

Outcomes of Flexor Hallucis Longus Percutaneous Tenotomy for Great Toe Tip Callosity and Ulcers in Patients with Diabetes Mellitus: Cohort Study

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ABSTRACT

Aims and background: Great toe ulcers are the most common index lesion in persons with diabetic foot syndrome in 43–55.5% of patients. The most typical foot deformity in persons with diabetic peripheral neuropathy is claw toe deformity. The present study is a retrospective analysis of percutaneous flexor hallucis longus (FHL) tenotomies done on patients with diabetes, hallux claw deformities with ulcers of the hallux tip and their outcomes.

Methods: A retrospective study was done to identify patients who underwent percutaneous FHL tenotomy between May 2016 and January 2022.

Results: A total of 38 diabetic patients had percutaneous tenotomy of FHL. A total of 18 patients had grade 0, 12 patients had grade I, and eight patients had grade II ulcers, according to Wagner's grading. The mean time to heal for callosities and ulcers was 37 and 45 days, respectively, post tenotomy. Four patients had a recurrence of toe tip ulcer in a mean of 14 months. One patient had developed a transfer ulcer at the interphalangeal (IP) joint region. None of the patients had difficulty in gait or doing routine day-to-day activities and wearing footwear due to the loss of FHL action.

Conclusion: Percutaneous tenotomy of the FHL tendon resulted in the healing of great toe tip ulcers in 94.8% of patients at a mean follow-up of 24 months.

Clinical significance: Neglected great toe tip ulcers lead to gangrene and amputation of the affected toe. Timely treatment of these ulcers can prevent needless amputations.

Keywords: Callosity, Diabetic foot, Flexor hallucis longus, Great toe, Hallux, Percutaneous, Tenotomy, Ulcer.

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AIMS AND BACKGROUND

Great toe ulcers are the most common index lesion in persons with diabetic foot syndrome in 43–55.5% of patients.¹ Neuropathic ulcers of the great toe can present as either a plantar interphalangeal (IP) joint ulcer or an ulcer of the hallux tip. In our study, we concentrated on the treatment of neuropathic hallux tip ulcers. Neglected toe tip ulcers act as a portal of entry of infection and may eventually lead to gangrene and amputation of the affected toe. Timely treatment of these ulcers can prevent needless amputations.

Currently, conservative therapy, which includes vigorous external offloading, wound care, and infection control, is used to treat neuropathic hallux tip ulcerations in persons with diabetes mellitus. Even then, these ulcers have the potential to persist, develop an infection, and necessitate a toe amputation. It is commonly known that individuals with diabetic peripheral neuropathy have anatomical alterations in their feet, including claw, mallet, and hammer toe deformities.² The most typical foot deformity in persons with diabetic peripheral neuropathy is claw toe deformity.^{3,4} The toes are the most commonly affected by ulcers in diabetic patients, and a claw toe, which affects 3% of diabetic patients, is the most common deformity in persons with diabetic neuropathy.^{5–7} Motor neuropathy, which affects the intrinsic foot muscles, is blamed for this deformity. In the foot, the intrinsic muscles to the great toe, the flexor hallucis brevis, the adductor hallucis, the abductor hallucis, and the extensor hallucis brevis help to maintain its orientation. The lesser toes are stabilized by the flexor digitorum brevis, and the four Lumbricals in the second

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layer of the sole and two groups of interossei muscles in the deepest layer help maintain them in the neutral position. The three plantar interossei adduct the lateral three toes, while the four dorsal interossei abduct the toes. During stance, these muscles normally flex the metatarsophalangeal (MTP) joints and keep the IP joints extended. The lateral three lumbricals are supplied by the lateral plantar nerve and the medial lumbrical by the medial plantar nerve. Diabetic neuropathy affects the nerve supply to these muscles and weakens or paralyzes them. This causes the loss of stability in the toes as the intrinsic muscles are no longer able to counteract the action of the extrinsic muscles inserted into the tips of the toes and the ground reaction forces during walking. The unbalanced toe retroflexes proximally and collapses with flexion at the IP joints

only (hammer/mallet toe) or associated dorsiflexion at the MTP joint (claw toe), which is further worsened by the ground reaction force pushing the proximal phalanx further into dorsiflexion during terminal stance.⁸ The pull of the long extensors in the clawed toe gets transmitted into a downward force on the metatarsal head through the proximal phalanx and worsens the claw deformity and, secondarily, the plantar metatarsal prominence. The shortened long flexor acts like a draw rein and limits MTP dorsiflexion, causing the tip of the toe to dig into the ground during the terminal stance.

Consequently, the insensate and deformed toes experience elevated axial pressures and shear loads during walking, particularly the terminal stance phase. The resultant “toe tip to floor” contact causes the development of calluses and eventual ulceration at the tips of these toes. Offloading pressure from ulcer sites is a crucial therapy objective to foster healing and avoid the recurrence of the ulcer. The traditional method of pressure unloading has been conservative, including removing calluses and corns, deflective padding, insoles, and/or therapeutic footwear. However, there is a scarcity of reliable data supporting the effectiveness of such therapies, and what is available is complicated by low patient compliance. The International Working Group on the Diabetic Foot (IWGDF) guidelines also warn against and actively discourage the prescription of therapeutic footwear for forefoot ulcers.⁹ Patients with diabetes and peripheral neuropathy may lower their risk of recurrent foot ulcers by undergoing specific surgical procedures. Surgery using less invasive techniques may result in faster recovery and less infection. The flexor tenotomy treatment, which may be carried out on both the hallux and lesser toes, is recommended for flexible toe abnormalities. The 2023 IWGDF guideline document suggests that in a high-risk patient with diabetes, hammertoes, and either a preulcerative lesion or an ulcer on the toe, digital flexor tenotomy should be taken into consideration to prevent or heal a toe tip ulcer⁹ when conservative therapy fails. The present study is a retrospective analysis of percutaneous flexor hallucis longus (FHL) tenotomies done on patients with diabetes, hallux claw deformities with ulcers of the hallux tip and their outcomes.

METHODS

A retrospective study was done to identify patients who underwent percutaneous FHL tenotomy between May 2016 and January 2022 at our institute. The age, gender, duration since diagnosis of diabetes mellitus, hemoglobin A1C (HbA1C), presence of peripheral neuropathy, peripheral arterial disease, nature of deformity and lesion at the tip of great toe, Meggitt Wagner grading of ulcer, duration of preulcerative lesions, ulcer, complications during the immediate and late postoperative period, time taken to healing, recurrence and time to recurrence if any, preoperative and postoperative scoring at 6 months follow-up were collected and analyzed. For lack of a better alternative functional scoring system in diabetic patients, we used the American Orthopaedic Foot & Ankle Society (AOFAS) hallux MTP-IP score to score the pre- and postoperative functional status of the hallux.

PROCEDURE

Percutaneous FHL tenotomies were done under local anesthesia. The patient was voluntarily asked to flex the great toe at the IP joint, and the surgeon using the nondominant hand, gave opposing force trying to dorsiflex the toe. This makes the FHL tendon taut. Using a 16 or 18-gauge needle, a stab is made at the proximal flexor

crease of the great toe with the bevel of the needle held at right angles to the underlying tendon. The resistance of the tendon is felt. The beveled sharp edge of the needle is moved carefully in a swiveling side-to-side manner to cut the tendon (Fig. 1). The snap of the tendon or the giveaway feel of the resistance denotes the endpoint of tenotomy. The patient is asked to flex the IP joint of the great toe; the inability to do so indicates the completion of the tenotomy. However, if the patient still flexes the IP joint of the great toe, any residual band of the tendon is divided by gently repeating the swivel maneuver till the division of the tendon is complete. The ulcer and the tenotomy stab sites are dressed with topical antiseptic ointment. The patient is advised to take rest for 24 hours. After that, they can resume their activities with protective footwear and may shower and change their dressings daily. The patient is reviewed weekly till the index lesion heals and thereafter monthly for the first 6 months and then every 3 months till 1 year.

RESULTS

During the study period, out of 422 diabetic foot patients we encountered with hallux problems, 109 patients had hallux ulcers at presentation. A total of 74 patients had great toe tip ulcers. A total of 38 diabetic patients had percutaneous tenotomy of FHL during the period between May 2016 and January 2022. Seven patients had undergone open flexor tenotomy as there was suspicion of osteomyelitis. A total of 29 great toe amputations were done secondary to infections from toe tip ulcers. So, all patients who had great toe tip ulcers and did not suffer amputation had either open or closed FHL tenotomy. The details of the population are given in Table 1. All patients who underwent tenotomy had flexible clawing. A total of 20 patients had ulcers, and 18 patients had toe tip callosity during presentation. The mean duration of the presence of callosities and ulcers was 5.5 and 4.3 months, respectively. A total of 18 patients had grade 0, 12 patients had grade I, and eight patients had grade II ulcers, according to Wagner's grading. The mean time to heal for callosities and ulcers was 37 and 45 days, respectively, post tenotomy (Figs 2 to 5). One patient had developed local cellulitis and was managed with oral antibiotics. Four patients had a recurrence of toe tip ulcer in a mean of 14 months. These patients had FHL function during follow-up, suggesting a possibility of incomplete tenotomy or bridging fibrosis between the tendon



Fig. 1: Intraoperative photograph showing the FHL tenotomy being done using a 16-gauge needle. The surgeon is using the nondominant hand to give opposing force, trying to dorsiflex

ends. Two patients underwent repeat completion percutaneous flexor tenotomy as the FHL was still functioning in them. Two patients were advised to complete flexor tenotomy but did not turn up for the procedure. During the follow-up recall of the patient, they had undergone delayed toe amputations due to infective complications in the recurrent ulcer. One patient had developed a transfer ulcer at the IP joint region and had undergone Keller gap arthroplasty for the same. The mean AOFAS hallux MTP-IP score

Table 1: Study population characteristics

Patients	38
Age range	41.5 years (33–73)
Gender	28:10 (M:F)
Diabetes duration	7.3 years (2–15)
HbA1C	7.9 (5.8–12.3)
Neuropathy	34 (89.5%)
PAD	6 (15.8%)
Ulcer	20
Callosity	18
Flexible clawing	38
Ulcer grade (Wagner)	Grades 0–18, 1–12, and 2–8
Callosity duration	5.5 months (1–16 months)
Ulcer duration	4.3 months (1–8 months)
Postoperative offloading	Soft sandals
Follow-up period	2 years (0.5–3.5 years)
Healing time	Callosity–37 days (10–60) Ulcer–45 days (15–75)
Recurrence	4 (10.5%)
Time to recurrence	14 months (5–24 months)
Infections	1
Complications	Toe amputation 2 (6, 18 months) IP joint callosity 1 (16 months)
AOFAS hallux MTP-IP score—preoperatively	52 (27–83)
AOFAS hallux MTP-IP score—preoperatively (6 months)	83 (62–90)

PAD, peripheral artery disease



Figs 3A and B: (A) Preprocedural image showing the great toe tip ulcer; (B) 1-month postprocedure picture showing complete healing of the great toe tip ulcer



Figs 4A and B: (A) Preprocedural image showing the great toe tip ulcer; (B) 1-month postprocedure picture showing complete healing of the great toe tip ulcer



Figs 2A and B: (A) Preprocedural image showing the great toe tip ulcer; (B) 1-month postprocedure picture showing complete healing of the great toe tip ulcer



Figs 5A and B: (A) Preprocedural image showing the great toe tip ulcer; (B) 1-month postprocedure picture showing complete healing of the great toe tip ulcer

Table 2: Population characteristics of a subgroup with great toe amputation following preexisting toe tip lesions

Patients	31
Age range	38 years (28–71)
Gender	21:10 (M:F)
Diabetes duration	5.3 years (1–10)
HbA1C	8.5 (6.9–14)
Neuropathy	29
PAD	4 (13.8%)
Ulcer	31
Ulcer grade	3–18; 4–13
Ulcer duration	5.7 months (1–12 months)
PAD, peripheral artery disease	

pre- and post tenotomy was 52 and 83, respectively. None of the patients had difficulty in gait, doing routine day-to-day activities, and wearing footwear due to the loss of FHL action. During the same study period, 31 patients had undergone great toe amputations secondary to ulcer complications. The details of the population are given in Table 2.

DISCUSSION

Flexor hallucis longus (FHL) tendon tenotomy has been described for treating toe tip ulcers induced by claw or mallet toe deformities. FHL tenotomy can be performed percutaneously or through an open method. Great toe tip ulcers with infection, suspected deep abscess, active osteomyelitis, and flexor tenosynovitis were treated with debridement and concomitant open tendon excision, and rest were treated with percutaneous flexor tenotomy. Tenotomy of the FHL for neuropathic ulcers of the great toe tip has been reported to have successful outcomes in 96.3% (92–100%) of patients and reported rates of 9.8% recurrences (0–12%).¹⁰ In our series, all ulcers healed within a mean of 37–45 days, but 10.5% of the toe tip pathologies recurred in the mean of 14 months. In two cases where completion tenotomy was done, they remained recurrence-free in the follow-up. In the published literature, the time to recurrence ranged between 13 and 48 months.^{11–15} One patient had cellulitis of the great toe, which settled with oral antibiotics. One patient had a transfer ulcer to the plantar IP joint region 16 months after the procedure. This may be secondary to the unmasking of a concomitant hallux limitus at the MTP joint once the mallet deformity was corrected.

CONCLUSION

This study reconfirms that percutaneous tenotomy of the FHL tendon resulted in the healing of great toe tip ulcers in a high percentage of patients. Since at 24 months follow-up, the recurrence rate is low, it is recommended that all toe tip ulcers be offered this procedure.

Clinical Significance

Great toe tip ulcers are common in patients with diabetes mellitus and have an incidence of 43–55.5%. Neglected great toe tip ulcers lead to gangrene and amputation of the affected toe. Timely

treatment of these ulcers can prevent needless amputations. In our series, a percutaneous tenotomy of the FHL tendon resulted in the healing of great toe tip ulcers in 94.8% of patients at a mean follow-up of 24 months.

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