Surgical Correction of the Achilles Tendon for Diabetic Foot Ulcerations and Charcot Neuroarthropathy

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KEYWORDS

• Diabetic Charcot foot • Charcot neuroarthropathy • Achilles tendon
• Diabetic neuropathy • Equinus • Diabetic foot ulcer

KEY POINTS

- Equinus is associated with elevated plantar pressures, which may increase the risk of plantar ulceration in patients with diabetic peripheral neuropathy.
- Diabetic foot ulcerations and Charcot neuroarthropathy have been linked to lower extremity equinus deformity.
- Tendo-Achilles lengthening and gastrocnemius recession are some of the most common surgical procedures addressing the diabetic equinus deformity.

Lower extremity equinus is associated with the development of several diabetic foot pathologic entities. Two of these clinical manifestations, diabetic foot ulceration and Charcot neuroarthropathy (CN), have been linked to tightness or shortening of the Achilles tendon, which can cause equinus contracture, defined as limited ankle joint dorsiflexion specifically less than 10° of passive ankle dorsiflexion with the knee flexed and extended.[1] Equinus is associated with elevated plantar pressures, which may increase the risk of plantar ulceration in patients with diabetic peripheral neuropathy.[2] Additionally, in the presence of peripheral neuropathy, increased plantarflexion of the ankle caused by equinus can affect joint forces and gait patterns leading to diabetic CN changes. In each of these clinical scenarios, surgical lengthening of the Achilles tendon has been used to increase ankle joint dorsiflexion with the notion of

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adequately distributing plantar pressures across the foot to prevent recurrent skin and osseous breakdown.

THE ACHILLES TENDON IN PATIENTS WITH DIABETES MELLITUS

Chronic hyperglycemia can cause tissue damage through many pathways.[3] Studies postulate that nonenzymatic glycosylation of collagen in diabetes mellitus can lead to changes within the Achilles tendon resulting in thickening and stiffness. In a rabbit model, Reddy[4] showed that glycation-induced collagen cross-linking was directly associated with increased matrix stiffness of the Achilles tendon. Perhaps the most compelling evidence for the effects of diabetes mellitus on the human Achilles tendon came from a study by Grant and colleagues[5] that compared diabetic and nondiabetic Achilles tendon specimens under electron microscopy. The study found increased packing density of collagen fibrils, decreases in fibrillar diameter, and abnormal fibril morphology in the diabetic Achilles tendons, whereas the nondiabetic Achilles tendons showed normal structural organization. These investigators deduced that such structural changes can contribute to shortening of Achilles tendon-gastrocnemius-soleus-complex, resulting in equinus. Furthermore, on a macroscopic level, a study by Giacomozzi and colleagues[6] found the Achilles tendon in the diabetic patients was statistically thicker than in controls. These investigators concluded this thickening leads to a more rigid foot and ankle that poorly absorbs shock during gait. A study of 1666 consecutive diabetic patients by Lavery and colleagues[7] found that diabetic patients with equinus had higher peak plantar pressures than those without equinus and that those with equinus were associated with a longer duration of diabetes mellitus. Further supporting a link between diabetes mellitus and equinus, a prospective survey of 102 patients by Frykberg and colleagues[8] found a 3-fold risk of equinus in the diabetic population.

Most common conditions in the diabetic foot that are attributed to lower extremity equinus include a forefoot ulceration in the presence of or without partial foot amputation, tendinous or osseous imbalance, and CN. The notion about surgical correction of the equinus deformity in the diabetic patient is based on allowing adequate dorsiflexion at the ankle joint level and, therefore, reducing plantar pressures in the distal aspect of the foot or at the level of CN collapse. Multiple surgical procedures have been proposed to address the equinus deformity in the diabetic patient from a percutaneous tendo-Achilles lengthening (TAL) and gastrocnemius recession to a complete Achilles tenotomy. Special attention must be taken when surgery is performed on the Achilles tendon in the diabetic population, as its complications can cause a serious effect in the overall management of the diabetic foot condition. For instance, overlengthening or rupturing the Achilles tendon after surgical correction of equinus in the diabetic patient may lead into an antalgic gait and development of calcaneal plantar ulcerations that can be quite challenging to heal. In addition, overcorrecting or undercorrecting the equinus deformity during a CN midfoot reconstruction may lead to a surgically induced CN joint, hardware failure, nonunion, malunion, or chronic nonhealing ulcerations.

ACHILLES TENDON SURGERY FOR DIABETIC FOOT ULCERATIONS

Although surgical TAL has become popular in the treatment of diabetic foot ulcerations, there are limited high-level studies in support of this modality. In 2003, Mueller and colleagues[9] published a randomized, controlled trial comparing immobilization in a total-contact cast alone or combined with percutaneous TAL, resulting in healing of all ulcerations in the TAL group and decreased risk of ulcer recurrence compared with