Tendon Rebalancing as a Means to Achieve a Plantigrade Foot: An Equinovarus Case Review

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Abstract

Complete resection of the 5th metatarsal secondary to infection has significant consequences. Of the biomechanical sequelae that can result, loss of eversion power from the peroneus brevis against the inverting anterior and posterior tibial muscles is concerning. This may leave the forefoot in a plantarflexed and inverted position, leading to significant shearing stress against the lateral foot and ultimately ulceration. Literature describing biomechanical changes in tendon balancing is limited. And while there are studies that describe tendon transfers, there are fewer focused on muscle lengthening to reduce deformity in an equinovarus foot.

The purpose of this poster is to present tendon lengthening as a viable option for correction of a flexible equinovarus deformity, achieving a plantigrade foot, and to alleviate areas of pressure on underlying wounds. Further studies in this topic would provide patients and surgeons an additional option for non-osseous correction of a flexible equinovarus deformity.

Literature Review

The equinovarus foot is a challenging pathology to correct. If left untreated, it could lead to serious sequelae such as conversion to a rigid deformity, ulceration, and fracture of the lateral column. When assessing, physical examination should include a thorough neurologic and orthopedic evaluation with special attention to weight-bearing, gait, shoe gear, and x-ray [1].

If the deformity is rigid, corrective procedures should include osseous reconstruction. However, if the deformity is flexible and surgery is indicated there are several options. *Radical Plantar Release* and *Medial Tarsal Release* involve sequential release of intrinsic soft tissue structures including tendon, capsule, and ligament in cavovarus deformites [2] and may be of similar benefit to release of equinovarus deformities. Tendon transfers are a mainstay in treatment for flexible and non-progressive deformities, principally with the tibialis anterior. One study compares the results between a 2-incision, 3-insicion, and a split anterior tibial tendon transfer – all with varying results [3].

A less popular, yet still viable option, is tendon lengthening. Very little study has been explored in this area. Kim et al described a sagittal plane Z lengthening of the tibialis anterior tendon as an adjunctive procedure for a diabetic foot in varus rotation with a chronic ulceration at the lateral column [4].

Case Study

This is a 58-year-old male with a 30-year history of insulin-dependent diabetes with peripheral neuropathy who presented to our service in February of 2015 for evaluation and treatment of a non-healing wound at the plantar-lateral column of the left midfoot. This wound was resultant from a complete 5th ray resection and 5th toe amputation secondary to osteomyelitis in 2014. He unsuccessfully utilized a diabetic-type walking boot to off-load pressure to the area.

The overall attitude of the foot non-weight-bearing was in a plantarflexed and inverted position and was semi-reducible. The midfoot was unstable upon manipulation, especially at the tarsal-metatarsal joint (TMTJ). On weight bearing the deformity only partially reduced, and lateral column was the main point of contact on the weight bearing surface (Figure1A). A full thickness ulceration, Wagner Grade II, was present at the proximal portion of the lateral column and measured 4.2cm x 1.0cm x 0.1cm (Figure 1B). Michigan Neuropathy Screening Index Score was 9/10.

Case Study (cont.)

Radiographic evaluation revealed evidence of the resected 5th ray and toe and an old transverse, comminuted fracture just proximal to the 4th metatarsal neck. There was complete medial and dorsal dislocation of the 1st TMTJ (Figures 1C-1D) and complete lateral dislocation of the 2nd-3rd TMTJs with all metatarsals in an adducted position (Figure 1C). Diffuse fragmentation was noted throughout the TMTJs with no consolidation.

The patient was initially offered a tibiotalocalcaneal fusion for correction, but deferred due to lifestyle preferences. After many months of numerous local wound care modalities, off-loading, total contact casting, and bracing the patient did agree to soft tissue correction consisting of multiple tendon lengthenings and capsulotomies to correct the equinovarus deformity.

Figures 1A-1D

Figure 1A

Figure 1B

Figure 1C

Figure 1D

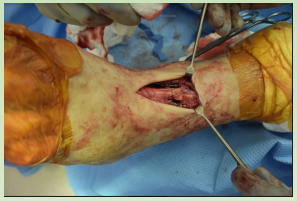
Procedure

The patient was placed on the operating table in a supine position. Following induction of general anesthesia, a thigh tourniquet was placed about the left lower extremity, which was then scrubbed, prepped, and draped in the usual aseptic manner. After a formal time-out and exsanguination were performed, attention was first directed over the posterior aspect of the leg.

Procedure (cont.)

Three incisions were made to the posterior aspect of the leg. Incisions were taken through skin and subcutaneous tissue and an Achilles tendon lengthening was performed. This did increase the amount of dorsiflexion and eversion capability. We then assessed the anterior portion of the ankle. The tibialis anterior was quite taut and noted to be a deforming source. Therefore, lengthening was performed to this area through a separate incision (Figure 2).

Figure 2



Next, a medial incision was made at the level of the ankle posterior to the medial malleolus. Lengthening was done to the posterior tibial tendon, which did decrease the inversion power at the ankle. A talonavicular and first metatarsocuneiform capsulotomy were then performed to reduce the patient's Charcot neuroarthropathy deformity. This did help to reduce the deformity as well to allow for a plantigrade foot.

The area was then flushed with copious amounts of sterile saline and the tourniquet was deflated, a total of 53 minutes. Deep and subcutaneous closure were obtained with 2-0 and 3-0 absorbable suture respectively and skin closure with 3-0 and 4-0 non-absorbable suture. Lastly, when the incision sites were protected, subcutaneous debridement of the lateral wound was performed and did measure 2.5cm x 2.0cm x 0.3cm. The wound was dressed and the patient was placed in a non-weight-bearing below-knee cast in a dorsiflexed and everted position.

The patient tolerated the procedure and anesthesia well and was transferred to the post-anesthesia care unit with vital signs stable and vascular status intact to left lower extremity. The patient was given a prescription for pain control and began aspirin for deep venous thrombosis prophylaxis.

Results

The first post-op visit was at 12 days wherein the wound measured 2.5cm x 1.7cm x 0.2cm with no signs of infection. The foot did retain a rectus position when dorsiflexed and everted. Sutures were removed and replaced with steri-strips. Local wound care and dressings to the ulcer were done before the foot was again re-casted in a dorsiflexed and everted position for an additional two weeks

At 4 weeks post-op, patient was transitioned to a diabetic walking boot but remained non-weight bearing. At 6 weeks post-op the wound had decreased in size to 0.8cm x 1.1cm x 0.0cm, and the patient began weight bearing in a diabetic walking boot. Finally, at 10 weeks post-op the wound was clinically healed (Figure 3A-3B) and patient began ambulation in normal shoe gear with an ankle-foot-orthosis.

The patient follows up every 2-3 months, most recently December 2017, for evaluation of Charcot changes and correction of the left foot, which remains plantigrade and free of ulceration.

Figures 3A-3B

Figure 3A

Figure 3B

Discussion

In a review article, Ryssman and Myerson state achieving a plantigrade foot cannot be accomplished without tendon transfers, which serve two purposes: 1. *To augment or replace the strength or function that has been lost from the disease process*, and 2. *Remove the deforming force responsible for exacerbating the deformity* [5]. To fully correct for an equinovarus deformity, an understanding of the biomechanics to each tendon involved and the imbalance of power between antagonistic groups is paramount. Reeves et al describes the antagonistic muscle pairing of the tibialis anterior and peroneus longus, which dorsiflex and plantarflex the first ray respectively. He also pairs the peroneus brevis and tibialis posterior as an antagonistic muscle pair wherein the peroneus brevis is an everter of the foot and the tibialis posterior is an inverter of the foot [6].

If there is loss in power or function of the peroneus brevis, or it's insertion to the 5th metatarsal base, a equinovarus deformity can quickly ensue. Shariff et al retrospectively studied 18 patients who underwent 5th metatarsal base resection as a part of forefoot reconstruction for correction of rigid cavus foot deformities. Different combinations of tendon lengthenings and transfers were done, and all outcomes resulted in the inferolateral portion of the foot further from the ground postoperatively compared to preoperatively [7]. Finally, Boffeli et al proposed a 2-stage surgical protocol for correction of the plantarflexed and inverted foot wherein the peroneus longus tendon is transected plantar to the cuboid and transferred into the same bone. A review of 21 patients undergoing this staged procedure revealed 11 of the 21 patients needing no further surgical revision at an average of 36.8 months. And an overall 15 of the 21 patients having a functional limb at final follow-up [8-9].

In conclusion, while there is multiple evidence for fusions and tendon transfers for correction of an equinovarus foot, this case gives validation for further exploration and studies in tendon lengthenings as a viable option for correction of flexible equinovarus deformities.

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