CHAPTER **28**

DIGITAL FLEXOR TENDON TRANSFER UTILIZING BIOABSORBABLE INTERFERENCE SCREW FIXATION

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Digital deformities are commonly encountered by the podiatric surgeon. Hammertoes are most often surgically corrected in a sequential manner which has been described in the literature.[1] Correction of the deformity is especially challenging when crossover deformity is present or when significant metatarsophalangeal joint instability is encountered. These complicated cases often require a multitude of surgical procedures including metatarsal osteotomy, proximal interphalangeal joint arthrodesis and soft tissue balancing procedures. A flexor digitorum longus tendon transfer is among the most popular procedures utilized to alter the mechanical forces acting on the digit.

Many tendon transfer procedures have been described for correction of digital deformities.[2-16] In 1925, Trethowan[2] made reference to transfer of the FDL tendon for claw toe surgery. The Girdlestone-Taylor procedure was performed by Girdlestone[3] and later described by Taylor[4] in 1951. This procedure involved transfer of the long and short flexor tendons to the extensor expansion. Parrish[5] in 1973 described splitting the FDL tendon longitudinally and bringing the tendinous slips around either side of the proximal phalanx. The tendon ends are then sutured to themselves and the dorsal expansion of the extensor tendons. Kuwada and Dockery[6] in 1988 described creating a drill hole in the neck of the proximal phalanx for passage of the long flexor tendon to the dorsum of the digit. Schuberth[7] later modified this procedure and placed the drill hole in the base of the proximal phalanx.

The mechanical advantage of the flexor tendon transfer has two distinct effects.[17] The function of the flexor tendon is converted from a deforming force to an active plantarflexor of the proximal phalanx against the weight-bearing surface. Additionally, with the tendon's relocation, it can now passively resist future dorsal dislocation of the digit. Conversely, two of the potential complications of flexor tendon transfer are postoperative stiffness and a floating toe.[14,16] Thus, appropriate tensioning and fixation of the tendon transfer are paramount in attaining a good functional outcome.

We describe a procedure that may assist in "dialing in" and maintaining the amount of tension that is appropriate for flexor tendon transfer. This modification includes the accepted use of a drill hole in the base of the proximal phalanx and an absorbable interference screw technique for "locking" the tendon within the bony canal. There is an upcoming publication describing this technique and its usage in crossover toe deformity correction.[18] There is also a similar procedure recently submitted for publication, but with plantar-to-dorsal insertion of the interference screw through a plantar incision utilizing a 3.0mm interference screw.[19]

Interference screw fixation has been frequently utilized for a multitude of orthopedic procedures ranging from anterior cruciate ligament reconstructions[20,21] to larger tendon transfers of the foot including posterior tibial tendon transfers[22] and ankle ligament reconstructions. The primary advantages of interference screw fixation are allowing exact tensioning of tendons and grafts, as well as better stability than with surface placement of a tendon with an anchor or simple suturing to adjacent tendons. Suture failure and tendon slippage are often a concern with existing techniques. Additionally, absorbable materials such as Poly-L-lactic Acid have been used safely for many years with infrequent significant reactions or complications.[23,24] Other polymers such as polyglycolic acid, even when mixed with Poly-L-lactic acid have had more significant issues and even granuloma formation associated with their faster resorption rate and foreign body reactions.[2]

SURGICAL TECNIQUE

Incision Placement

Many difficulties have been encountered with a linear incision placement over metatarsophalangeal joints. As such, it is recommended to perform a lazy-S type approach making the incision as transverse as possible across the metatarsophalangeal joint (Figure 1). This will help to decrease post surgical scar contracture. Additionally, if multiple digits are going to be addressed, care should be taken to avoid leaving small skin islands between incisions. This can be accomplished by directing the lazy-S of each incision away from the other, thus providing a wide skin island between the two incisions.

Anatomic Dissection

As has been described frequently in the Podiatry Institute literature, preservation of normal anatomy is essential for safe dissection and trouble-free healing. Subcutaneous dissection should be kept at a minimum, getting down to the deep fascial plane, allowing retraction of the neurovascular structures within the subcutaneous layer. Utilizing a sharp and blunt technique, retract the subcutaneous tissue and neurovascular structures away from metatarsophalangeal joint.

Extensor Lengthening

Many options exist in the lengthening and exposure of the extensor tendon apparatus. In an effort to minimize tendon trauma and dissection, an opening Z-Plasty will be utilized. The tendon will be exposed dorsally and a Z-Plasty performed at the metatarsophalangeal joint level. The distal tendon slip will then be freed dorsally to the level of the middle phalanx allowing entry into the proximal interphalangeal joint. Certainly this is surgeon preference, but care should be taken to avoid excessive dissection and tissue trauma.

MPJ Capsulotomy

The metatarsophalangeal joint will then be easily visualized and should be released as necessary. Depending upon the degree of transverse plan deviation, dorsal, medial and lateral capsulotomies are typically performed. If severe crossover or medial deviation is present, care should be taken to release the medial capsular structures down to the level of and including the flexor plate if necessary.

PIPJ Resection

It is the author's preference to perform a proximal interphalangeal joint arthrodesis instead of arthroplasty in cases of digital contracture. An end-to-end technique is most often utilized. Joint resection can be performed utilizing hand or power instrumentation. The advantage of using hand instrumentation is decreased chance of thermal injury to the arthrodesis site and better bone to bone apposition. If a flexed arthrodesis position is desired it can easily be performed at this time by beveling the bone surfaces as desired. A small rongeur is utilized to remove cartilage and subchondral bone from the head of the proximal phalanx and base of the middle phalanx down to bleeding cancellous bone.

Harvest of Flexor Tendon

At the level of the proximal interphalangeal joint, the flexor plate should be easily visualized. Carefully elevate the proximal phalanx proximally exposing enough of the flexor plate to facilitate deep dissection. Make a longitudinal incision sharply into the flexor plate allowing visualization of the flexor tendons. At this level, the slips of the flexor digitorum brevis will be superficial, and the singular flexor digitorum longus tendon will lie immediately deep to these slips. Utilizing a curved hemostat, initially spread horizontally. This will move the slips of the brevis laterally allowing the long flexor tendon to be looped up into the wound (Figures 2-3). Utilizing this technique, tendon length is not typically an issue, but still section the tendon distally and tag the tendon utilizing a whip stitch or similar with 3-0 or 4-0 non-absorbable suture. This stitch must be secure as it will be used to pull the tendon through the bone tunnel (Figure 4). Now with the tendon mobilized, release the flexor tendon sheath proximally to allow adequate mobility for transfer. This can be accomplished utilizing a small tenotomy scissor and gentle traction on the harvested tendon.

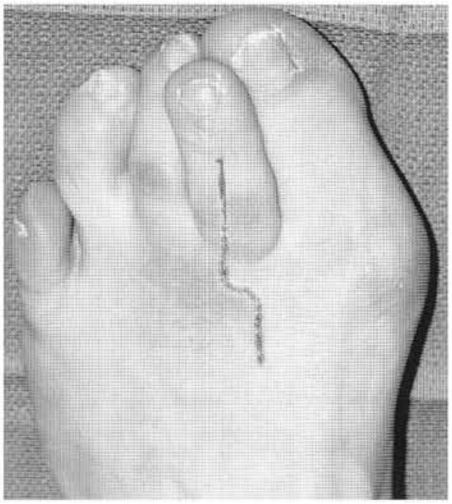


Figure 1. Lazy-S type incision to minimize scar contracture over the MTPJ.

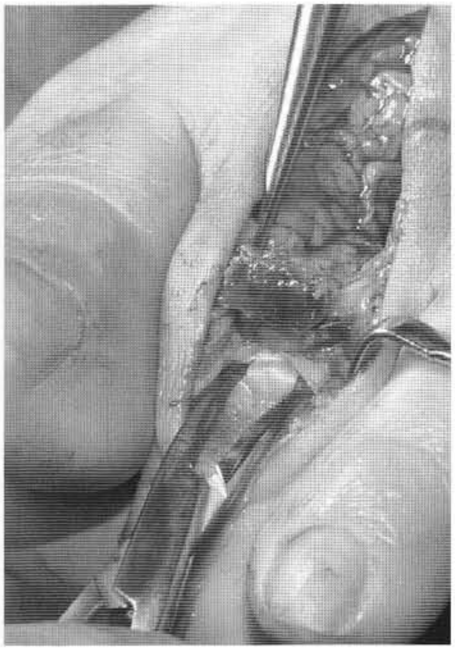


Figure 2. Brevis tendon slips spread laterally allowing easy visualization of the long flexor tendon. Note use of ragnell retractor to hold the proximal phalanx.

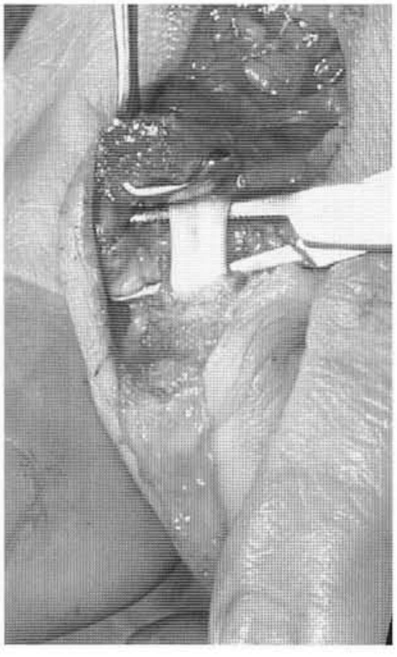


Figure 3. Long flexor tendon now exposed and separated from brevis tendon slips.

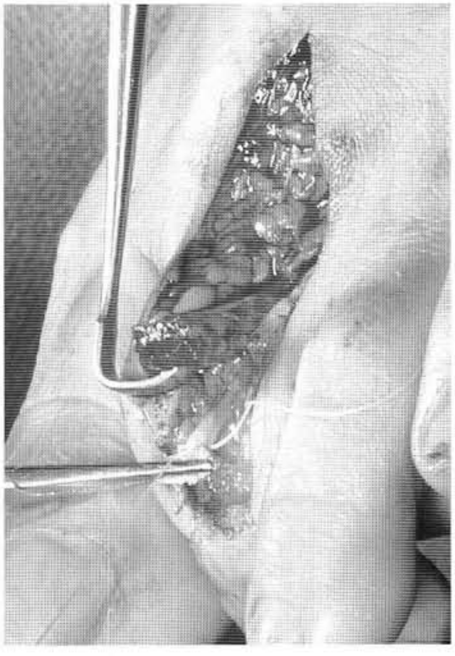
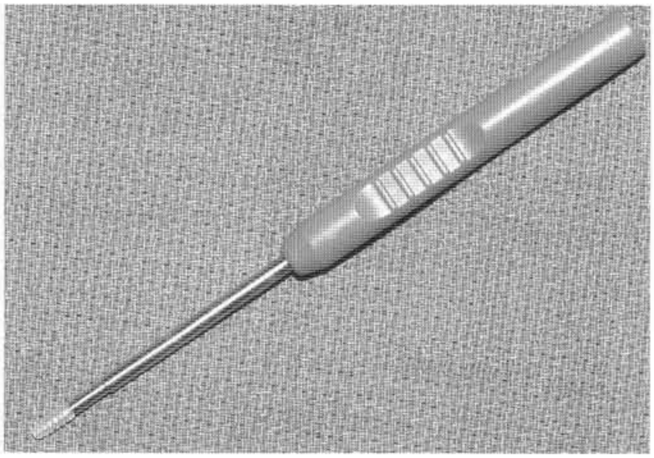


Figure 4. Long flexor tendon sectioned and then tagged with 3-0 or 4-0 non-absorbable suture in a whip or krakow fashion.



Figures 5. Arthrex 3.0mm Biotenodesis Screw and disposable driver.

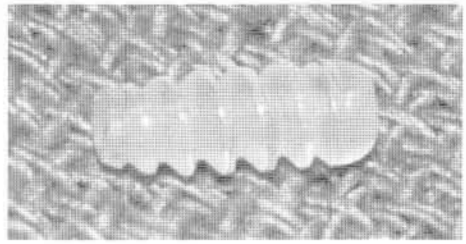


Figure 6. Arthrex 3.0 mm Bio-Tenodesis screw.

Tendon Transfer / Anchor

The instrumentation for this procedure is available from Arthrex called the 3 or 4 mm Bio-Tenodesis® screw. The screw utilized most often is the 3.0 mm x 8 mm, and is supplied with the needed instrumentation (Figures 5, 6). The screw itself is made from Poly-L lactic Acid. The base of the proximal phalanx should be easily visualized at this point. A pilot hole utilizing a smooth 0.062" Kirschner wire should be developed in the metaphyseal region of the proximal phalanx (Figure 7). As the screw to be utilized will be 3.0 mm in diameter, it is critical not to perform this technique too distally into the diaphysis or on osteopenic bone. Depending upon the degree of transverse plane deformity, the hole can be directed somewhat more laterally if desired. It is important to note that the axis of pull will be from the plantar exit of the hole and thus should be biased laterally to correct for a medially deviated digit. Additionally, a slight distal and plantar bias will make it easier to thread your flexor tendon and minimize dissection. Once an acceptable orientation of your guide hole has been developed, the final drill hole can then be made. As the tendon itself will occupy space within the tunnel, a 2.5 mm drill bit is used and will allow for a tight fit between the screw, tendon and osseus tunnel (Figure 8). Next using a wire loop or the Arthrex angled "Micro Suture Lasso" (Figure 9), retrieve the tagged flexor tendon and pull it through the hole from plantar to dorsal (Figure 10). The lasso should loop the tag suture, not the flexor (Figures 11, 12). Once the tag suture is pulled through the hole, gently draw the flexor tendon up through the hole (Figure 13). At this point, fixate the PIPJ arthrodesis using a K-wire or other digital implant (Figure 14). Care should be taken to avoid the drill hole with the K-wire. If you intend to cross the MTPJ, you must wait until the tendon has been fixated before final advancement of your K-wire. Once the PIPJ arthrodesis is stabilized, the flexor tendon can be tensioned and fixated (Figures 15, 16). As with all tendon transfers, an ankle tourniquet can distort the resting tension on the tendon. As such, the procedure should be performed with no tourniquet or using a thigh tourniquet. If an ankle tourniquet is used, it should be deflated at this time. The digit should then be positioned in slight plantarflexion, with care to load the forefoot intraoperatively and avoid overtensioning. Overtensioning can result in a painful, stiff toe. Once the desired tension is achieved, the screw is inserted down flush with the bone. Check stability at this time. The remaining tag of tendon can now be trimmed; but, as adjunctive fixation, the tendon can be sutured down to the periosteum or extensor structures using 3-0 or 4-0 non-absorbable suture (Figure 17). In cases of significant transverse plane instability, the tendon can be used to reinforce the lateral MTPJ capsule.

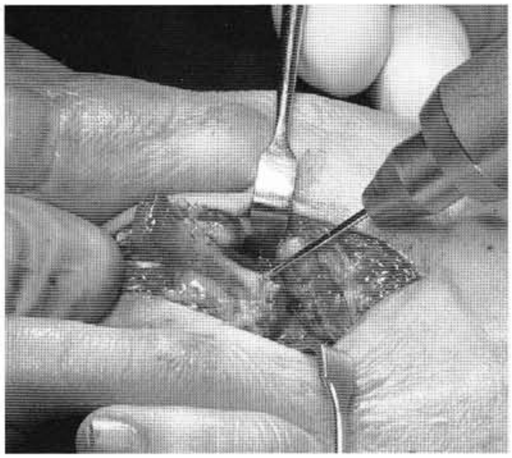


Figure 7. Pilot hole drilled with a 0.062" Kirchner wire into base of proximal phalanx.

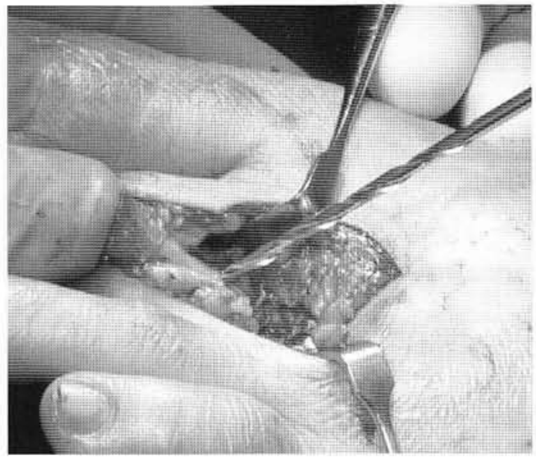


Figure 8. 2.5 mm final drill hole into base of proximal phalanx.

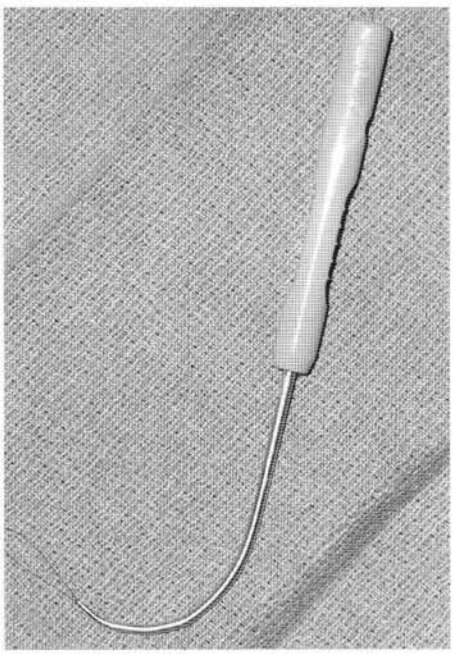


Figure 9. Arthrex Micro Suture Lasso™.

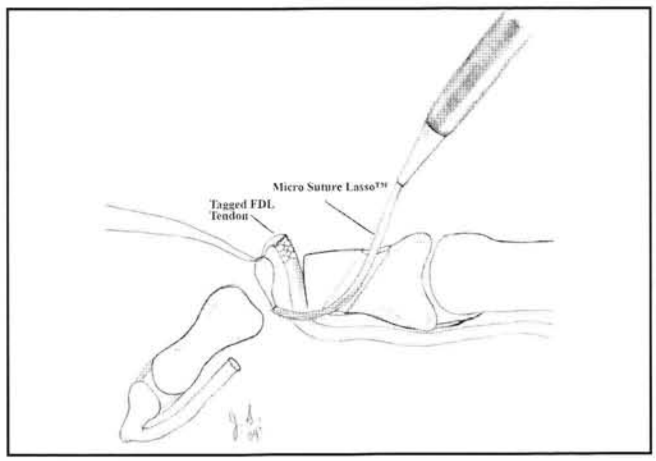


Figure 10. Diagram demonstrating the looping of the tagged flexor tendon with the Arthrex Micro Suture Lasso™.
Diagram courtesy of Paul Shurnas, MD.

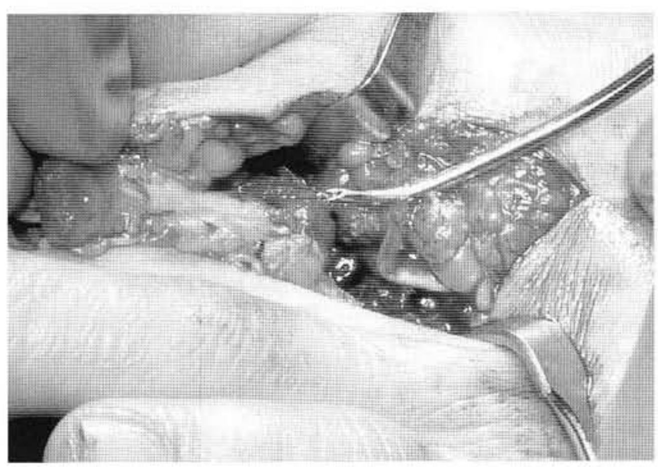


Figure 11. Arthrex Micro Suture Lasso™ introduced into drill hole.

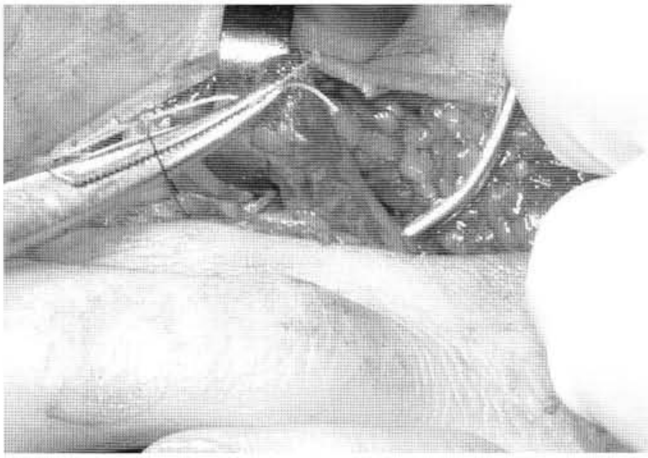


Figure 12. Microsuture Lasso used to retrieve the tagged tendon.

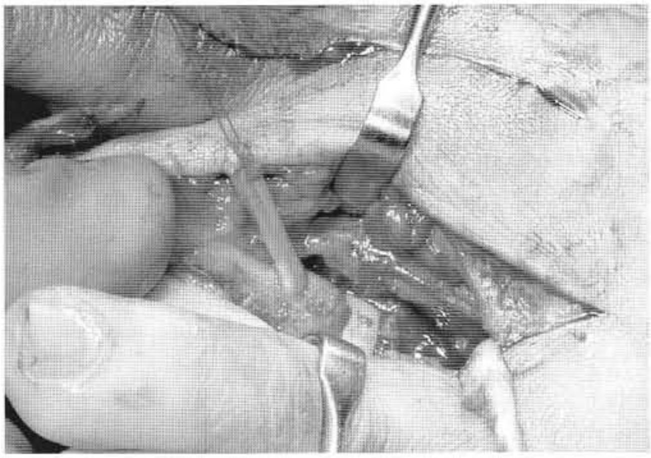


Figure 13. Tendon then gently pulled dorsally through hole.

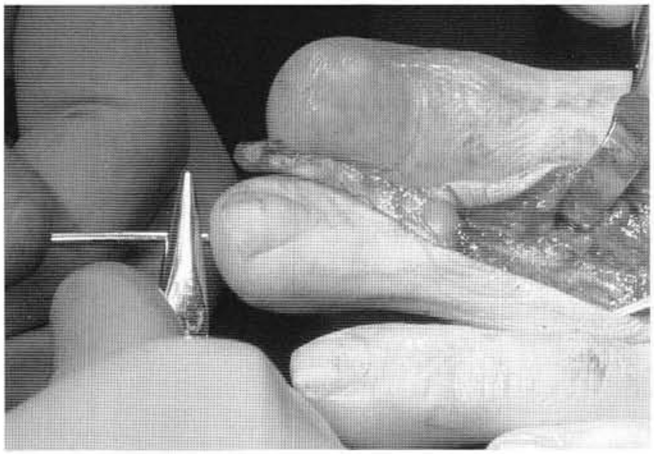


Figure 14. Final K-Wire fixation of PIPJ Arthodesis.

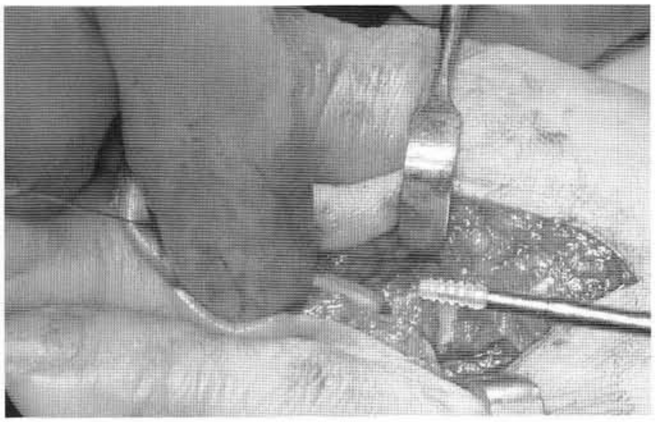


Figure 15. 3.0mm Biotenodesis screw insertion.

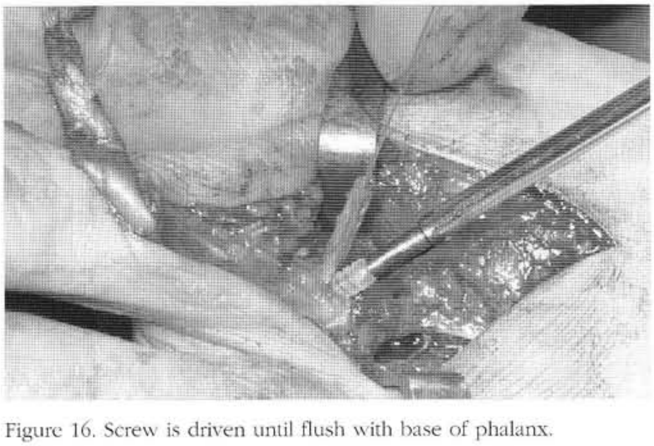


Figure 16. Screw is driven until flush with base of phalanx.

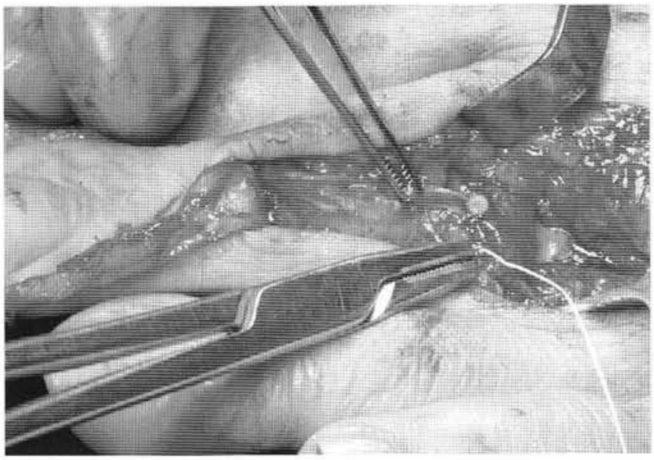


Figure 17. Remaining portion of flexor tendon is sutured to periosteum or used to reinforce lateral MTPJ capsule.

Closure

Closure should proceed anatomically in layers. The extensor tendon should be reapproximated with 3-0 absorbable suture and the subcutaneous tissues and skin according to surgeon preference. It is the author's preference to use 5-0 absorbable suture in a running fashion for both layers followed by the application of 1/4" steri-strips. A moist to dry gauze and cling dressing is then applied to provide adequate splinting. Postoperatively, the patient will be placed into a short-leg fracture walker with crutch assistance.

SUMMARY

This technique is simply a modification of existing procedures and can be easily adapted to a surgeon's desired technique. The specific limitations of this technique center on the desire to fixate across the metatarsophalangeal joint. Certainly a pin can be driven through the absorbable screw, but this has not been necessary. It can be argued that if a digit cannot be relocated without fixation across the metatarsophalangeal joint, adequate release may not have been performed. Many surgeons have seen a digit drift back into malalignment after pin removal. This point will certainly require further study, but in those cases an alternate means of tendon fixation should be employed. The advantages of this technique are stable transosseous tendon fixation, controlled tension application and less reliance on suture for maintenance of tendon tension.

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