GUNDERSEN HEALTH SYSTEM®

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Introduction

Increased forefoot pressure due to ankle joint equinus is a contributing factor in the development of diabetic neuropathic forefoot ulcerations. Ankle joint equinus is generally defined as less than ten degrees of ankle joint dorsiflexion¹. It has been proposed that diabetics are predisposed to equinus due to the process of non-enzymatic glycosylation which leads to stiffening of the Achilles tendon². Frykberg et al. reported that the incidence of equinus is increased in the diabetic population threefold, and the incidence of ulceration is increased in those with equinus fourfold³. As the Achilles tendon loses flexibility in patients with diabetes, the ankle fails to adequately dorsiflex during gait which places increased forces on the forefoot and leads to the development of an ulceration⁴.

The standard treatment of neuropathic foot ulcerations includes wound debridement, nutritional and vascular assessment, infection management, and offloading. The goal of offloading is to reduce pressure at areas of ulceration. This can be achieved with modified shoe gear, total contact casting, or surgical intervention. One surgical method of addressing equinus is percutaneous tendo Achilles lengthening (TAL), most commonly in the form of a triple hemi-section. Tagoe et al. found a moderate level of evidence to support addressing ankle joint equinus as an elective procedure in diabetic patients with forefoot ulcerations recalcitrant to conservative cares⁵. The advantages of percutaneous TAL include technical ease, minimal soft tissue disturbance and speed of procedure. The disadvantages of percutaneous TAL include the risk of tendon over-lengthening and rupture. One of the most debilitating complications of TAL is a transfer plantar heel ulceration; however, the incidence of this complication remains unknown.

Methods

A systematic review of three electronic databases was performed to identify publications for study inclusion. Search terms included "Percutaneous" AND "Tendo" OR "Tendon" AND "Achilles" AND "Lengthening" AND "Diabetes" AND "Ulcer," where all upper-case words represent Boolean operators employed. Inclusion criteria included percutaneous-type TAL procedures only, follow-up \geq 1 year, forefoot ulcerations, diabetes, and equinus. Exclusion criteria included biomechanical studies, surgical technique guides, midfoot/rearfoot ulcerations, percutaneous TAL for purpose other than treatment of forefoot ulceration, and previous TAL (Table 1). The references of each article meeting these criteria were reviewed for additional studies missed in the initial electronic search.

The Incidence of Heel Ulcerations Following Percutaneous Tendo-Achilles Lengthening for the Treatment of Diabetic Neuropathic Forefoot Ulcerations: A Systematic Review Mark K. Magnus, DPM (PGY-3)¹; Ellen C. Barton, DPM (PGY-1)¹; Andrew D. Elliott, DPM²

Table 1. **Inclusion Criteria** Percutaneous-type TAL procedures only • Diabetes • Follow-up \geq 1 year Equinus Forefoot ulcerations **Exclusion Criteria** • Biomechanical studies Surgical technique guides Midfoot/rearfoot ulcers at presentation Previous TAL Potentially relevant articles after search in digital databases (n= 23) Full-text articles reviewed for detailed

comparison with inclusion criteria (n=11)

Articles eligible for systematic review (n=4)

Review of references for additional articles (n=2)

Articles included in systematic review (n = 6)

Figure 1. Flowchart of articles during the selection process.

Table 2.							
Author/Year	Evidence Level	Number of Patients	Average Follow-up (months)	Target Ulcer Healed	Target Ulcer Recurrence	Tendon Rupture	Heel Ulcer
Lin 1996		15	17.3	100%	0%	0%	0%
Mueller 2003	I	30	25	100%	38.5%	0%	13%
Holstein 2004	IV	75	12	91%	14.1%	9.3%	14.7%
Allam 2006	I	6	24	83.3%	16.7%	16.7%	50%
La Fontaine 2008	3	28	28.8	85.7%	35.7%	0%	17.9%
Colen 2013		131	35	100%	2%	0%	1.5%

 Percutaneous TAL for purpose other than forefoot ulcer

> Articles excluded on abstract: Biomechanical study (n=4)No equinus (n = 1)Not isolated TAL (n=7)

> Articles excluded on full-text: Biomechanical study (n=1) Not isolated TAL (n=1)Review only (n=5)

Results

with a deep infection.

Discussion

Overall, percutaneous TAL demonstrated success in healing the index ulceration, and all studies included in this review concluded that the procedure was useful. However, this procedure is not without risk and complication. Heel ulceration was one of the most common complications encountered in this systematic review. Heel ulcerations are difficult to treat and may present a greater risk to patients than the initial forefoot ulceration. This is due to the relative avascularity of the tissue and limited surgical reconstructive options in the setting of infection. Saleem et al. concluded that the location of an ulceration to the heel is an independent risk factor for poor outcome in diabetic foot ulceration patients¹¹.

Identifying patients at risk for post-operative complications remains a challenging task. Holstein et al. The amount of ankle joint dorsiflexion achieved intra-operatively was variable in the included studies.

concluded that heel anesthesia should be a contraindication to percutaneous TAL after noting a 47% heel ulceration rate in a subgroup of patients with neuropathic heels⁷. Mueller et al. also recommended evaluating the quality of heel fat pad pre-operatively as part of determining the risk for heel ulceration⁶. While increased ankle joint dorsiflexion decreases recurrence of forefoot ulcerations, it is also associated with the development of heel ulceration and calcaneal gait⁴. Some authors argue that gastrocnemius recession provides more controlled correction than percutaneous TAL and therefore decreases the risk of Achilles tendon over-lengthening and rupture¹. Ideal future research would compare the risks of post-operative complications of gastrocnemius recession versus percutaneous TAL for the treatment of neuropathic forefoot ulcerations with associated equinus.

With an estimated incidence of 8.7%, the risk of heel ulceration should be judiciously weighed against the benefit of forefoot ulceration resolution when considering percutaneous TAL procedures. Surgeons and patients should be aware of this risk and remain vigilant in monitoring for early signs and symptoms.

References

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After title, abstract, and full article review, a total of 6 studies met all criteria (Figure 1). Individual study outcomes are reported in Table 2. In total, 285 patients with an average follow-up of 23.7 months were reported and all received percutaneous TAL procedures. 95.7% (n=273) of the initial forefoot ulcerations were reported healed following the percutaneous TAL procedure. However, there was a forefoot ulceration recurrence rate of 12.3% (n=34) within the follow-up time periods. A total of 8.7% (n=25) of patients developed a new transfer ulceration to the plantar heel. Other reported complications included 2.8% (n=8) of patients with Achilles tendon rupture, 0.3% (n=1) with a wound hematoma and 0.3% (n=1)

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