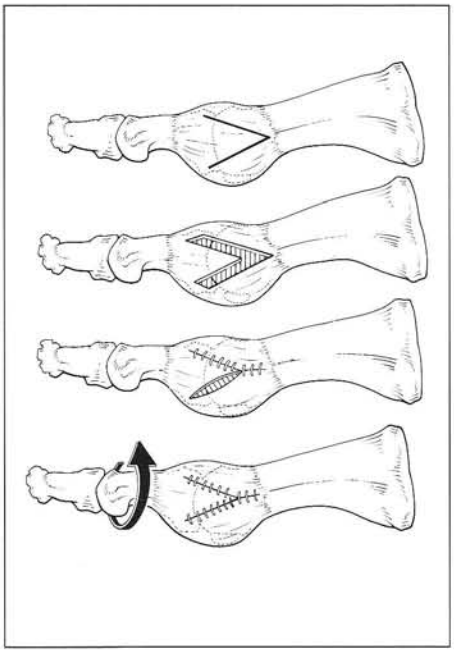

Fig. 8B. V-Y medial capsulotomy. After advancement, it is occasionally necessary to leave the plantar arm open as closure may create a varus deforming force and possible reoccurrence of the deformity...

Medial Capsulotomy

Upon releasing capsular tissue and exposing the joint, one must consider the lengthening of capsular tissues required with abduction of the hallux. Two common capsulotomies performed are the U shaped flap and V-Y flap. (Fig. 8) These flaps will allow additional length in the transverse plane, however, upon closing the plantar arm, a deforming rotational force may be created. To eliminate this deforming force the plantar arm is occasionally left open. The authors prefer the U shaped flap capsulotomy. (Fig. 9)

Lateral Release

Although a tight lateral capsule will help maintain correction of hallux varus, release of lateral scar and/or the deep transverse intermetatarsal ligament is required. An intact intermetatarsal ligament or its remnants will maintain a negative IM angle and subsequently inhibit determination of the deformity's flexibility.

Total Intracapsular Release

Severe adaptation of capsular tissues frequently occurs with hallux varus deformities. Mobility of the sesamoids and inferior capsule require a complete capsular release. Fibrotic capsular tissue may be released from the metatarsal head by degloving with a metatarsal elevator.(Fig. 10)

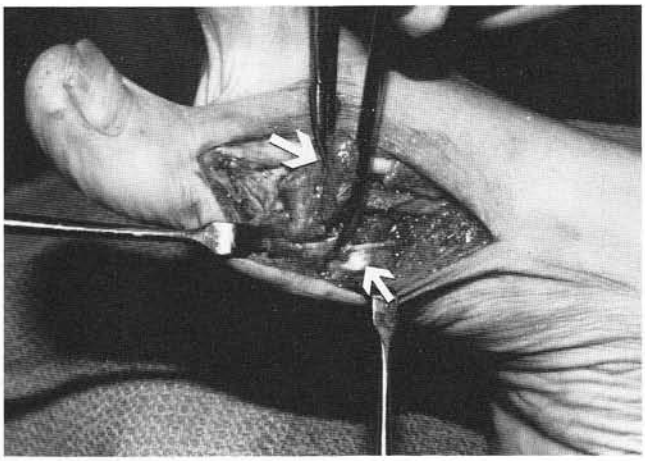

Fig. 9. Intra-operative demonstration of U shaped capsulotomy (Top arrow). Also notice the abductor hallucis tendon (Bottom arrow) which may be used for transfer.

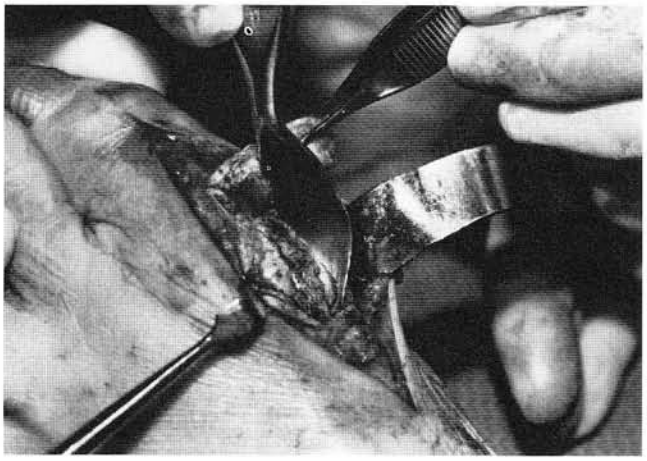

Fig. 10. Total joint release performed by degloving of 1st metatarsal head with metatarsal elevator.

Correction of Structural Deformity

True osseous deformities consist of a staked 1st metatarsal, structural negative IM angles and negative proximal articular set angles. A staked 1st metatarsal head often leads to a hallux varus deformity with significant loss of joint integrity. Staked 1st metatarsal heads create a challenge for reconstruction of the joint and often require joint destructive procedures for correction of the deformity. Negative IM angles and negative PASA's can be addressed directly.

Negative IM Angles

Minimal or no improvement of the negative IM angle with soft tissue release indicates a structural component of the negative angle. A negative IM angle or a minimally positive angle with a severely deviated sesamoid apparatus increases risk of reoccurrence of the deformity and should be addressed. Osseous correction may be achieved by an osteotomy (ie. reverse Austin, opening base wedge, etc.). Selection of the osteotomy depends on the severity, previous procedure and post-operative capabilities of the patient. (Fig. 11)

Negative PASA

If a negative proximal articular set angle is present upon surgical evaluation of the joint, correction should be performed. A negative PASA predisposes medial subluxation as described previously. Generally a negative PASA is corrected with a reverse Reverdin procedure.

Fig. 11A. 18 month post-operative radiograph of patient in figure 6. With dynamic deformity the mild medial incongruency has progressed to severe medial subluxation with tibial sesamoid peaking.

Fig. 11B. Immediate post-operative radiograph follow correction of hallux varus with appropriate soft tissue release and reverse Austin osteotomy.

Tendon Release/Transfers

After osseous correction, relocation of the hallux varus may remain inadequate. Additional balancing of deforming forces will be necessary and may be performed by addressing the abductor hallucis, adductor hallucis or, EHL muscles. Availability and individual assessment of each structure at this stage of the procedure will aid in determining which tendon to address and if transfers are necessary.

Adductor Hallucis

If found unresected, the adductor hallucis tendon may be plicated to strengthen the lateral capsular structures. With a previously transected or transferred tendon, an attempt can be made to reattach or re-transfer the tendon to the inferior lateral aspect of the base of the proximal phalanx. However, unless the surgeon performs the hallux varus correction early, the tendon will be fibrosed within capsular tissues and not available for use. Alternative means for rebalancing the joint will be required.

Abductor Hallucis

Thomson[2] described the abductor hallucis as a strong medial deforming force. For correction of hallux varus, he performed a total resection of the muscle and reported 90% good results. Hawkins[4] and Clark[8] also addressed the deforming force of the abductor hallucis muscle. The tendon was released medially and transferred to the lateral base of the proximal phalanx. They transferred the tendon plantar to the metatarsal and superior to FHB. They also reported good results. Banks et al described the abductor hallucis transfer dorsal to the 1st metatarsal and attached it to the lateral capsule. (Fig. 12) This follows the same principal as the adductor hallucis transfer for hallux abductovalgus surgery.

Extensor Hallucis Longus

As described earlier, the EHL may be a deforming force for hallux varus. Traditionally, if contracture of the EHL is present, a Z lengthening and extensor hood release are performed. For additional correction of deforming forces, Johnson and Spiegl[9] describe an EHL tendon transfer. The tendon is released from its attachment, transferred plantar to the deep transverse intermetatarsal ligament in the 1st interspace and attached to the lateral base of the proximal phalanx. The tendon will now act as an abductor and plantarflexor of the hallux. The authors will not routinely perform this EHL transfer. Usually the intermetatarsal ligament is transected with the lateral soft tissue release which eliminates the necessary fulcrum for this procedure to function.

Tibial Sesamoidectomy

After all efforts to relocate the tibial sesamoid under the 1st metatarsal (including transection of the medial head of FHB) have failed, tibial sesamoidectomy is performed. Occasionally, due to the severely abnormal tibial sesamoid position and size, it is obvious that tendon balancing will be of no benefit in achieving relocation and subsequently the tendon balancing steps are bypassed.

A tibial sesamoidectomy in conjunction with a previously excised fibular sesamoid will weaken the entire plantarflexory strength of FHB and predisposes the toe to hallux malleolus. To prevent this occurrence, one of three methods are utilized; the FHB (preferably the lateral head) can be reattached to the base of the proximal phalanx, the FHL can be attached to the base of the proximal phalanx or the IPJ can be fused.

Joint Destructive Procedures

The final options for correction of hallux varus are 1st MPJ arthroplasties and 1st MPJ arthrodesis. These techniques are generally reserved for severe cases which are non-reducible after all other releases have been performed or for patients with severe erosions and adaptations at the joint surface. Arthroplasties are also indicated in patients with poor bone stock or patients requiring minimal postoperative limitation.

"Straight" Keller arthroplasties and arthroplasties with hemi and total implants are utilized for hallux varus correction. When performing implant arthroplasties, it remains essential to release all deforming forces. Excessive medial or lateral tension will lead to failure of the implant and loss of correction. Frequently additional tension can be released around a joint by resecting

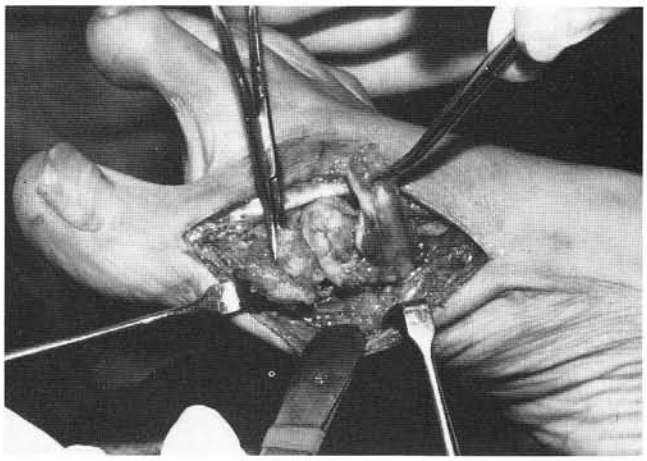

Fig. 12A. Intra-operative demonstration of abductor hallucis tendon transfer dorsally. The abductor hallucis tendon is released fro proximal phalanx and freed of its soft tissue attachments.

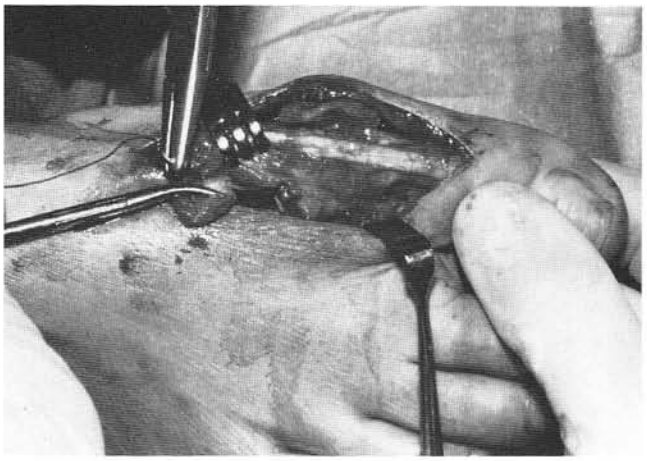

Fig. 12B. Abductor hallucis tendon (within hemostat) is being sutured to lateral capsule.

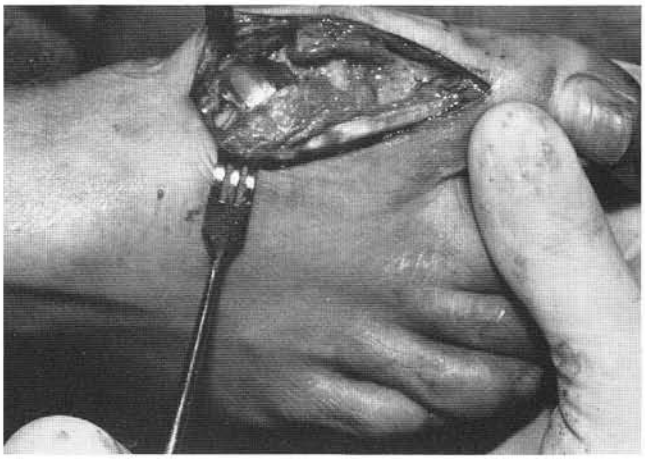

Fig. 12C. Transferred tendon plantar to EHL.

additional bone and decreasing internal cubic content. The amount of bone resected depends on initial tension of deforming forces.

SUMMARY

Hallux varus is frequently a complication of hallux abducto valgus repair. Both prevention and successful treatment requires a complete understanding of the deforming forces and contributing factors. Prudent judgement for the need of a plantar-lateral release, medial balancing procedures and osseous correction will decrease the incidence of hallux varus deformity following hallux abducto valgus repair. Also, in surgical correction of hallux varus, one needs to address the deforming forces and their contributing factors in a sequential manner. Soft tissue release, osseous correction and muscular tendon balancing are assessed and addressed in a logical step-wise approach. At Northlake Regional Medical Center minimal occurrence of hallux varus following hallux abductovalgus repair and reliable surgical correction of hallux varus have been achieved utilizing these techniques.

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