CASE STUDY

Use of Novel Fixation Solution to Address Flexible Hammertoe as a Replacement for Girdlestone-Taylor Procedure

Exclusively foot & ankle Paragon 28®

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FEATURED PRODUCTS: TenoTac® Soft Tissue Fixation System

Introduction

Treatment of hammertoe contractures vary based on a fixed vs. flexible deformity, and severity and location of contractures across the metotarsophalangeal joint (MTPJ), proximal interphalangeal joint (PIPJ), and distal interphalangeal joint (DIPJ). Further confounding the deformity can be rotational or transverse plane forces. Due to the numerous deformities that can occur within a relatively small space, surgeons employ an array of different procedures in the treatment of contracted toes.

The Girdlestone-Taylor (GT) flexor tendon transfer was first described in 1951 in the treatment of contracted toes.[1] The procedure can be utilized as a primary procedure in the reduction of a flexible hammertoe. The procedure has also gained popularity in severe contractures or in subluxated or dislocated toes in combination with other soft tissue balancing or osseous procedures. A traditional GT procedure involves release of the flexor digitorum longus (FDL) tendon from its insertion at the plantar base of the distal phalanx and transfer dorsally to the extensor complex (Figure 1). While this does preserve the flexor tendon function at the MTP joint, the IP joints can progress into extension deformities due to loss of the flexor pull.

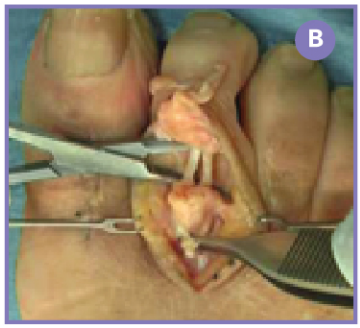
The standard dissection required for the GT tendon transfer is lengthy which may increase post operative healing time. Additionally, stiffness and swelling may result from the invasive nature of this procedure (Figures 2A-D). Revision of the technique is extremely difficult, as the distal insertion of the flexor tendons is sacrificed when they are released and re-inserted dorsally.

Figure 1: Flexor Tendon Transfer – Traditional method showing release of flexor tendons to correct toe position.

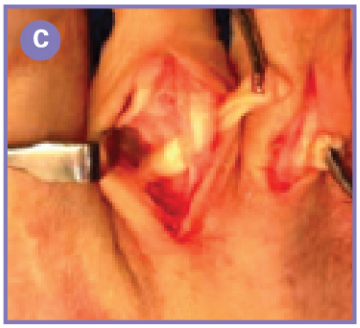
Girdlestone-Taylor

Figure 2 (A-D): Traditional approach and repair GT – Large incision and invasive approach to allow for exposure and repair

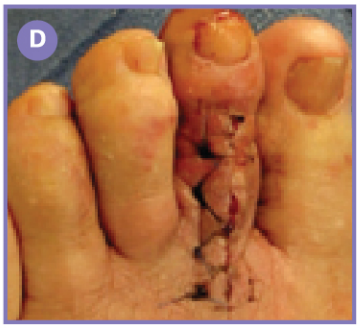
(A) Lengthy dorsal incision.



(B) Dorsal exposure, toe positioning, and tensioning.



(C) Dorsal exposure and routing of flexor tendons to achieve correction.



(D) Postoperative edema following tendon transfer.

TENOTAC® Soft Tissue Fixation System

The Paragon 28 TenoTac Soft Tissue Fixation System was developed to provide surgeons an alternative fixation option for flexible hammertoes, mallet toes or claw toes. Additionally, the TenoTac System was designed to supplement fixation of rigid hammertoes and plantar plate repair by providing stabilization of the MTPJ in the sagittal and transverse planes. The system allows the surgeon to select whether only the flexor digitorum brevis (FDB) tendon, FDL tendon or both are "tacked" down against the proximal phalanx, depending on deformity (Figures 3A, 3B). Medial and lateral tendon tensioning can be performed to correct transverse plane deformity prior to securing the implant.

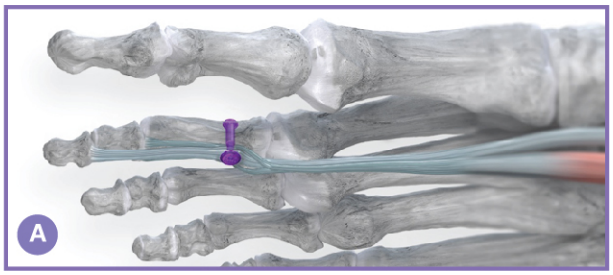


Figure 3: (**A**) Plantar oblique view of the TenoTac implant.

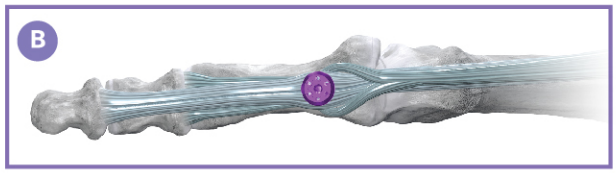


Figure 3: (**B**) Plantar view of the TenoTac implant showing capture of the FDB and FDL tendons.

The TenoTac Soft Tissue Fixation System is a surgical innovation which may be utilized as a replacement to a traditional Girdlestone-Taylor procedure. The TenoTac facilitates the creation of a new insertion at the plantar base of the proximal phalanx while maintaining the original insertion at the base of the distal phalanx (Figure 4). This helps to limit the evolution of extension deformities of the interphalangeal joints and allows the "tacked" flexor tendon to more effectively plantarflex the metatarsophalangeal joint. The advantages of this technique may include decreased dissection, decreased stiffness or post-operative edema, and reduced operating time, all while maintaining the distal tendon insertion (Figures 5A-F).

Figure 4: TenoTac – Distal insertion of the FDL and FDB is maintained allowing balance to remain between the extensors and flexors distal to the implant.

Indications for Use

The TenoTac Soft Tissue Fixation System is intended to be used for soft tissue to bone fixation. Specific indications for the TenoTac device include: medial/lateral repair and reconstruction of the foot and ankle, mid and forefoot repair, hallux valgus repair, metatarsal ligament/tendon repair or reconstruction, and Achilles tendon repair.

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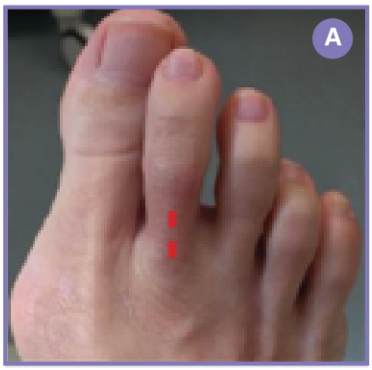
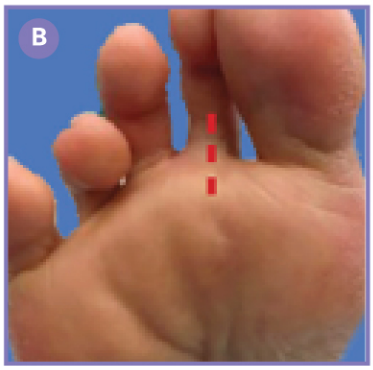
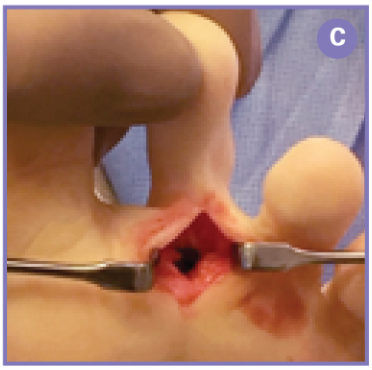
Figure 5 (A-F): TenoTac approach – Minimal incision, exposure, and scarring.



(A) Dorsal Incision – made to expose 4.5 mm implant sleeve and head.

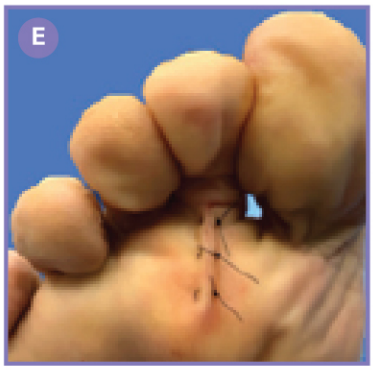


(B) Plantar Incision – made to expose 6.0 mm tack portion of implant.



(C) Fixation with TenoTac – FDB and FDL tacked against plantar proximal phalanx.

(D) Closure of dorsal incision.



(E) Closure of plantar incision.

(F) Healing of plantar incision – very limited scarring.

Presentation

A 76 year old female with a past medical history remarkable for hypertension and osteoarthritis presented for a second opinion for chronic right foot pain. She reported a history of worsening pain over the last three years especially with ambulation, in spite of activity modification, change to wider and more supportive shoes, and custom molded shoe inserts. She explained that her second toe was most painful, as she felt irritation while shod, but also pain to the second metatarsal head with or without shoes. Following recommendations from another surgeon, she sought a second opinion as she was told her toe was now dislocated and toe amputation was considered a viable option based on her age.

Clinical Examination

Physical examination revealed a normal neurovascular status. Generalized pain with palpation was reported to the forefoot with associated deformity. Contractures were noted at the second toe at the MTPJ, PIPJ, and DIPJ consistent with a claw toe deformity. Upon stance examination, a crossover second toe deformity was noted. Tenderness was noted to the plantar second metatarsal head with an excessive retrograde force secondary to the claw toe. Additionally, there was hallux valgus deformity of the great toe with decreased range of motion and sub-sesamoid pain with palpation. A clinical tailor's bunion with associated pain to the bunionette was also noted.

Radiographic Examination

Weightbearing radiographs displayed several areas of deformity to the right foot (Figure 6A-B). An increased hallux valgus angle was noted, with the first and third toes abutting each other. Moderate arthritic changes were associated at the first MTPJ, with joint space loss and mild joint spurring. The second toe was significantly contracted at all joint levels and severe dorsal subluxation existed at the MTPJ. There was an enlargement of the fifth metatarsal head and associated tailor's bunion.

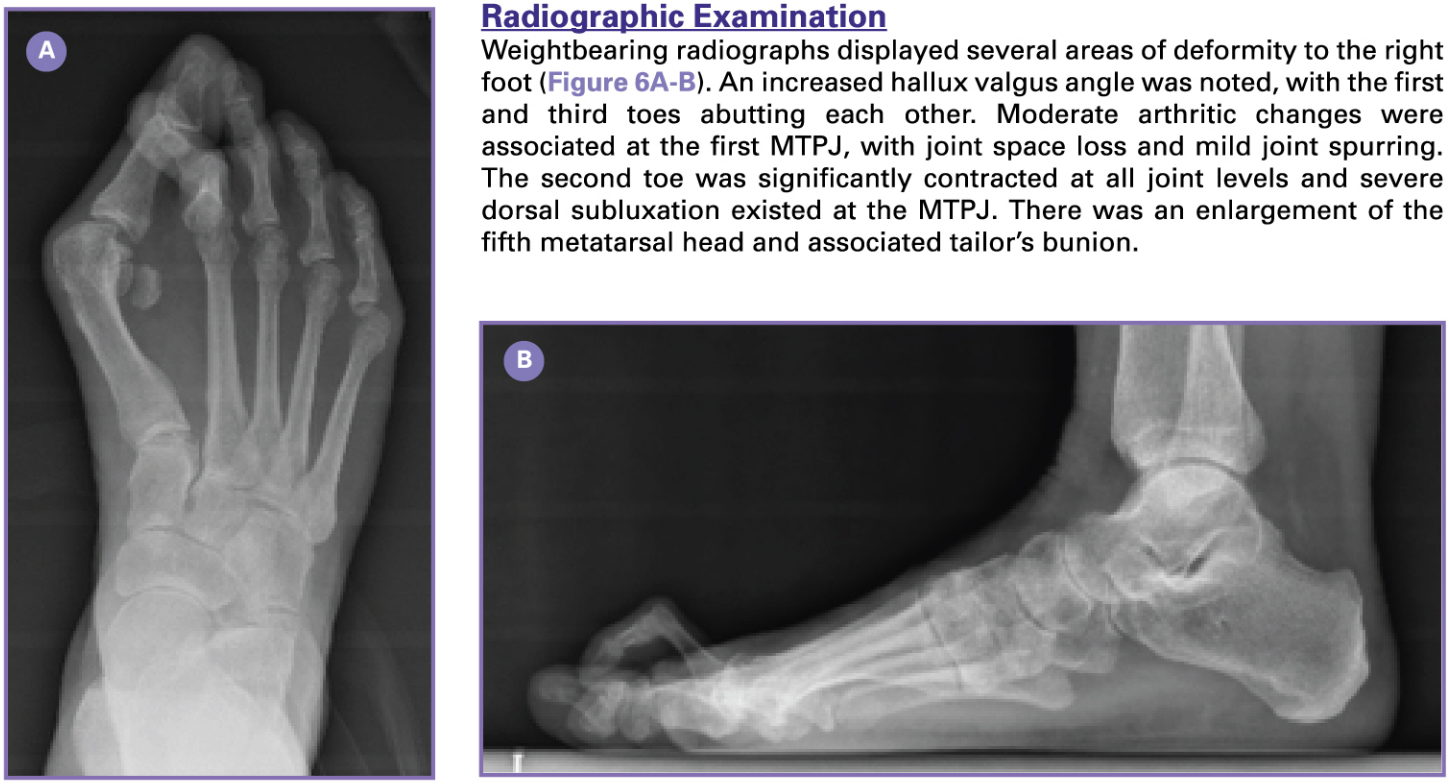


Figure 6: Preoperative radiographs showing arthritic changes at the first metatarsophalangeal joint and contracture and crossover of the second toe: **(A)** Anteroposterior and **(B)** Lateral.

Initial Management and Decision Making

After reviewing all non-surgical treatments that were attempted and failed, surgical decision making was discussed with the patient in detail. As the initial surgeon recommended toe amputation based on her deformity and age, surgical intervention with toe salvage and realignment was thoroughly explained. Based on the numerous contractures across the second ray, a multi-procedural option was deemed most beneficial as this would address both the joint and bony adaptations across the second MTPJ while re-balancing the soft tissues contributing to contractures at the toe level.

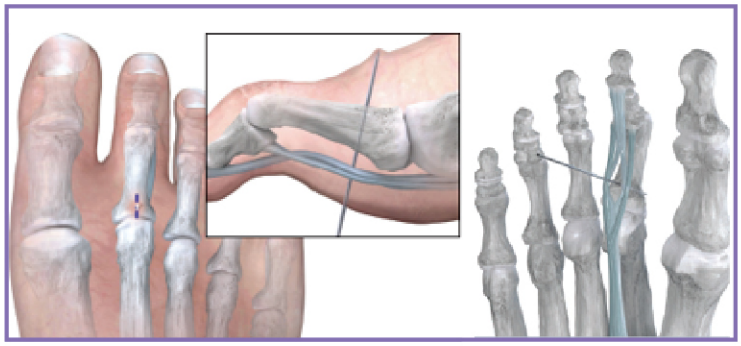
To decrease the dissection needed, soft tissue handling, and exposure which may compromise the neurovascular structures to the digit, the TenoTac Soft Tissue Fixation System was chosen to address the deformity.

As the great toe joint was arthritic and hindering adequate reduction of the second toe, arthrodesis of the first MTPJ was necessary. A remodeling of the fifth metatarsal head was also discussed based on the clinically painful bump at the tailor's bunion.

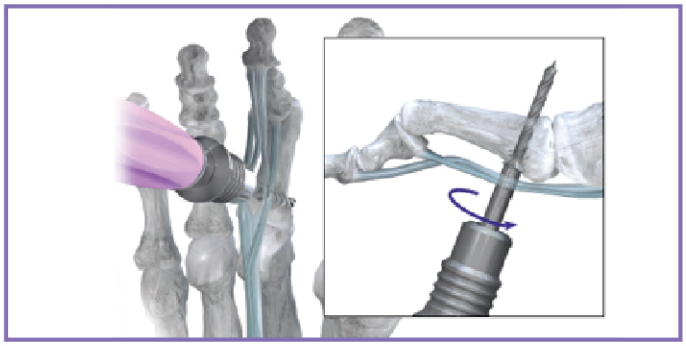
Surgical Technique

A first MTPJ arthrodesis was performed first to create space for the reduced second toe. A metatarsal head osteotomy, PIPJ fusion, and TenoTac were performed on the second ray to address the multi level contractures.

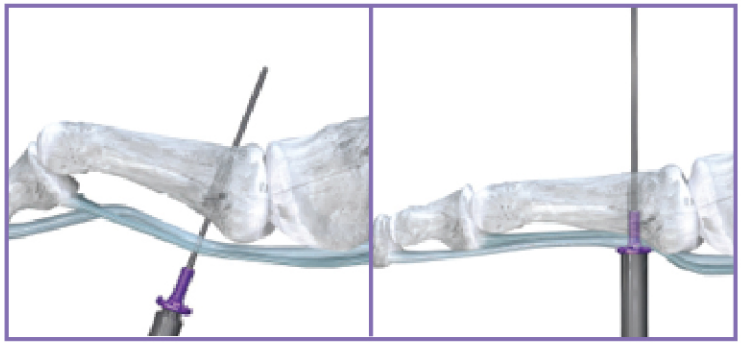
TenoTac Instructions



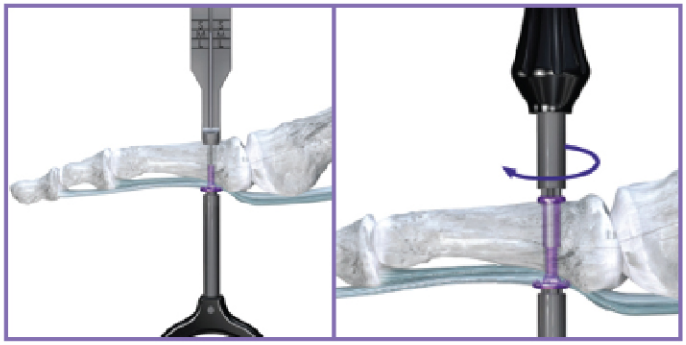
Step 1: Guide Wire Placement



Step 2: Drill/Countersink



Step 3: Male Tack Insertion



Step 4: Female Sleeve Insertion

A dorsal incision is first created directly overlying the second metatarsal phalangeal joint. Care is taken to identify the extensor tendon and retract laterally. Sub-periosteal dissection is performed at the base of the proximal phalanx. Under interoperative fluoroscopy, a guide pin in placed centrally at the base of the phalanx, while distal enough from the joint surface to avoid any intra-articular damage. Lateral fluoroscopy is used to verify the guide pin is perpendicular to the long axis of the bone. Once satisfactory position has been established, the guide pin can be delivered plantarly to aid the surgeon in proper incision placement (Figure 7A).

Once the exit pin site is marked to the plantar foot, the pin is partially withdrawn and maintained just within the proximal phalanx (Figure 7B). Plantar dissection is performed, where the surgeon will spread the soft tissues down to the tendon sheath. Once the flexor tendon sheath is encountered, controlled dissection is performed to expose the FDL and FDB tendons.

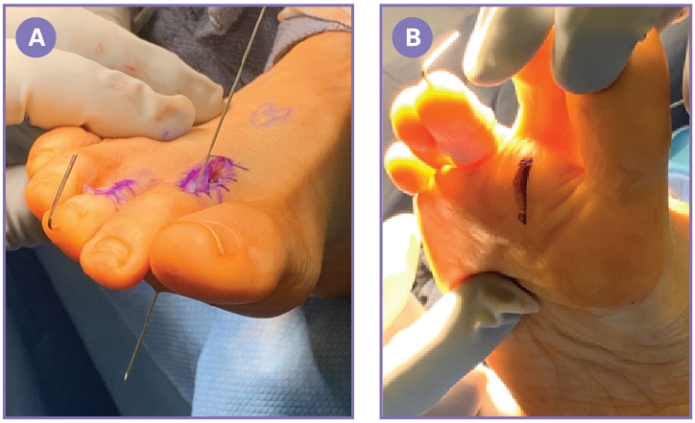


Figure 7: Intraoperative examples showing positioning of the guide wire from dorsal to plantar (**A**) and marking for the plantar dissection distal to the weight bearing surface (**B**).

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While protecting the exposed tendons, the guide pin can again be advanced plantarly. A cannulated drill is inserted by hand from plantar to dorsal and care is taken to clear out any debris from the bone tunnel that has been created. The drill has a countersink allowing the surgeon to create space for the implant at the plantar ridge of the proximal phalanx.

Based on the surgeon's preference and deformity presented, the tendon slips are placed adjacent to the bone tunnel and the toe is maintained in the desired position for the remainder of the procedure. The guide pin is then removed from the drill hole as the Tack Inserter and implant are seated (Figure 8). Following placement of the Plantar Tack, a depth gauge is used to measure for the Dorsal Sleeve. The properly sized Dorsal Sleeve is then delivered from the dorsal aspect of the bone tunnel and once contact is made with the Plantar Tack, the Dorsal Sleeve is manually screwed to two-finger tightness. The surgeon can verify proper reduction of the toe in the simulated position.

The surgeon has the ability to change the toe position by loosening the Dorsal Sleeve, repositioning the flexors under the Plantar Tack and re-tightening as necessary.

Figure 8: Intraoperative example showing insertion of the Plantar Tack on the Tack Inserter compressing the flexor tendons against the bone.

Postoperative Protocol

The patient was seen two weeks postoperatively. An incision check was performed and all sutures were removed. The patient was permitted partial weightbearing in a fracture boot for an additional four weeks. At six weeks postoperative, x-rays were obtained revealing improved healing (Figure 9). The patient was able to be transitioned back to a supportive shoe.

Figure 9: Weightbearing radiographs obtained six weeks postoperative showing alignment of the 2nd interphalangeal joint: **(A)** Anteroposterior and **(B)** Lateral.

A final examination (Figure 10) was performed at three months where the patient was asymptomatic with greatly improved toe position and function. The patient was allowed to resume all pre-surgery activities without restrictions.

Figures 10: Three month postoperative images showing alignment of toe position: **(A)** Anteroposterior and **(B)** Lateral.

References

[1] Taylor RG. The treatment of claw toes by multiple transfers of flexor into extensor tendons. J Bone Joint Surg [Br] 1951;33-B:539-542.

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