Emerging Concepts With Tendon Transfers

Transferring the peroneus longus tendon to the peroneus brevis tendon can be a valuable correction for peroneus longus overdrive due to a sub-first metatarsal diabetic foot ulcer as the procedure helps balance the foot and prevents recurrence of deformity. These authors detail the diagnosis of peroneus longus overdrive and offer a comprehensive guide to performing the procedure.

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Multiple authors have described a wide variety of tendon transfer procedures in the foot and ankle literature. The purpose of these procedures can vary in function in order to strengthen a weakened tendon, reduce an overpowered tendon and/or keep the foot in a biomechanically stable alignment. These tendon transfers are useful tools in the correction of a deforming force of the lower extremity.

A procedure that surgeons do not often utilize involves the routing of the peroneus longus tendon into the peroneus brevis tendon. This technique can correct conditions in patients who present with a peroneus longus overdrive in the face of a diabetic foot ulcer under the first metatarsal. The literature is sparse for this procedure, which surgeons can utilize to correct the deformity, balance the foot and prevent recurrence in the long term.

Accordingly, we will review the indications for tendon transfer, how to diagnose peroneal longus overdrive, offer a closer look at the procedure and discuss the postoperative course of a peroneal longus/peroneal brevis tendon transfer for the treatment of a diabetic foot ulcer under the first metatarsal in the face of a peroneal longus overdrive.

Often patients with neuropathy will present with a longstanding plantar foot ulcer under the first metatarsal head and sesamoids. This complication can lead to unnecessary, prolonged and unsuccessful non-operative treatment, and possible amputation. The presence of such a condition should prompt the treating physi-

cian to investigate why the ulcer is present and what underlying pathology is causing the ulcer. Typically, the treating physician is looking for a rigid plantarflexed metatarsal, an unusually prominent first metatarsal head or an enlarged or infected sesamoid complex.

In these scenarios, one may address the condition with a dorsiflexion osteotomy of the first metatarsal or sesamoidectomy. Resecting sesamoids can produce a flexion deficit at the metatarsophalangeal joint (MPJ) and a cock-up deformity of the great toe. This can exacerbate the scenario under the first metatarsal head and/or lead to a wound to the dorsum of the great toe when a cock-up deformity occurs.[1]

On the other hand, in patients who present without a fixed deformity and excessive weightbearing under the first metatarsal head, this is often caused by an overpull of the peroneus longus tendon. This results from recruitment of the peroneus longus muscle to assist a weak Achilles tendon. Based on the findings of the physical exam, the surgeon can transfer the peroneal longus to the peroneal brevis tendon. This will remove the deforming force of "over-plantarflexion" of the first metatarsal and provide additional foot and ankle dorsiflexion to the foot. This procedure will balance the foot, remove the underlying pathology and prevent recurrence.

This explains the presence of a forefoot sub-first metatarsal ulcer in the absence of a fixed deformity of the first metatarsal/sesamoid complex. Ulcers under the first metatarsal/sesamoid complex can resolve quickly with good local wound care and the appropriate use of custom-made insoles following the aforementioned tendon transfer of the peroneus longus to the peroneus brevis tendon. In all cases, it is appropriate to evaluate the underlying pathology, abnormal muscle balance and treat the underlying condition for long-term healing of the wound and prevention of recurrence.

Essential Biomechanical Considerations

The alignment of a normal foot should resemble a tripod, in which the body's weight should mainly remain on the calcaneus, the first metatarsal head and the fifth metatarsal head. In a cavovarus foot, the majority of the weight will remain on the outer portion of the foot and the inside of the foot will be turned into a varus type deformity.[2] This gross deformity affects the entire foot. For example, a select few patients will present with a sub-first metatarsal ulcer from a peroneal longus overpull. With the condition of a peroneal longus overdrive, the forefoot will experience an overactive plantarflexion. When the patient is non-weightbearing, the first metatarsal will be in a plantarflexed position due to the overactive firing of the peroneus longus tendon. During the gait cycle, the peroneus longus will continue to be active and dynamic, resulting in increased pressure under the first metatarsal/sesamoid complex, often leading to an ulcer of the sub-first metatarsal.

In this event, the resulting alignment may lead to an either reducible or irreducible varus malposition of the calcaneus. Due to the malposition and the inadequate contact of the plantar fat pad with ground reactive forces, there will likely be less shock absorption during the gait cycle. The result of this chronic stress will be on the laterally based osseous and soft tissue structures of the foot with each step in the patient's gait. Furthermore, studies show a prevalence of fifth metatarsal stress fractures in such a patient population.[3]

When there is a cavovarus deformity, the clinician should note if there is a fixed equinus deformity of the ankle and assess the pathologic elevation of the longitudinal arch. Normally, the intrinsic muscle would lose its functions with this deformity. Widespread muscle imbalance in the foot will result in the varus malposition of the hindfoot as the posterior tibialis tendon will remain less opposed by the peroneus brevis tendon. In addition, the anterior tibialis tendon will become weaker relative to the peroneus longus tendon, leading to plantarflexion of the first metatarsal. Secondary to the weakness of the anterior tibialis muscle, recruitment of the extensor hallucis longus muscle occurs, resulting in a cock-up deformity of the great toe with further depression of the metatarsal head, which leads to plantar contracture and callus and/or formation at that level.

This image shows the foot of a patient who presented with a non-healing, longstanding neurotrophic ulcer under the first metatarsal secondary to peroneal longus overdrive and a gastrocnemius equinus.

The examining physician has the left thumb under the second through fifth metatarsals with the right thumb under the first metatarsal. One can see the first metatarsal plantarflexes more than the second through fifth lesser metatarsals as the patient plantarflexes the ankle and foot. This is clearly visible and palpable to the examining physician when peroneal longus overdrive is present.

Here one can see the foot in a relaxed position and the first metatarsal is more plantarflexed in comparison to the lesser metatarsals.

Pertinent Anatomical Insights On The Peroneus Longus And Peroneus Brevis Tendons

The peroneus longus has two functions. One function is acting as a plantarflexor for the first ray. Secondarily, it acts to evert the foot. The peroneus longus arises from the head and upper two-thirds of the lateral surface of the fibula. It runs posterior to the peroneus brevis and passes through the synovial sheath and fibro-osseous tunnel at the level of the lateral malleolus. Anteriorly, the tunnel has fibula. Posterolaterally, the superficial peroneal retinaculum, the calcaneofibular ligament and the posterior talofibular ligament form the medial boundary. Slightly distally, the peroneus longus tendon passes obliquely under the cuboid to attach onto the lateral side of the base of the medial cuneiform and the first metatarsal, opposing the anterior tibial tendon action.[4]

The peroneus brevis originates at the middle one-third of the fibula as well as the intermuscular septum. The peroneus longus originates off the lateral tibial condyle as well as the head of the fibula. Coursing distally, the tendon sheath of both tendons unite to share a common synovial sheath being proximal to the tip of the lateral malleolus. Once reaching the posterior aspect of the lateral malleolus, the tendon runs within the retromalleolar groove. At this level, the peroneus longus sits posterior and lateral to the peroneus brevis tendon.

Coursing distally along the lateral wall of the calcaneus, the common tendon sheath splits into two separate inferior and superior sheaths by the peroneal tubercle. The superior sheath envelops the peroneus brevis and the peroneus longus is contained within the inferior sheath. From this point, the peroneus longus turns within the cuboid groove and heads medially to insert onto the plantar base of the first metatarsal and the medial cuneiform. The peroneus brevis inserts onto the base of the styloid process of the fifth metatarsal. The peroneus longus and brevis muscles work as strong everters of the foot and weak plantarflexors of the ankle. The peroneus brevis provides 63 percent of the total eversion power assists in ankle plantarflexion and maintains the lateral longitudinal arch.[4] It also contributes to the maintenance of the transverse arches of the foot.

Both the peroneal brevis and peroneal longus are supplied by the superficial peroneal nerves, which are supplied by the branches of the peroneal artery.

Keys To An Effective Clinical Exam

The physical examination is very specific for evaluating peroneal longus overdrive. The physical exam is the only way to diagnose the condition to determine whether there is excessive weightbearing under the first metatarsal head and sesamoids because of the peroneal longus overpull.

The physician places one thumb on the second through fifth lesser metatarsal heads and the other thumb under the first metatarsal/sesamoid complex, and asks the patient to plantarflex the ankle.[2–5] For example, if a patient presents with a sub-first metatarsal ulcer in the right foot and the physician is facing the patient, the physician will place the left thumb under the second through fifth metatarsal heads of the patient's right foot. The examining physician then will place the right thumb under the patient's ulcer (first metatarsal sesamoid complex) and ask the patient to slowly plantarflex the ankle. Overactivity of the peroneal longus is indicated when the first metatarsal goes into a much stronger and more exaggerated plantarflexion in comparison to the rest of the forefoot (lesser metatarsals). The examining physician should clearly feel and see this.

Additionally, one should evaluate the patient for a tight posterior muscle contracture. Utilize the Silfverskiold test in order to assess if an equinus deforming force is a contributing factor as well. Often, this patient population will present with an equinus contracture, resulting in increasing forefoot pressure in addition to the pathologic peroneal longus overdrive.

Also, a Coleman block test is a simple examination that can help guide treatment. This test also determines the extent of forefoot-driven and hindfoot deformity in a patient. For example, in a cavovarus foot deformity, one sees a plantarflexed first ray at first and over time, there is an observable change to the hindfoot position as the disease progresses. The result of this test will help the physician determine if there is additional involvement with the pathological condition. Testing each quadrant of the muscle to appreciate the strength is important.[5] This tells us which muscle is weak and which is strong.

For any neurological deficits or a loss of

Here is an intraoperative view following the distal cut of the peroneal longus tendon (with the Allis clamp) as far distal and plantar to the cuboid. The peroneal brevis tendon (with umbilical tape) remains separated and intact in preparation for a weave graft tendon transfer of the peroneal longus into the peroneal brevis tendon under physiologic tension, and in a neutral position.

This preoperative view shows the foot of a patient with diabetes who experienced a longstanding, non-healing diabetic foot ulcer under the first metatarsal. The patient experienced a long course of offloading and standard of care wound care, and did not heal.

Here is a postoperative clinical view of the foot in the left photo following an endoscopic gastrocnemius recession and a peroneal longus/peroneal brevis tendon transfer. Several years after the surgery, the patient has not had a recurrence as the surgeon addressed the underlying lower extremity pathology.

protective sensation, the patients suffering from cavovarus deformity often have neurological conditions and an insensate foot, which is prone to ulceration and skin breaks. It is important to conduct an electromyography test to determine the level of neuromuscular abnormalities.

The patient should also have a thorough vascular examination. We highly recommend non-invasive vascular studies, especially for patients with a history of tobacco use, diabetes, atherosclerosis, coronary artery disease and peripheral vascular disease. The vascular examination will provide predictability with healing if the patients receive surgical intervention.

Standard radiographs could provide information when it comes to cavovarus foot deformity. The most notable is Meary's angle (i.e., lateral talo-first metatarsal angle), which should normally be 0. However, an increased angle would mean the patient has a cavus foot type. To assess the hindfoot alignment, the clinician can look at a standing X-ray, a calcaneal axial view, hindfoot alignment or standing computed tomography (CT). Signs of hindfoot varus on a lateral X-ray include a bell-shaped cuboid, a posterior placed fibula and open sinus tarsi. A 3D CT image could also help with surgical planning. Magnetic resonance imaging (MRI) can be useful as well to address concomitant pathology, including peroneal pathology, tears, stress reaction, peroneal subluxation or tendinosis. Additionally, advanced imaging can assist in identifying the extent of an infection if one is present.

Step By Step Pearls On Performing The Tendon Transfer Procedure

Place the patient on the operation table in a supine position. After the administration of anesthesia, prep the extremity above the knee and drape it in the standard fashion. Direct attention to the posterior aspect of the leg and perform a Silfverskiold test to evaluate if an equinus component of pathology is present. If it is present, the surgeon needs to determine if the equinus pathology consists of a gastrocnemius pathology or a gastrocnemius and soleus muscle pathology. It is the senior author's experience that an equinus component is commonly involved and it typically in-

Here are preoperative clinical views of a longstanding, non-healing diabetic foot ulcer under the first metatarsal. Note the inflammatory response to the sub-first metatarsal area in addition to the wound secondary to overload of the soft tissues and irritation from the peroneal longus overdrive. The patient experienced a long course of offloading, standard of care wound care and did not heal prior to surgical intervention.

Here is a post-op view of the foot from the above photos following an endoscopic gastrocnemius recession and a peroneal longus/peroneal brevis tendon transfer. Several years after the surgery, the patient has not had an ulcer recurrence.

volves an isolated gastrocnemius contracture. If an equinus contracture is present, then perform the appropriate posterior muscle lengthening.

Direct your attention to the hindfoot to determine if a calcaneal varus is present. When we need to address the calcaneus, we typically perform a percutaneous calcaneal displacement osteotomy, mobilizing the posterior portion of the heel laterally and employing percutaneous fixation for the osteotomy, minimizing the soft tissue involvement.[6–8]

Direct attention to the dorsal lateral aspect of the foot over the cuboid where the peroneal brevis and longus tendons are located. Make an incision of approximately 4 cm proximal to the cuboid. Using sharp and blunt dissection, carry the incision deep in the same plane but avoid the sural nerve. Expose and isolate the peroneal longus and brevis tendons. Follow the peroneal longus tendon as far distal as possible as it courses under the cuboid and cut the peroneus longus. Then transfer the proximal stump of the peroneal longus tendon onto the peroneal brevis tendon with a "weave graft technique" under physiologic tension with the assistant holding the ankle and foot into a neutral position. Suture the peroneus longus tendon and secure it onto the peroneal brevis tendon with 0 Vicryl under physiologic tension. Close the subcutaneous tissue and skin.

Apply the postoperative bandage and apply a univalve below-the-knee cast with the lower extremity in a neutral position and out of equinus.[9] The patient is immobile for one month. At one month postoperative, place the patient in a walking boot and schedule physical therapy three times a week for six weeks. ■

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