



ACHILLES TENOTOMY FOR CHRONIC NON-HEALING DIABETIC FOOT ULCERATION: A CASE SERIES

Surgery

Sandeep Maharajh*

Medical Associates Hospital, St Joseph Trinidad and Tobago. *Corresponding Author

Samara Hassranah Medical Associates Hospital, St Joseph Trinidad and Tobago.

Dave Harnanan Medical Associates Hospital, St Joseph Trinidad and Tobago.

Vijay Naraynsingh Medical Associates Hospital, St Joseph Trinidad and Tobago.

ABSTRACT

The prevalence of non-healing diabetic foot ulcers in increasing and its management continues to be a challenge with high rates of progression and recurrence. The Achilles tendon in diabetics undergoes microscopic reorganization leading to its shortening. The resulting equinus deformity, combined with neuropathy and arthropathy, may cause pressure ulcers to form on the plantar aspect of the forefoot. Without offloading the pressure at these points, the lesions remain open. Lengthening of the Achilles tendon restores normal range of motion of the ankle and decreases pressure facilitating ulcer healing. This short, same day procedure, done under local anaesthesia allows immediate extension of the tendon. Fourteen patients with non-healing ulcers had tenotomies. Ankle dorsiflexion before and after was documented and time taken for the ulcers to heal post operatively recorded. All patients showed immediate improvement in the amount of ankle extension postoperatively; ulcer healing was achieved on average by 8 weeks. One patient has recurrence of ulceration at 15 months postoperatively. Follow up time was 18 months. Achilles tendon lengthening is an easy, safe, same day procedure for diabetic patients and should be considered as an option for non-healing pressure ulcers to the soles of their feet.

KEYWORDS

Achilles Tenotomy, Non-healing Diabetic Foot Ulcer.

METHODOLOGY

We included in this study 14 patients with Type 2 Diabetes Mellitus for more than 10 years who had non-healing diabetic foot ulceration of the forefoot for more than 6 months. The angle of passive dorsiflexion at the ankle joint was recorded pre-operatively. Intraoperatively the patient was positioned recumbent and starting at the tendoachilles insertion, an indelible pen was used to make 3 markings at 3 cm intervals ascending proximally. With the use of a 15 Blade scalpel, short stab incisions were done, starting at the first 3 cm marking from the tendoachilles insertion, then alternating on medial and lateral sides at each subsequent marking for partial tenotomies. The foot is then passively dorsiflexed to stretch the tendon fibres. Following this, the ulcer debridement was done. The angle of passive dorsiflexion at the ankle joint postoperatively was recorded. All procedures were done as same-day cases. Patients were followed up over a period of 18 months. Best medical therapy was provided, Optimal wound care was done and appropriate footwear to off-load abnormal pressures was fitted. The rate of ulcer healing, ulcer progression, transfer ulcers, new ulceration and foot amputation were noted.

RESULTS

Six male and 8 female patients were treated. Preoperatively, the angle of passive dorsiflexion of the ankle joint ranged from 0° to 5°. Postoperatively, the angle of passive dorsiflexion increased to 8°-12° (Figure 1). In all, complete healing of ulceration occurred over the follow up period. (Figure 2). Only in case, after 15 months, there was recurrence of ulceration at the plantar aspect of the great toe on the same side; recurrence rate of 7%. This patient had recurrent limited dorsiflexion as the tendon healed with the same shortening as occurred preoperatively. Among the other 13 patients, none experienced transfer ulcers, ulcer progression or had foot or toe amputation.

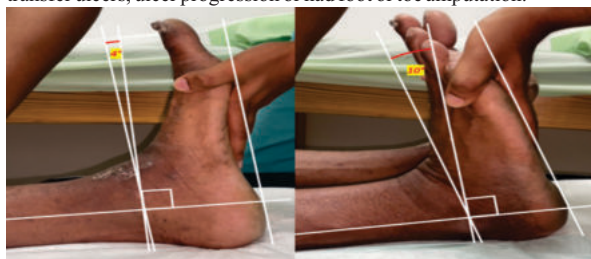


Fig 1: Photo showing reduction in ability to dorsiflex ankle joint due to Achilles tenopathy in longstanding diabetes; 4° shown (left). Postoperatively, increased and sustained ability to dorsiflex joint up to 12°; 10° shown on right.



Fig 2: Chronic Ulceration on plantar surface of left great toe and early callosities to 3rd, 4th & 5th metatarsal heads (Arrowed)(Left). Eight weeks after Achilles tenotomy showing complete healing of ulcer and softening of callosities (arrowed). (Right)

DISCUSSION

The World Health Organization estimates in 2022 that 422 million adults worldwide have Diabetes Mellitus and is more prevalent in lower income countries.¹ Its prevalence is expected to increase to 693 million by 2045.² The Global Burden of Disease Study in 2016 showed 131 million people, 1.8% of the world's population, suffered Diabetes-related lower-extremity complications.³ These include neuropathy, ulceration and amputation.

Ulceration is among the leading causes of morbidity and lower limb amputation.⁴ Management of Diabetic foot ulcers has proven to be challenging with the need for a multidisciplinary team including endocrinologists, vascular surgeons, general surgeons and physiotherapists. Unfortunately, there remains a high rate of non-healing, recurrence, progression of ulceration, sepsis and limb loss. This combined with the global distribution of disease, management of diabetic foot ulceration needs to continue to improve given economic restraints.

The cause of ulcerations in diabetics is multifactorial. In addition to

motor-sensory neuropathy and Charcot arthropathy, Achilles tenopathy plays a significant role. Progressive stiffening of the gastrocnemius-soleus musculotendinous unit results in reduced range of dorsiflexion of the ankle joint causing chronic abnormal loading and increased stress on the forefoot and metatarsal heads.⁵ This stress can lead to callus formation and foot ulceration.

Grant et al showed increased nonenzymatic glycation of collagen fibres in diabetics. Fibrils become more densely packed with a reduction in fibrillar diameter. Morphological abnormalities including overlapping and curved fibres have been reported.⁶ These pathological changes correlate with duration of diabetes disease and advancing age and have not been shown to be related to glycosylated haemoglobin and fasting blood sugar.⁷

Treatment of diabetic foot ulceration involves optimal wound care with control of infection, best medical management of comorbidities and off-loading of ulcer location. One meta-analysis found a recurrence rate of 31% at 20 weeks for diabetic ulcers receiving only optimal wound care.⁸

Abnormal stress loading contributes to ulcer formation and precludes timely healing. Of the various off-loading devices available, total contact-casting (TTC) is considered the gold standard. One prospective study showed a 76% healing rate after a median follow up of 33 days with total contact casting. Moderate peripheral artery disease and presence of infection were cited as the major factors resulting in poorest wound healing rates; 36% of such ulcers.⁹

Achilles tenotomy is a proven intervention to aid in pressure distribution in nonhealing diabetic foot ulceration. The Silfverskiöld test can be utilized to differentiate isolated gastrocnemius, soleus and Achilles tendon stiffening.¹⁰ Contraindications to this procedure includes the presence of heel ulceration, infection of bone and overwhelming sepsis or necrosis otherwise warranting amputation.¹¹

As shown, Achilles tenopathy results in stiffening of tendons, persistent plantar flexion and increased forefoot pressures. Off-loading devices do not definitively address this anatomical abnormality. Achilles tenotomy reduces peak plantar pressure from $86 \pm 9.4 \text{ Nm}^2$ to $63 \pm 13.2 \text{ Nm}^2$ and increases range of dorsiflexion from $0 \pm 3.1^\circ$ to $9 \pm 2.3^\circ$ at 8 weeks post operatively.⁵ Our series of patients resulted in an increased range of up to 12° . The increased ability to dorsiflex the foot during walking aims to restore the normal range of motion of the ankle joint and allows for better distribution of pressure throughout the hindfoot, midfoot and forefoot.

Diabetic foot ulcers treated with optimal care wound alone can have recurrence rates up to 61% at 3 years, ulcers treated also with Achilles tenotomy have a significantly reduced recurrence rate of 14% after 3 years.^{8, 11} The 14 patients managed in this study showed a recurrence rate of 7%. A randomised clinical trial done by Mueller et al compared TTC to TTC plus AT for plantar ulcers in patients with longstanding diabetes found a difference in ulcer recurrence rates; 81% at 2-year follow up with TCC alone vs 38% with TCC and AT.¹² In patients with ulcer recurrence, repeat tenotomy is also beneficial.

Holstein et al, in their series of 63 patients, identified transfer ulceration to the heel and rupture of the Achilles tendon as the major potential complications; occurring in 13-14% and 10% of patients respectively.¹³ Heel ulceration was more likely to occur in those with sensory neuropathy resulting in insensate heels and in those with hyperextension of the ankle joint postoperatively in excess of 15° . As done in our series, the use of a shorter surgical blade and alternating between medial and lateral aspects of the Achilles tendon attempts to minimize the risk of tendon rupture.

CONCLUSION

This case series adds to the evidence that Achilles tenotomy can be beneficial in the management of non-healing diabetic foot ulcers in the appropriately selected patients. It has high ulcer healing rates over a relatively shortened duration and few complications which can be reduced with improved surgical technique. It is a short same-day procedure that addresses the ongoing abnormal gross and microscopic collagen changes in diabetics which result in ulceration and poor rates of ulcer healing rates with other nonsurgical interventions alone.

REFERENCES

1. Diabetes. Accessed July 17, 2022. <https://www.who.int/health-topics/diabetes>

2. Cho NH, Shaw JE, Karuranga S, et al. IDF Diabetes Atlas: Global estimates of diabetes prevalence for 2017 and projections for 2045. *Diabetes Res Clin Pract.* 2018;138:271-281. doi:10.1016/j.diabres.2018.02.023
3. Zhang Y, Lazzarini PA, McPhail SM, van Netten JJ, Armstrong DG, Pacella RE. Global Disability Burdens of Diabetes-Related Lower-Extremity Complications in 1990 and 2016. *Diabetes Care.* 2020;43(5):964-974. doi:10.2337/dc19-1614
4. Pecoraro RE, Reiber GE, Burgess EM. Pathways to diabetic limb amputation. Basis for prevention. *Diabetes Care.* 1990;13(5):513-521. doi:10.2337/diacare.13.5.513
5. Armstrong DG, Stacpoole-Shea S, Nguyen H, Harkless LB. Lengthening of the Achilles Tendon in Diabetic Patients Who Are at High Risk for Ulceration of the Foot*. *J.BJS.* 1999;81(4):535-538.
6. Grant WP, Sullivan R, Sonenshine DE, et al. Electron microscopic investigation of the effects of diabetes mellitus on the Achilles tendon. *J Foot Ankle Surg Off Publ Am Coll Foot Ankle Surg.* 1997;36(4):272-278; discussion 330. doi:10.1016/s1067-2516(97)80072-5
7. Batista F, Nery C, Pinzur M, et al. Achilles Tendinopathy in Diabetes Mellitus. *Foot Ankle Int.* 2008;29(5):498-501. doi:10.3113/FAI-2008-0498
8. Margolis DJ, Kantor J, Berlin JA. Healing of diabetic neuropathic foot ulcers receiving standard treatment. A meta-analysis. *Diabetes Care.* 1999;22(5):692-695. doi:10.2337/diacare.22.5.692
9. Nabuurs-Franssen MH, Slegers R, Huijberts MS, et al. Total Contact Casting of the Diabetic Foot in Daily Practice: A prospective follow-up study. *Diabetes Care.* 2005;28(2):243-247. doi:10.2337/diacare.28.2.243
10. SILFVERSKIÖLD N. Reduction of the uncrossed two-joints muscles of the leg to one-joint muscles in spastic. *Acta Chir Scand.* 1924;56:315.
11. Laborde JM. Tendon Lengthening for Neuropathic Foot Problems. *Orthopedics.* 2010;33(5):319-326. doi:10.3928/01477447-20100329-26
12. Mueller MJ, Sinacore DR, Hastings MK, Strube MJ, Johnson JE. Effect of Achilles tendon lengthening on neuropathic plantar ulcers. A randomized clinical trial. *J Bone Joint Surg Am.* 2003;85(8):1436-1445.
13. Holstein P, Lohmann M, Bitsch M, Jørgensen B. Achilles tendon lengthening, the panacea for plantar forefoot ulceration? *Diabetes Metab Res Rev.* 2004;20 Suppl 1:S37-40. doi:10.1002/dmrr.452