The Percutaneous Flexor Tenotomy

The author outlines an MIS approach to healing neuropathic diabetic toe ulcers.

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Introduction

A toe ulcer can become a devastating complication for a diabetic patient (Figure 1). The minimally invasive percutaneous flexor tenotomy procedure is a safe and effective technique for healing diabetic toe ulcers caused by flexible hammertoe deformities.[1,3,7,8,16-22] The purpose of this article is to present the effectiveness of the percutaneous flexor tenotomy as reported in the literature. There is increasing evidence that surgical correction of foot deformities triggering neuropathic ulcers is the most effective way to heal and prevent re-occurrence of diabetic foot ulcers (DFU). Surgical intervention is particularly suitable for neuropathic digital apices ulcers.[1-3]

Figure 1: A neuropathic diabetic apices toe ulcer with osteomyelitis.

The author describes the version of the technique as he uses it and summarizes his results with the technique in the conclusion.

The Devastation of Diabetic Toe Ulcers

Eighty five percent of diabetic amputations begin with a foot ulcer.[4] Moreover, prevention and cure of foot ulcers would prevent most amputations in diabetics.[4] Foot surgeons are aware of the dismal five-year mortality rate seen following a non-traumatic lower extremity amputation. Often overlooked is the significance of digital amputations. Of all the ulcerations that lead to amputation, the five-year mortality rate is the highest for toe amputation. The five-year mortality rate for a patient who has a digital amputation is 26.2%. In comparison, a ray resection has a five-year mortality rate of 15.8%, with mid-foot ulcers being 21%. Only below-knee amputation with a mortality rate of 36% is higher than digital amputation.[5] Cure and prevention of diabetic toe ulcers is unquestionably an important goal for the foot surgeon.

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Neuropathic Etiology of Toe Ulcers

Neuropathic manifestations are virtually guaranteed in our diabetic population and this leads to tendon imbalances in the lower extremity. Over 90% of diabetic patients have equinus, and as a result are unable to dorsiflex the ankle 10 degrees with the knee extended.[6] This biomechanical deformity leads to excessive forefoot pressure and triggers significant biomechanical alterations instigating digital and plantar forefoot ulcers. Often extensive hospitalization and loss of limb overshadow the outwardly benign underlying biomechanical deformity that initiates the situation in the first place. The percutaneous MIS flexor tenotomy can be utilized for hallux and lesser digit ulcers in the presence of flexible toe deformities and can be performed safely under local anesthetic in the office setting.[20] Publications have given credence to the percutaneous flexor tenotomy when dealing with diabetic neuropathic toe ulcers. The learning curve for the procedure is small and the complication rates are minimal.

Research Backup

The first research paper published on the results of flexor tenotomies for neuropathic toe ulcers was written by Monroe LaBorde, who is a professor in the Academy of Ambulatory Foot

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and Ankle Surgery.[1] The research scrutinized neuropathic toe ulcers treated with percutaneous flexor tenotomy. In every case, the ulcers initially healed. The average follow-up was 36 months with no patients lost during the research. With the lesser toes, 11 ulcers were followed with no re-occurrences. There were 13 hallux ulcers followed with three re-occurrences. Two of the re-occurrences in the hallux ulcers underwent a repeat flexor tenotomy that resulted in complete healing. Only one unhealed hallux ulcer was reported, and no post-operative infections occurred.[1]

Figure 2: Diabetic foot ulcer present for over one year despite off-loading conservative care.

Figure 3: The same patient depicted in Figure 2 eight weeks after percutaneous ATL performed under local anesthesia.

In 2016, authors Jennifer E. Scott, Gordon J. Hendry, and John Locke published *Effectiveness of Percutaneous Flexor Tenotomies for the Management and Prevention of Recurrence of Diabetic Toe Ulcers: A Systematic Review,* a research review of the percutaneous flexor tenotomy for the treatment of neuropathic diabetic toe ulcers, published in the *Journal of Foot and Ankle Research* 2016, 9:25. From a total search yield of 42 articles, five eligible studies were identified for inclusion in their review. A total of 250 flexor tenotomy procedures were performed in 163 patients. The studies reported good healing rates of 92–100% within two months, relatively few recurrences, and low incidences of infection.[8]

Why Do Surgery for Digital DFU?

The toes are at risk for ulceration, with studies showing digits 1–5 accounting for 43 to 55.5% of all foot ulcers.[9-11] Digital ulcers tend to be smaller and heal faster than forefoot, mid-foot, or heel ulcers.[4] Ironically, they serve as an important prognostic indicator given that they precede up to 63.9 % of all diabetic limb amputations.[11] Cure and prevention of toe ulceration is crucial to avoid poor long-term outcomes.[10]

An insensate foot with deformed toes is subject to increased pressures and shear stresses which ultimately lead to ulcerations.[12] Ideally, the best way to treat ulcers is to correct

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Figure 4: Positioning of dominant and non-dominant hand during percutaneous flexor tenotomy. During the initial incision, the 316 blade is placed parallel to the flexors.

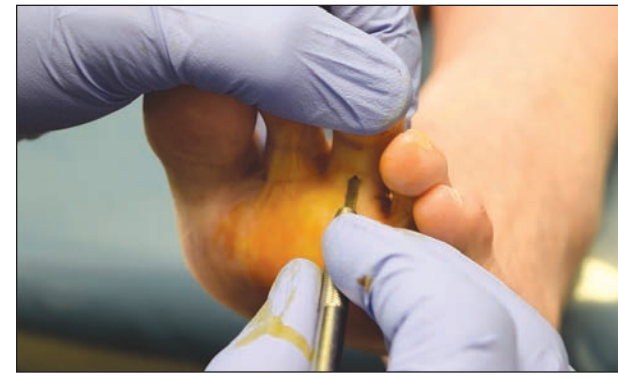

Figure 5: The 316 Blade is rotated perpendicular to the long flexor prior to transection of flexor tendons.

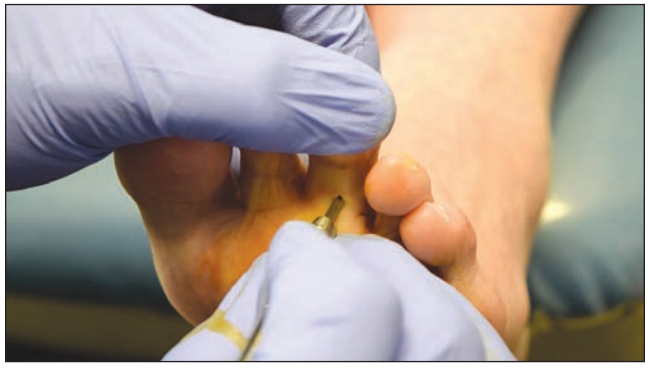

Figure 6: A sweeping motion of a 316 Blade utilized to transect flexors without bone contact.

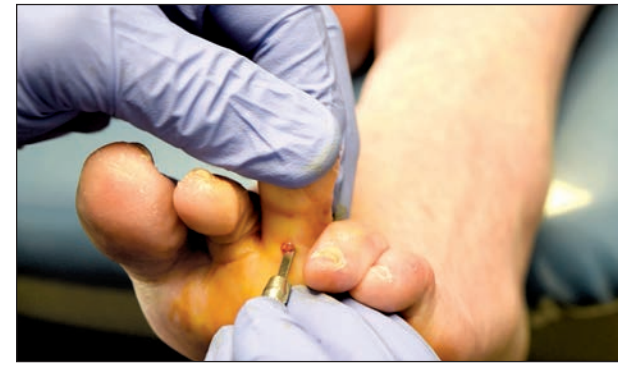

Figure 7: Hyperextending the flexors during transection to assure total release.

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biomechanical deformities before an ulceration begins.[2] The off-loading of pressure from an ulcer site is an important goal in healing and preventing ulcers from recurring.[7] The conventional approach to pressure off-loading has been conservative, through debridement of superficial skin lesions, debridement of ulcers, padding, insoles, therapeutic footwear, and the gold standard—total contact casting.[12-15,23,24]

Robust evidence of the long-term efficacy of these interventions is confounded by poor patient adherence and the fact that the underlying biomechanical defect is not addressed. In fact, patient compliance to wearing removable off-loading devices such as pressure-relieving footwear has been reported as problematic.[14]

Ideally, the best way to treat ulcers is to correct biomechanical deformities before an ulceration begins.

Surgery corrects the underlying deformity and relies less on continued patient compliance.[15] Furthermore, even non-removable total contact casting yields less than ideal long-term results.[24] Total contact casting is currently the leading modality in the care of forefoot Wagner 1 and 2 ulcers despite poor long-term outcomes. Studies comparing the long-term healing rates of forefoot ulcers following total contact casting versus gastrocnemius recession or percutaneous ATL lengthening unanimously report superior outcomes in the surgical group.[24]

A study by Frigg, et al. in *Foot Ankle International* found the re-occurrence of ulcers after total contact casting to be 57%. In this study, some of the patients also had surgical intervention after initial healing with TCC. This would suggest that re-occurrence with TCC was higher than 57%.[24] A better comparative study reported an 80% re-occurrence rate

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Figure 8: The digit assumes a more rectus position once the flexor tendons are transected.

Figure 9: Incision placement is one cm. from the 1st MPJ with hallux FHL tenotomy.

Figure 10: Brevis tendons are preserved with the 1cm. placement of incision.

Figure 11: A sterile band-aid is applied to the plantar proximal sulcus aspect along the incision area.

Figure 12: The digit is splinted into rectus position with band-aid.

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Figure 13: 3rd toe ulcer in diabetic patient present for six weeks.

Figure 14: Two-week post-op percutaneous flexor tenotomy on patient represented in Figure 13.

Figure 15: DFU at plantar medial hallux area present for three months.

Figure 16: Three-year post-operative FHL tenotomy of FHL in patient depicted in Figure 15.

with TCC alone.[25] It was suggested by the authors in these studies that foot deformities should be operatively corrected immediately after primary healing with TCC rather than waiting until there are further recurrences. In conclusion, correcting the foot deformity has better outcomes than conservative off-loading (Figures 2 and 3).[24]

Performing the Percutaneous Flexor Tenotomy

Percutaneous flexor tenotomy is employed to correct a flexible deformity when an apices or distal plantar toe ulcer is present. The author recommends treating soft tissue infection with appropriate antibiotics before performing a flexor tenotomy unless immediate surgical treatment is warranted. The presence of osteomyelitis is not a contra-indication for the procedure.[15,16] The patient must have adequate circulatory status to heal both the ulcer and the surgical trauma. The technique is contraindicated in ischemic ulcers. Fortunately, most diabetic foot ulcers are non-ischemic.[4]

Percutaneous flexor tenotomy is employed to correct a flexible deformity when an apices or distal plantar toe ulcer is present.

Figure 17: Hallux Ulcer present one year despite extensive conservative treatment.

Figure 18: 18 months post FHL tenotomy in patient depicted in Figure 17.

The author usually performs the procedure in the clinical setting under local anesthetic. The patient assists in the procedure by plantarflexing the toes. Therefore, the technique is best performed without sedation. A digital block consisting of 1.5- 2 cc of lidocaine 1% plain is used, except in patients who are completely insensate. The patient may be seated, reclined, or in the supine position. No tourniquet is required. Sterile technique is followed in the usual sterile manner.

The author grasps the affected digit by the non-dominant hand with the index finger on the dorsum of the proximal interphalangeal joint and the

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thumb on the plantar distal aspect of the digit. The digit is extended to help place the flexors under tension (Figure 4). The patient is asked to curl the toes and the long flexor is palpated with the dominant index finger. A 316 blade is inserted through the skin vertically and parallel to the long flexor at the level of the toe sulcus until reaching the long flexor tendon. Once the 316 blade is through the skin, the blade is rotated perpendicular (Figure 5) to the long flexor, and a sweeping motion is engaged while deepening the blade to transect the long and short flexors (Figure 6). Performing the procedure at this level will ensure transection of both the long and short flexors. It is not usually necessary to come in full contact with the bone.

Preserving hallux toe purchase is important to prevent transfer lesions to the 2nd toe and 2nd metatarsal head, and is the main reason for sparing the brevis tendons.

The author hyperextends the toe to complete the resection of the flexors (Figure 7). The patient is asked to curl the toes again to actively plantarflex the digit to help determine if the tenotomy is complete. The practitioner brings the blade vertical again for removal from the percutaneous stab incision site.

The procedure can be performed again in the same manner if there is suspicion that transection of the tendons has not occurred. The digit will assume a more rectus position once the tendons are transected (Figure 8).

Special Considerations for the Hallux

The author performs the procedure for hallux ulcers in the identical fashion as described above for the lesser toes, with the exception that the incision placement is made approximately one cm. from the first metatarsophalangeal joint. By placing the incision in this location, the brevis tendons are preserved (Figure 9). Preserving hallux toe purchase is important to prevent transfer lesions to the 2nd toe and 2nd metatarsal head, and is the main reason for sparing the brevis tendons.

Only the FHL is transected in pa-

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tients with hallux ulcers (Figure 10). Sacrificing the brevis tendons may lead to over-extension and subsequent dorsal footgear pressure when the patient resumes normal shoe wear. The author has witnessed the development of dorsal apices hallux ulcers caused by overzealous resection of the brevis. If it is determined that inadequate dorsiflexion is realized by FHL tenotomy alone, the author augments the procedure by performing a distal plantar fascial release instead of transecting the brevis tendons (Figure 20).

Figure 19: Hallux Ulcer 21 days post FHL tenotomy despite concurring of osteomyelitis

Post-Op Care

A sterile Band-aid is applied to the plantar proximal sulcus aspect of the digit along the incision site and the toe is splinted into rectus position (Figures 11 and 12). A stockinet is applied and the patient is asked to keep the area dry for three days. The patient can wear a tennis or diabetic shoe immediately after surgery. After three days, the band aid is removed and the patient is instructed to wash the foot as normal.

Case Inclusions: All Patients have Neuropathic Diabetic Foot Ulcers

Case 1: Apex Ulcer of 3rd Toe, Left Foot

This patient is a 68-year-old female with well-controlled type II diabetic and palpable pedal pulses. Previous treatments included oral antibiotics and a crest pad with surgical shoe. The patient lives in an assisted living environment and has a history of schizophrenia. The patient did not wear the crest pad or surgical shoe. A percutaneous flexor tenotomy was performed under local anesthetic in the office setting at the follow-up visit. The ulcer healed in 14 days and has remained healed for eight months (Figures 13 and 14).

Case 2: Chronic Diabetic Plantar Medial Hallux Ulcer (Six Months Duration)

The patient is a 72-year-old male with moderately controlled type II diabetes. Previous treatments included self-treatment with pocket knife trimming and salt water foot soaks. The patient presented to the office after self-trimming the area and developing an infection. Initial treatment included stabilizing the infection with oral antibiotics and dispensing of a surgical shoe. The patient was compliant with the conservative care. Ten days later, a percutaneous FHL tenotomy was performed and the ulcer healed in two weeks. The patient has remained ulcer-free for three years and maintains appropriate routine foot care appointments. He has made significant lifestyle changes and is achieving better control over his diabetes (Figures 15 and 16).

Case 3: Chronic Stage 3 Hallux Ulcer in a Type II Diabetic with Previous CVA and Drop Foot

This is a 60-year-old male type II diabetic who had a stroke one year before presentation. The stroke resulted in drop foot and spastic contractures. The ulcer had been present for six months. Multiple treatments by other providers had been tried without success. An AFO brace had been fabricated for the drop foot and it exacerbated the ulcer. An FHL tenotomy was performed and the ulcer healed in 21 days. The ulcer has remained healed for 18 months (Figures 17 and 18).

Case 4: Hallux Ulcer with Osteomyelitis in a Type I Diabetic

This patient is a 71-year-old female with well-controlled type I diabetes with a chronic hallux ulceration. She was treated for one year by another provider. She had palpable DP pulses and non-palpable PT pulses. A vascular work-up was performed including toe pressures and ABI.

She stated that initial treatments by the first provider had healed the ulcer but the ulcer kept returning. She was diagnosed with osteomyelitis and an amputation was recommended. The patient sought a second opinion from the author, who scheduled her for a flexor tenotomy. The ulcer healed in 21 days and has remained

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Figure 20: Distal plantar fascial release to increase dorsiflexion of hallux without sacrificing the brevis tendons.

Figure 21: The ulcer in Figure 20 (FHL tenotomy and distal plantar fascial release) at 2 weeks post-op.

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healed for one year despite underlying osteomyelitis. The bone infection was also treated with six weeks of IV antibiotics (Figures 1 and 19).

Case 5: Hallux Ulcer Requiring FHL Tenotomy and Distal Plantar Fascial Release

This patient is a 62-year-old type I diabetic who presented with a semi-flexible hallux hammertoe. The ulcer had been present for two years and the patient was treated by multiple caregivers prior to presentation. The patient underwent an FHL tenotomy and a distal plantar fascial release. The ulcer healed in three weeks and has remained healed for three years (Figures 20 and 21).

Conclusion

The percutaneous flexor tenotomy is a simple and effective procedure with minimal risk. Most often, it leads to permanent wound healing even with the presence of osteomyelitis. It can be performed safely in the clinical setting and patients can ambulate in normal footgear. The procedure is economically superior to most other treatment modalities for diabetic foot ulcers.

The author is currently following 35 diabetic toe ulcer patients treated with flexor tenotomy with a minimal three-year follow-up. So far, all lesser toe ulcers have healed. The author has seen two re-occurrences in the hallux ulcer group. In addition, one hallux ulcer required partial hallux amputation after developing a dorsal ulcer.

After review of the literature and the author's personal experience, he confidently recommends the flexor tenotomy for diabetic ulcers on the apices of the hallux and lesser toes as an effective way to achieve toe ulcer healing and prevent recurrence. It is a simple and highly capable technique that can literally save a life. **PM**

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