TENDON TRANSFER TECHNIQUES IN THE FLEXIBLE PES VALGUS DEFORMITY: ANATOMIC DISSECTION OF THE MEDIAL ARCH AND TENDO-SUSPENSION FOR RECONSTRUCTION OF THE MEDIAL COLUMN

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Many different surgical techniques have been described for correction of the flexible pes valgus deformity. The technique for reconstruction of the medial arch presented in this paper is but one component of a multi-faceted surgical approach to complete repair of a complex deformity.

Additional procedures and techniques used in reconstruction of the pes valgus deformity often involve the lateral column of the foot as well as the triceps surae complex. These procedures include the Evan's Calcaneal Osteotomy and bone graft technique and gastrocnemius tendon recession or tendo Achillis lengthening.

Anatomic Dissection of the Medial Arch

The techniques of anatomic dissection are important in a systematic surgical approach to the medial arch. Tissue plane dissection provides an excellent means of establishing surgical hemostasis and evaluating unique pathological anatomy. Preservation of tissue planes and key anatomic structures allows for deliberate and effective reconstruction with restoration of anatomic and functional relationships.

The systematic approach to reconstruction of the medial arch is designed to attack three specific areas of laxity and malposition in the medial column of the pes valgus deformity. These specific points include (Fig. 1):

1. the gross medial and plantar luxation of the talonavicular joint and the associated stretch of the plantar calcaneonavicular or spring ligament,

2. the naviculocuneiform breach, and

3. hypermobility of the first ray segment.

The primary structures used in the reconstructive technique include the tibialis posterior tendon and the tibialis anterior tendon. The abductor hallucis muscle belly is also an important landmark in the technique of anatomic dissection of the medial arch.

Incision Placement

The surgical incision must be placed to provide access to both the superior course of the tibialis anterior tendon and the inferior structures including the tibialis posterior tendon and the underside of the lesser tarsals. The incision should also be placed to avoid transecting the prominent medial marginal vein.

The key topographic landmarks for the medial approach include:

the medial malleolus,
the prominence of the navicular,
and the inferior margin of the medial cuneiform and the first metatarsal.

The surgical incision runs from the tip of the medial malleolus, across the prominence of the navicular to the inferior aspect of the base of the first metatarsal (Fig. 2).

The technique of anatomic dissection and controlled hemostasis begins with the skin incision. The initial or intra-dermal incision does not actually penetrate the skin layer but only into the dermis. The second or transdermal incision allows the skin edges to separate without laceration of the underlying superficial veins. A delicate stroke is then used to release the superficial fascia and allow isolation of the individual veins that cross the surgical incision.

Individual veins are isolated, clamped, cut, and tied. Hand ties of 4-0 Dexon are recommended for vessels of larger diameter. Electrocautery may be used with caution to avoid migration of current into surrounding tissues or major vein trunks such as the medial marginal vein. A significant number of veins will be encountered in the

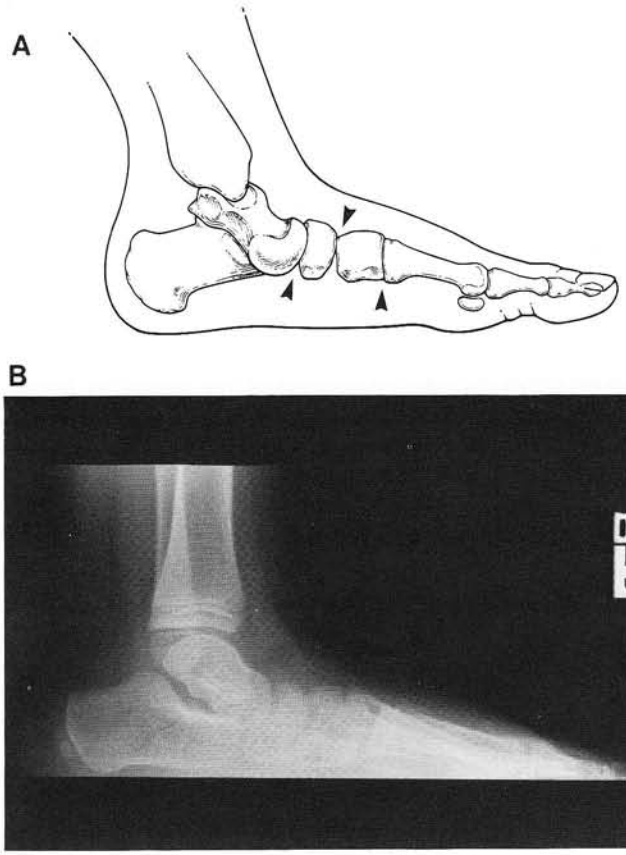

Fig. 1. A. Malposition of the medial column in flexible pes valgus deformity: -gross medial and plantar luxation of the talonavicular joint and the associated stretch of the plantar calcaneonavicular or spring ligament, -naviculocuneiform breach, and -hypermobility of the first ray segment. **B.** Radiographic demonstration of medial column collapse.

dissection through the superficial fascial layer and hemostasis can be easily maintained if each vessel is individually identified and secured.

The medial marginal vein should be retracted dorsally within the superficial fascia as it is separated from the underlying deep fascia.

Remaining fibers of the superficial fascia are sectioned along the line of the incision to cleanly expose the surface of the deep fascia. A surgical sponge may be used to aid in separating the superficial fascia from the intact deep fascia over the abductor hallucis muscle belly. A similar technique is used to pull the superficial fascia away from the deep fascia and retinaculum over the tibialis anterior tendon.

This clean separation of the superficial fascial layer from the deep fascia along the course of the medial incision is a key maneuver in establishing hemostasis in dissection of the medial arch. The complex network of superficial veins over the medial arch must be specifically isolated and secured to avoid troublesome intraoperative bleeding and the serious postoperative complication of hematoma.

Direct access to all deeper structures of the medial arch can be readily attained through incision of the cleanly exposed deep fascia.

Deep Fascial Incision

The deep fascia is a dense tissue layer that covers the entire medial surface of the foot. The deep fascia is most readily appreciated over the abductor hallucis muscle belly but is continuous and spreads proximally as a retinaculum over the tibialis posterior tendon. It must be incised and reflected as a layer to reveal the underlying structures of the medial arch.

The fascial incision is executed from distal to proximal to follow the course of the tibialis posterior tendon from the first metatarsal base back to the level of the medial malleolus.

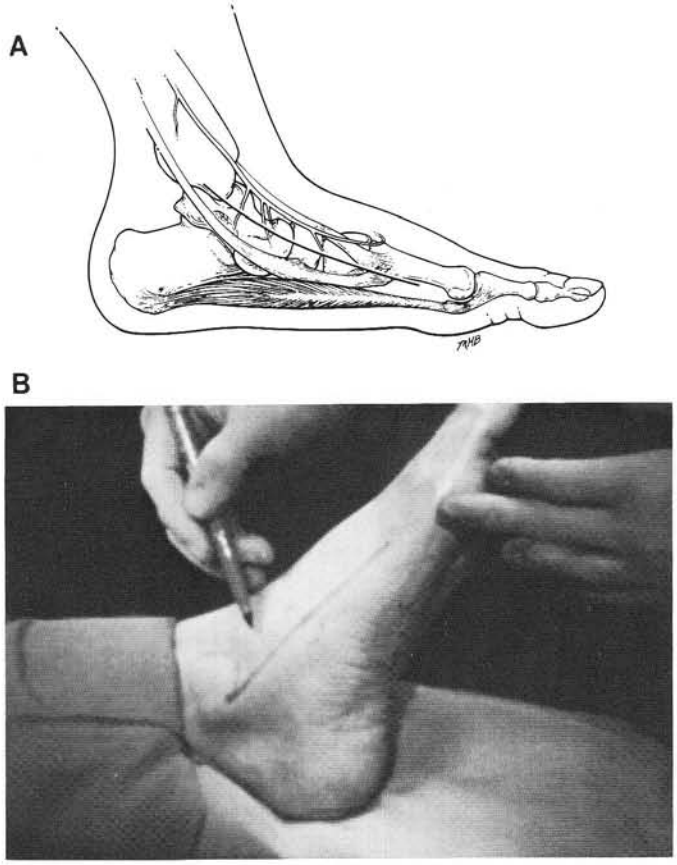

Fig. 2. A. Surgical incision must be placed to provide access to both tibialis anterior and tibialis posterior tendons. Incision should be placed to avoid medial marginal vein. **B.** Key topographic landmarks for the medial incision: -medial malleolus, -prominence of navicular, -inferior margin of medial cuneiform and base of first metatarsal.

The tip of a Metzenbaum scissor is inserted beneath the fascia to separate it from the underlying muscle tissues. The fascia is then incised to reveal the underlying muscle belly and other medial structures (Fig. 3).

As the scissor is passed beneath the fascia and around the prominence of the navicular, it enters the sheath of the tibialis posterior tendon. With incision of this proximal section of the deep fascia, the tibialis posterior tendon is visualized as it courses to its primary incision in the navicular. Additional dissection and separation is necessary to more fully expose the tendon as it passes to its insertion. The main body of the tendon can then be isolated and retracted with a moist umbilical tape.

Reflection of the Abductor Hallucis Muscle for Exposure of the Underside of the Lesser Tarsals

The incision through the deep fascia is placed to provide full access to the inferior structures of the medial arch by reflection of the abductor hallucis muscle belly. Full reflection of the abductor hallucis muscle belly will reveal the entire course of the tibialis posterior tendon from the medial malleolus to its primary insertion in the navicular and beyond, to its distal medial extension and insertion into the base of the first metatarsal (Fig. 4).

As the belly of the abductor hallucis muscle is gently teased away from the inferior aspect of the lesser tarsals, the distal extension of the medial arm of the tibialis posterior tendon is revealed as it travels to its insertion over the inferior aspect of the medial cuneiform and the base of the first metatarsal. Full separation of the muscle belly from the inferior aspect of the lesser tarsals is necessary to allow for full exposure of the medial extension of the tibialis posterior tendon and for later translocation of the tibialis anterior tendon in the reconstructive process. Care must be taken to avoid laceration of the deep penetrating veins of the plantar arch as the muscle belly is separated from the inferior aspect of the lesser tarsals.

Retrieval of the Tibialis Anterior Tendon

Once the abductor hallucis muscle has been reflected and the tibialis posterior tendon has been identified, the tibialis anterior tendon must be exposed. The tibialis anterior tendon is retrieved by using a meticulous dissec-

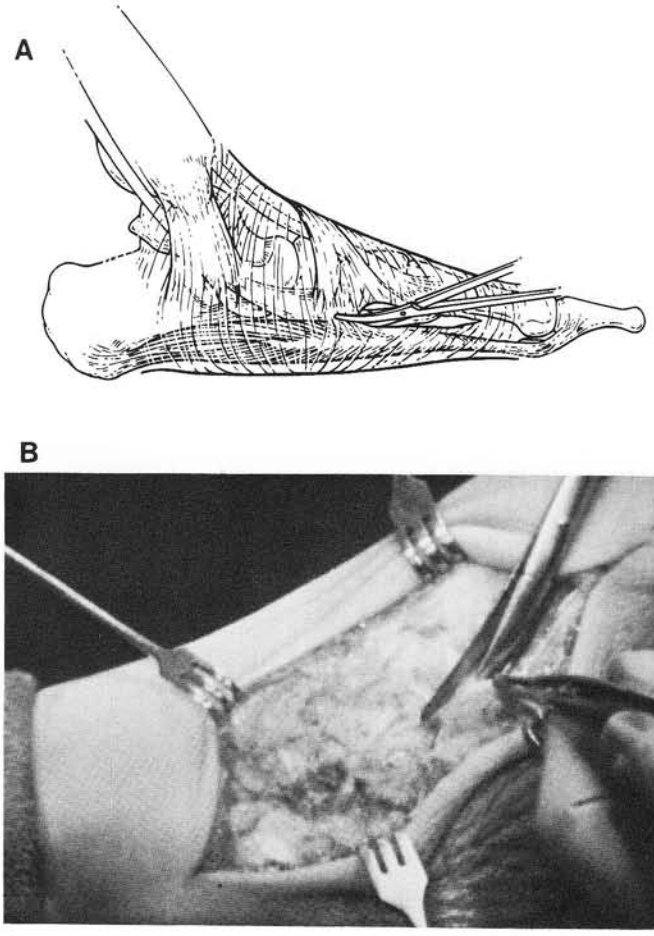

Fig. 3. A. Incision of deep fascia follows course of tibialis posterior tendon from base of first metatarsal to level of medial malleolus. **B.** Tip of Metzenbaum scissor is inserted beneath fascia to separate it from underlying abductor muscle.

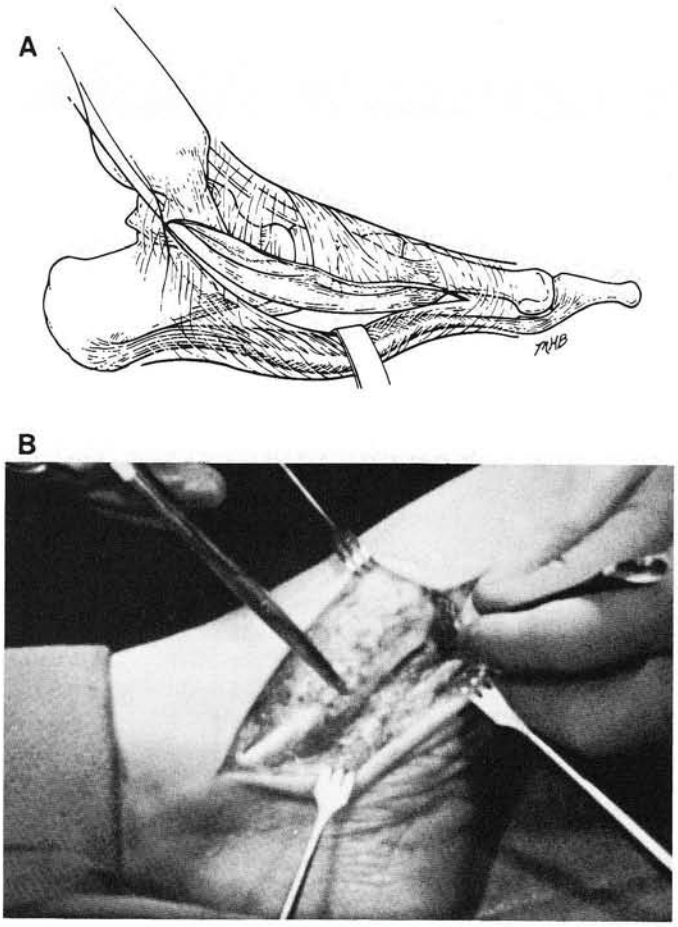

Fig. 4. A. Full reflection of abductor muscle will reveal entire course of tibialis posterior tendon from medial malleolus to its primary insertion in navicular, and beyond to its distal medial extension and insertion into base of first metatarsal. **B.** Full exposure of course of tibialis posterior tendon.

Fig. 5. Cross section of foot through cuneiform demonstrates relationship of deep fascia to underlying structures of medial arch. Critical structures include: -abductor hallucis muscle belly, -tibialis posterior tendon, -lesser tarsals, and -tibialis anterior tendon.

tion technique to separate the superior flap of the deep fascia from the capsular tissues over the medial and dorsal surfaces of the lesser tarsals. As the deep fascia is reflected, the tibialis anterior tendon is revealed (Fig. 5).

At this point the importance of preservation of the deep fascial layer is appreciated. Anatomic dissection with clean tissue layer separation allows for anatomic closure of tissue layers following even the most extensive and intricate reconstruction of the medial arch.

Complete mobilization of the tibialis anterior tendon is necessary for later tendon transfer. Additional dissection is necessary to separate the deep fascia back to a level proximal to the talonavicular joint. The body of the tendon is freed from peritendinous attachments proximally to the level of the ankle.

Dissection is then carried distally to the insertion of the tibialis anterior tendon into the cuneiform and the first metatarsal base. The superior fibers of the insertion are carefully released to allow for rotation of the tendon to the plantar aspect of the lesser tarsals, while retaining the majority of its insertion into the base of the first metatarsal.

The tendon is then isolated and retracted with a moist umbilical tape.

Detachment of the Tibialis Posterior Tendon

Detachment of the tibialis posterior tendon is specifically performed to take advantage of three separate portions of the tendon (Fig. 6):

1. the main body of the tendon,
2. the distal extension of the medial arm of the tendon,
3. the lateral slip of the tendon as it crosses beneath the navicular distally to its insertion in the lesser metatarsals.

The tibialis posterior tendon is initially retracted with a moist umbilical tape proximal to its main insertion into the navicular.

The medial extension of the tibialis posterior tendon is clearly defined and demarcated with a delicate incision through the retinaculum along the superior margin of the tendon. The incision should extend from the navicular to the base of the first metatarsal.

The level of transection of the medial arm of the tibialis posterior tendon is then determined. The tendon is sectioned just proximal to the naviculocuneiform joint and then sharply reflected from its main insertion into the navicular. This maneuver detaches the main body of the tibialis tendon from the navicular, however controlled dissection can reveal the lateral slip of the tibialis

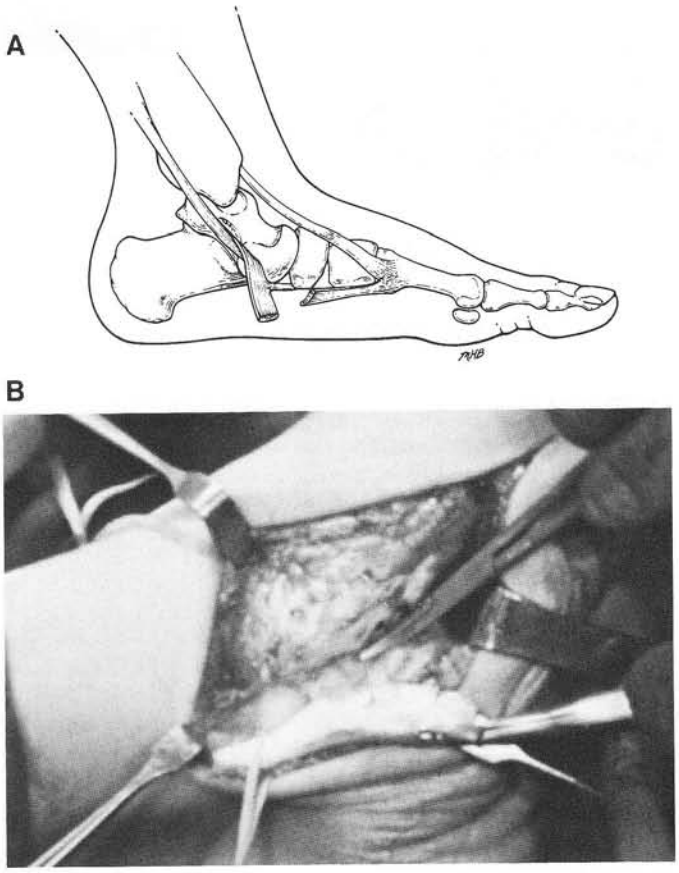

Fig. 6. A. Three main segments of transected and detached tibialis posterior tendon: main body of tendon, distal extension of medial arm of tendon, and lateral slip of tendon as it crosses beneath navicular to its insertion in lesser tarsals and metatarsals. **B.** Surgical demonstration of tibialis posterior tendon following detachment of primary insertion into navicular.

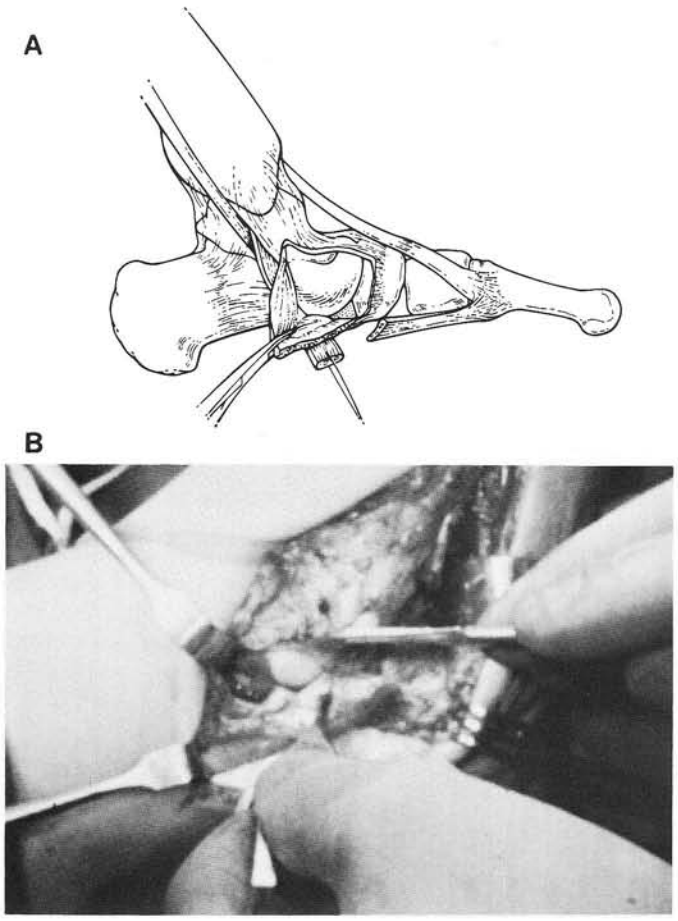

Fig. 7. A. Inverted "L" incision into talonavicular joint creates plantar-medial flap which includes spring ligament, and is attached proximally to greater tarsus. **B.** Surgical delivery of luxated head of talus.

posterior tendon. Care should be taken at the lateral edge of the tendon as it is detached from the navicular so as not to sever the lateral arm of the tibialis posterior tendon as it separates from the main tendon and passes beneath the navicular to its insertion in the lesser metatarsals.

Talonavicular Capsulotomy

With the tibialis posterior tendon reflected, the arthrotomy of the talonavicular joint is performed. An inverted "L" incision is used to create a plantar-medial flap which includes the spring ligament and is attached proximally to the greater tarsals. Reflection of the plantar flap will reveal the luxated head of the talus and the talonavicular joint (Fig. 7).

The gliding surface for the tibialis posterior tendon is a well defined groove over the medial aspect of the head and neck of the talus. This hyaline-like channel is preserved as the medial capsular incision is placed along its superior edge from the proximal neck of the talus, across the talonavicular joint and onto the body of the navicular.

This linear medial incision is performed cleanly with care taken not to damage the articular surface of the head of the talus. The neck of the talus and the articular surface of the head of the talus can be clearly exposed through this incision. A knife handle or Sayer elevator can be passed beneath the head and neck of the talus to define the plantar capsule and spring ligament. The distal attachments of the plantar capsule and spring ligament are then released from the inferior-proximal aspect of the navicular. This dissection must be followed to the inferior-lateral margin of the navicular to allow for later seating of the tibialis anterior tendon. Once the capsulotomy has been completed, the gross instability of the talonavicular joint can be appreciated.

Additional reflection of dorsal capsule and periosteum from the navicular is then performed to allow slotting of the navicular and later translocation of the tibialis anterior tendon.

The Navicular Slot

The slot in the navicular can be made with a side-cutting burr or a drill bit. The drill is passed from dorsal to plantar beginning at the proximal edge of the navicular. This ensures a strong dorsal cortex which will resist fracture following tendon transfer. The drill bit is also directed slightly lateral so that the plantar exit of the drill is lateral to the prominent medial corner or hook of the navicular. This placement will aid in securing the tendon within the slot of the navicular.

A sawing action is then used to cut the slot in a proximal direction so that the drill bit exits the proximal-medial surface of the navicular. The superior margin of the notch should avoid the talonavicular joint and the plantar exit should be well short of the naviculocuneiform joint. The edges of the slot are then smoothed with a hand rasp to facilitate later seating of the tendon (Fig. 8).

A "T" incision is then made in the dorsal capsular flap to coincide with the slot in the navicular. This maneuver will facilitate capsular closure following transfer of the tibialis anterior tendon.

A trial seating of the tibialis anterior tendon is then performed to determine if there is adequate mobility of the tendon and accurate contour of the navicular slot.

Translocation of the Tibialis Anterior Tendon

Prior to seating of the tibialis anterior tendon, a hemisection of the tendon is created by sectioning a superior portion of the tendon proximally. This section is then stripped distally, retaining its insertion, and is used later to reinforce the advancement of the tibialis posterior tendon (Fig. 9).

The remaining intact portion of the tibialis anterior tendon is then drawn into the slot of the navicular to create a new plantar ligament from the navicular to the first metatarsal and establish a new insertion for the tibialis anterior tendon (Fig. 10).

Tightening of the New Plantar Navicular-Cuneiform-Metatarsal Ligament

The primary effect of translocation of the tibialis anterior tendon is to reinforce the naviculocuneiform breach and stabilize the hypermobile first ray segment (Fig. 11).

The rerouted tibialis anterior tendon can now be used to create a new plantar ligament which is secured in the notch of the navicular by anchoring it to the lateral slip of the tibialis posterior tendon. A zero gauge nonabsorbable pulley suture is run from the lateral slip of the tibialis posterior tendon to the plantar segment of the translocated tibialis anterior tendon. As the suture is drawn and tied, the plantar portion of the tibialis anterior tendon is drawn proximally to create a new plantar ligament that can reduce the naviculocuneiform breech and decrease the hypermobility of the first ray segment.

The technique also secures the tibialis anterior tendon within the notch of the navicular and prevents its dislocation.

Reduction of the Talonavicular Joint

With the tibialis anterior tendon rerouted and secured, the distal portion of the medial arch has been reinforced. Reduction of the talonavicular joint and reinforcement of the proximal segment is accomplished with the

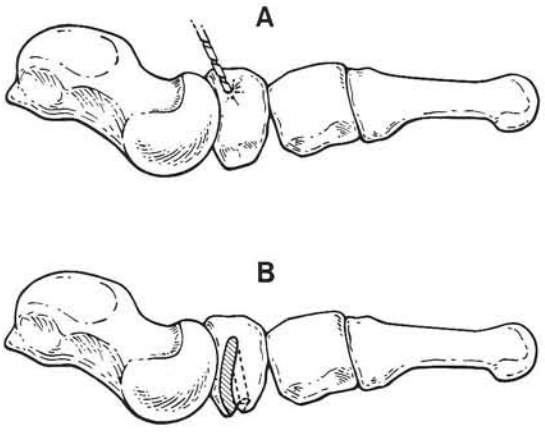

Fig. 8. A. & B. Orientation of navicular slot: drill bit penetrates dorsal surface of navicular just distal to talonavicular joint and is aimed plantarly with slight distal and lateral angulation.

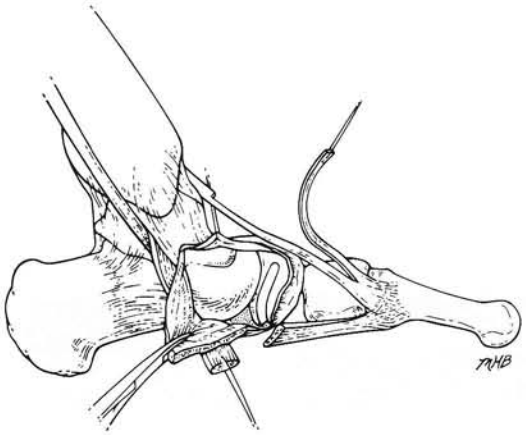

Fig. 9. Prior to seating of tibialis anterior tendon, hemi-section of tendon is created to use later as reinforcement strap for anchoring of tibialis posterior tendon.

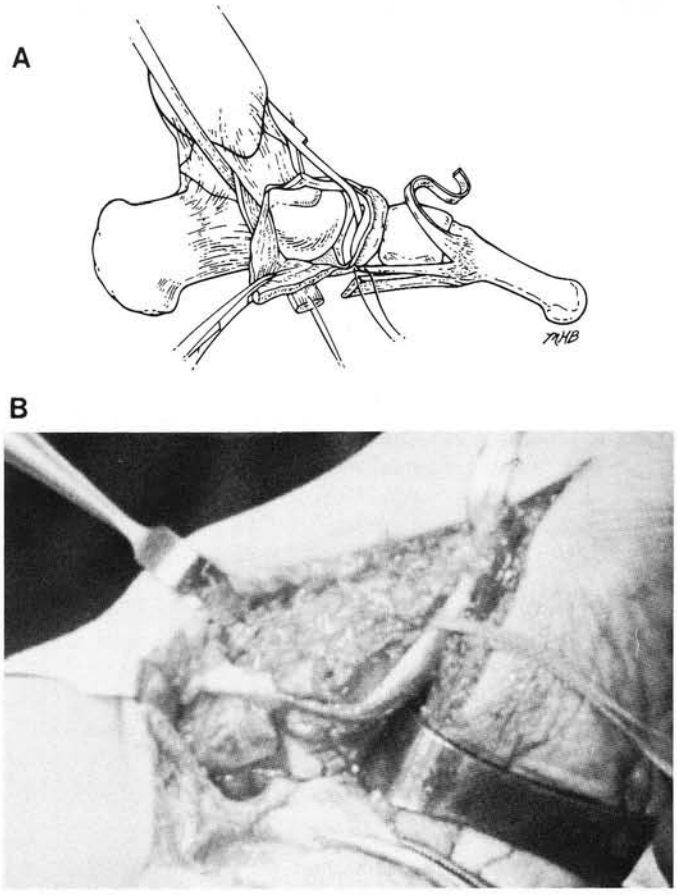

Fig. 10. A. Main section of tibialis anterior tendon is drawn into slot of navicular to create new plantar ligament and establish new insertion for tibialis anterior tendon. **B.** Surgical demonstration of translocated tibialis anterior tendon.

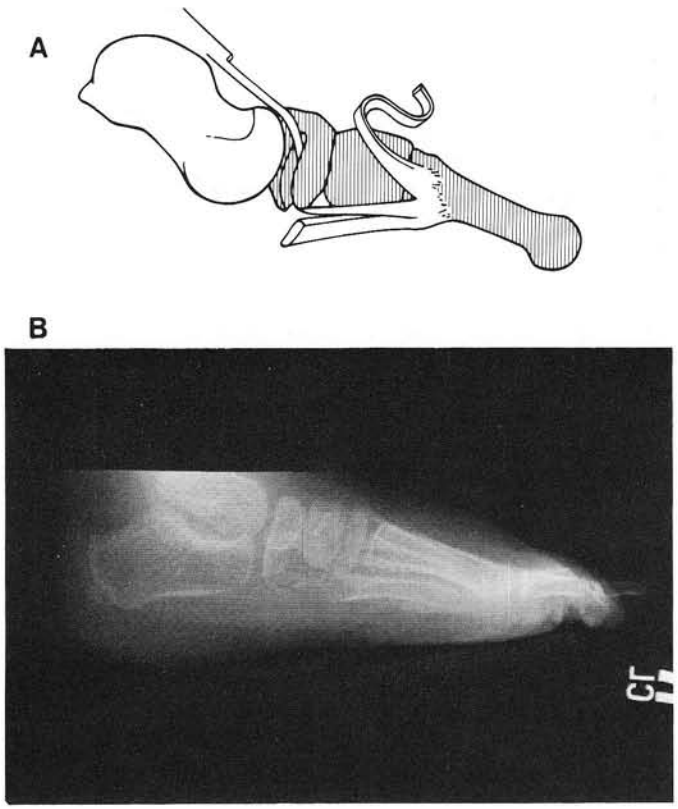

Fig. 11. A. Primary effect of translocation of tibialis anterior tendon is reinforcement of naviculocuneiform breach and stabilization of hypermobile first ray segment. **B.** Radiographic demonstration of reduction of naviculocuneiform breach and first metatarsocuneiform joint.

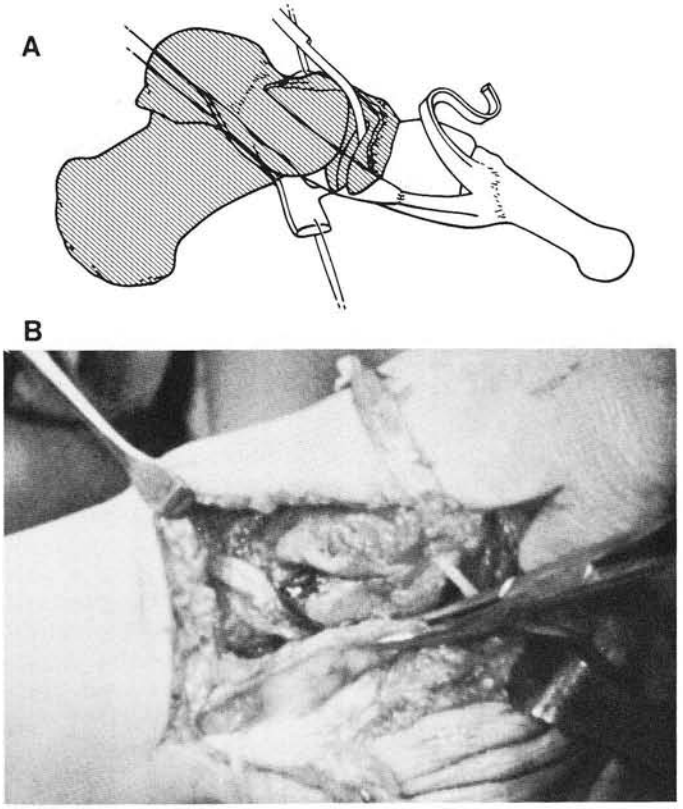

Fig. 12. A. Talonavicular luxation is reduced with advancement of plantar-medial capsular flap. Flap is anchored distally into inferior aspect of navicular. **B.** Plantar-medial capsular flap of talonavicular joint, which includes spring ligament, is anchored distally into fibers of translocated tibialis anterior tendon beneath navicular.

advancement of the plantar capsule and spring ligament (Fig. 12).

A pulley technique is again used to advance and secure the plantar capsular flap to the inferior aspect of the lesser tarsals. The heavy 0 gauge suture engages the fibers of the rerouted tibialis anterior tendon and the distal segment of the transected medial arm of the tibialis posterior tendon. The talonavicular joint is then reduced and a surgeon's knot is tied securely. The taunt plantar-medial capsule and spring ligament now stabilize and support the talonavicular joint.

The primary effect of the advancement of the spring ligament and plantar capsule is reduction and added stability to the proximal segment of the medial arch and talonavicular joint. The primary retention suture of the plantar capsular flap is nonabsorbable and it is reinforced with several 2-0 Dexon sutures to complete the medial and plantar anchoring of the strong capsular and ligamentous flap.

Capsular Closure

The "T" incision in the dorsal capsule over the navicular was designed to allow the superior capsular tissues to be pulled around the new insertion of the tibialis anterior tendon. The technique helps prevent dislocation of the transferred tendon and allows for a clean linear closure of the medial capsular incision. The capsular tissues are approximated with multiple "over and over" 2-0 Dexon sutures. At this point, anatomic restoration of the capsular structures has been completed and the new insertion of the tibialis anterior can be seen penetrating the dorsal capsule (Fig. 13).

Advancement of the Tibialis Posterior Tendon

With closure of the medial capsule completed, the main body of the tibialis posterior tendon is advanced and anchored into the tendinous structures on the plantar surface of the cuneiform (Fig. 14). An 0-gauge nonabsorbable suture is used in a pulley technique as the primary anchor suture. The hemi-section of the tibialis anterior tendon will be used to reinforce this transfer and the anastamosis is repaired with 2-0 Dexon (Fig. 15).

The tibialis posterior tendon should be advanced and sutured under physiologic tension.

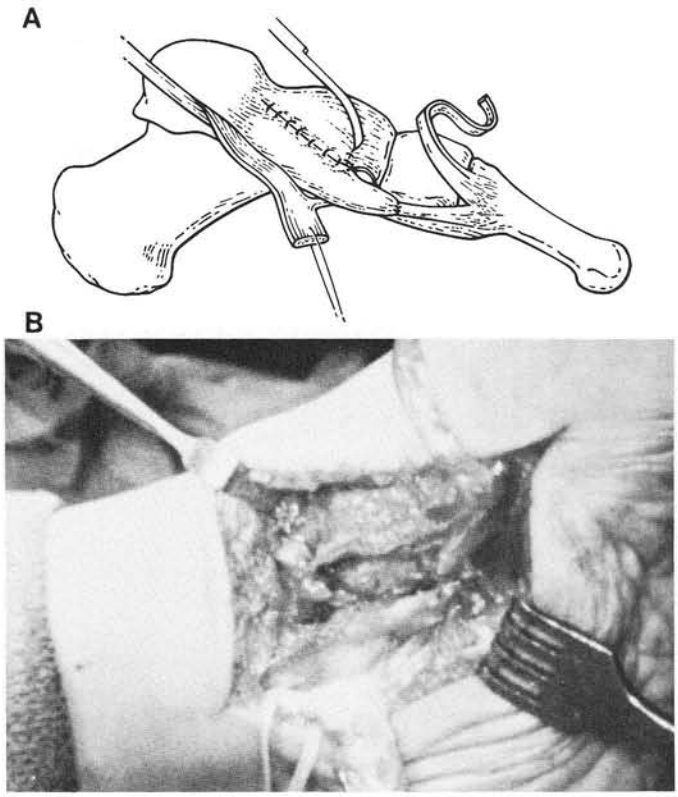

Fig. 13. A. "T" incision in dorsal capsule is designed to allow capsular tissues to be closed around new insertion of tibialis anterior tendon. B. Closure of capsular tissues around tibialis anterior tendon as it inserts into navicular slot help prevent dislocation of tendon from navicular slot.

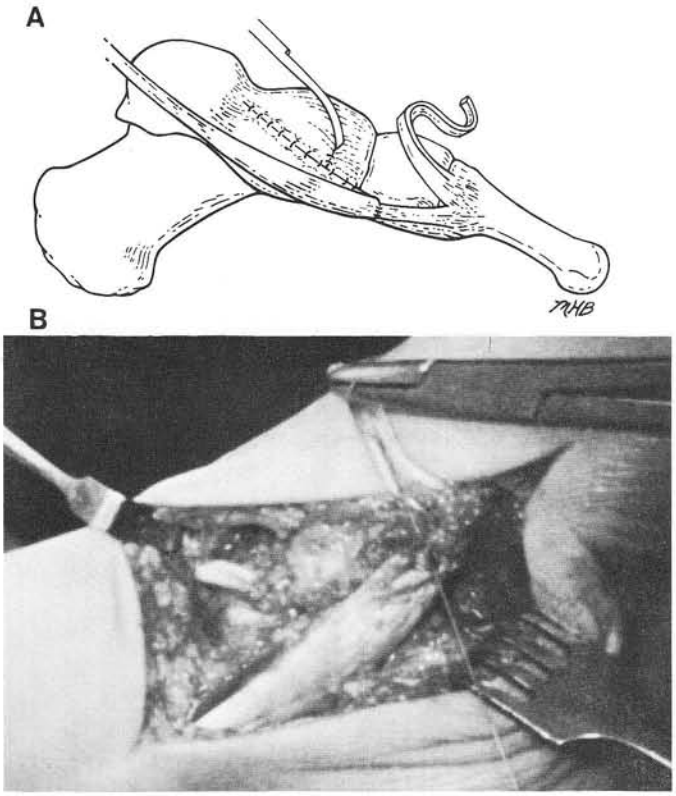

Fig. 14. A. With capsular closure completed, main body of tibialis posterior tendon is advanced and anchored into tendinous structures on plantar surface of cuneiform. **B.** Advancement of tibialis posterior tendon.

Wound Closure

With completion of the deep maneuvers, the tissue layers are closed in anatomic sequence. The deep fascia is approximated with a running 3-0 Dexon suture. The subcutaneous layer is then apposed with a running 4-0 Dexon suture and the skin is closed with an intra-dermal technique using 5-0 or 6-0 Dexon. The wound is then reinforced with Steri-strips and the surgical dressing and cast are applied.

SUMMARY

The reconstruction techniques discussed in this paper are made possible by preservation of specific anatomical relationships and structures. Many different types of repair and modifications are possible if the primary anatomy is preserved in the surgical dissection.

The techniques of anatomic dissection of the medial arch are also of great value in other conditions involving the medial structures of the foot, even in club foot and other adductus deformities.

Accurate anatomic dissection is the key to a minimally traumatic surgical procedure, control of hemostasis and appreciation of unique pathological anatomy.

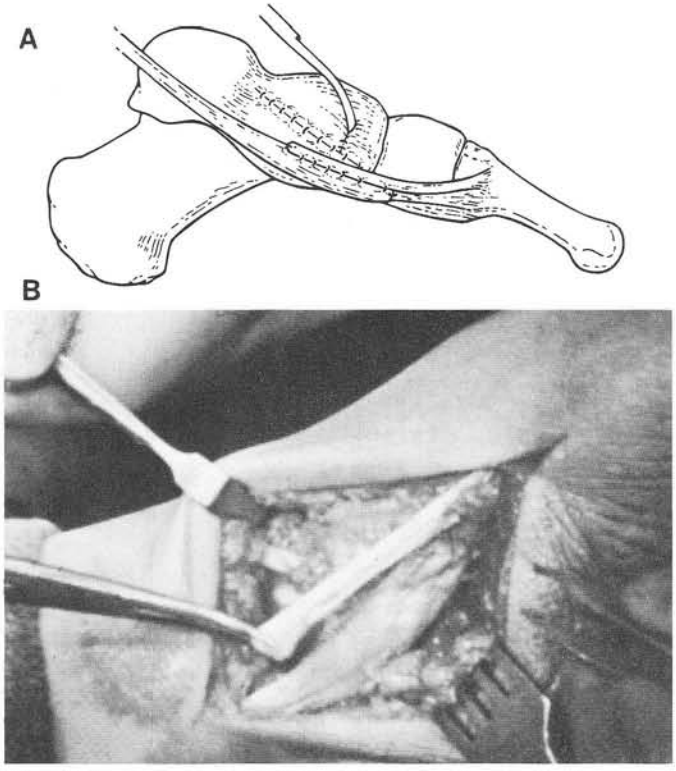

Fig. 15. A. Free slip of tibialis anterior tendon is used to reinforce advanced tibialis posterior tendon. **B.** Completion of tendon transfer and medial arch reconstruction.

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