Bilateral Adult Cavoadductovarus Deformity: Literature Review and Case Presentation

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INTRODUCTION

Adult cavoadductovarus deformity can be caused by a multitude of neurological assaults. The most common etiologies of adult clubfoot are head trauma, cerebrovascular accident, upper motor neuron lesions, and multiple sclerosis. According to Lawrence et al, following an acute cerebrovascular accident, there is a short-lived period of flaccidity, which is followed by spasticity due to loss of cortical modulation over primitive motor and postural reflexes (1). Spasticity is characterized by an increase in muscle tone, hyperactive stretch reflexes, and possible clonus.

Typically the patterning seen in patients after a cerebrovascular accident is consistent with either flexor posturing or extensor posturing. Flexor posturing is characterized by the hip in flexion, adduction, and internal rotation with the knee in flexion and the foot in equinovarus. Extensor posturing is characterized by an elevated and retracted hemipelvis with the hip extended, internally rotated, and adducted. In extensor posturing, the knee is also extended and the foot is in equinovarus. These postural deformities are caused by neurologically-induced muscle imbalances, which also affect the lower extremity resulting in a disproportionate distribution of biomechanical forces around the hindfoot leading to the characteristic cavoadductovarus deformity (1). This deformity predisposes patients to an increased risk of decubitus ulceration and infections, as well as posing significant difficulty in wearing shoes and ambulating safely (2).

BIOMECHANICAL ANALYSIS AND POTENTIAL INTERVENTIONS

According to Keenan et al, the greatest deforming force in patients with neurologically-induced cavoadductovarus deformity was the tibialis anterior tendon (3). The study included 59 patients with a spastic deformity that were treated using a split anterior tibialis tendon transfer and adjunctive procedures as necessary. Patients were preoperatively evaluated using gait analysis and dynamic electromyography. They found that tibialis anterior, flexor hallucis longus, and gastrocnemius had the highest rate of continuous fire throughout the gait cycle. Tibialis posterior was found to be silent throughout the gait cycle in 12 patients and prematurely phasic in 11 patients. Peroneus brevis was also found to be silent in 11 patients. Flexor digitorum longus, peroneus longus, and peroneus brevis were found to be less likely to fire continuously and more commonly were prematurely firing, but in phase. They concluded that the greatest deforming forces were the tibialis anterior, the flexor halluces longus, and the gastro-soleal complex.

Specifically, the tibialis anterior tendon results in an inversion deformity whereas flexor digitorum longus is responsible for forefoot cavus and claw toe deformities. The triceps surae is responsible for the severe equinus deformity and the posterior tibialis is responsible for forefoot adductus when it is involved. The flexor hallucis longus tendon is responsible for hallux malleus deformities. When involved, peroneus longus tendon is responsible for plantarflexion of the first ray (2-4).

Surgical intervention is reserved for patients who have already failed physical therapy and bracing efforts. Physical therapy treatments that are typically employed include active and passive mobilization, stretching exercises, neuromuscular re-education, biofeedback techniques, balance reactions, and gait training using specific bracing devices such as double upright aluminum braces with a medial T-strap. Once all conservative therapies have been exhausted, surgery can be explored. Surgical correction must be aimed at the specific plane of deformity in order to be effective (1,3,4). Potential surgical corrections include split or total tibialis anterior tendon transfer, gastrocnemius recession, tendo-Achilles lengthening, peroneal tendon transfer, posterior tibial tendon release, and double or triple arthrodesis (2,4-7).

CASE PRESENTATION

A 67-year-old male presented in 2014 with a lateral fifth metatarsal base wound that ultimately resulted in total amputation of the fifth ray with debridement and loss of the peroneus brevis tendon. The patient had a cerebrovascular accident in February of 2013 and had noticed subsequent progressive deformity (plantarflexion-adduction) of his right foot. After the surgical wound healed, initial release of the posterior tibial tendon was performed to remove the unopposed inversion force on the foot as a result of agonist-antagonist function. Following this, serial casting was begun with some degree of correction. However, a significant equinus contracture remained, which was then addressed surgically with an Achilles tenotomy, followed by casting, which reduced the equinus deformity for a short time. Botulinum toxin injections were applied to the tibialis anterior muscle belly to reduce its spastic nature. These therapies rendered mild improvement of deformity. However, these deformities became rigid (Figure 1) and required osseous intervention to completely correct and stabilize the foot.

On April 2, 2015 the patient was taken to the operating room and placed in the supine position. The patient was then placed under general anesthesia and a local field block was applied. Attention was directed to the posterior-medial aspect of the right foot and ankle where a curvilinear skin incision was made and dissection was carried deep to the Achilles tendon. In order to reduce the equinus deformity, approximately 4 centimeters of the Achilles tendon was removed. The posterior capsule of the ankle and subtalar joints were contracted and subsequently released.

While taking the foot through range of motion, the medial malleolus was iatrogenically fractured. This was easily reduced and repaired using a single 4.0 partially-threaded screw. The medial release was then performed (7-9). The flexor hallucis longus tendon was transected posterior to the medial malleolus to reduce the hallux malleus contracture. Upon release, the hallux was noted to have increased range of motion. The flexor hallucis longus tendon was left attached at the master knot of Henry. The remaining digits were still flexed in a claw-toe attitude, so the flexor digitorum longus tendon was identified and lengthened via an open Z-plasty technique.

Attention was directed to the subtalar joint. A medial incision was made into the capsule and the articular surfaces of the subtalar joint were prepared for arthrodesis (9-19). The talonavicular joint was also identified and denuded of articular cartilage (15). The subtalar joint was fixated in a rectus position using two 6.5 partially-threaded screws (16). The talonavicular joint was then fixated using one 5.0 partially-threaded screw with a washer and a second point of fixation using a single staple. Attention was then directed to the insertion of the tibialis anterior tendon, which was released from its insertion and prepared for transfer (5,10). The FDL tendon was repaired using 4-0 nylon.

Attention was then directed to the lateral aspect of the foot overlying the cuboid where a 4-centimeter incision was made. The extensor digitorum brevis muscle belly was identified and reflected to gain access to the cuboid. Once the cuboid was visualized, a 9-millimeter bone plug cutter was used to remove a circular piece of bone from the central cuboid. The tibialis anterior tendon was passed through the previously created subcutaneous tunnel using a tendon passer. Using Keith needles, the tibialis anterior tendon was then passed through the hole in the cuboid while the foot was held in a dorsiflexed-everted position, and anchored to the bottom of the foot using a washer and

Figure 1A. Stress radiograph. Note significant overlapping of the talus over the calcaneus.

Figure 1B. Lateral view stress radiograph reveals residual equinus position.

Figure 1C. Clinical view of the right foot. Note the foot is in maximum stress correction, still in inverted adducted position. There is evidence of equinus deformity, and the previously healed incision from the fifth ray resection is evident.

bolster dressing. All incisions were closed in layers followed by the insertion of a TLS drain (Figure 2).

The surgical sites were dressed appropriately and the patient was placed into a posterior splint with a modified Jones compression dressing. At the time of staple removal, the patient was noted to have full-thickness dehiscence at the medial incision site. After local wound care, this healed uneventfully and the patient did not require additional operative procedures or antibiotics. The patient was casted for custom molded shoes and was able to ambulate with a walker by December 2015. Although he was very satisfied with the correction of the right foot, he noticed a continued progression of deformity of the left foot despite being placed in custom molded shoes, and requested surgical intervention for the left foot as well (Figure 3).

On September 29, 2016 the patient was brought into the operating room and placed in a supine position. The patient had been given a popliteal block preoperatively and was then placed under general anesthesia. Under thigh tourniquet control, a long curvilinear incision was made on the medial aspect of the left foot and ankle and dissection was continued to the Achilles tendon. The equinus deformity was not as severe as it was on the right foot and a frontal plane Achilles Z-plasty tendon lengthening was sufficient to reduce the equinus deformity (10). No posterior release of the subtalar or ankle joints was needed.

Attention was then directed to the tarsal tunnel where the flexor tendons were identified. The tibialis posterior tendon was identified and released from its insertion (7-9). A Z-plasty was performed on the flexor digitorum longus tendon and repaired in a lengthened fashion.

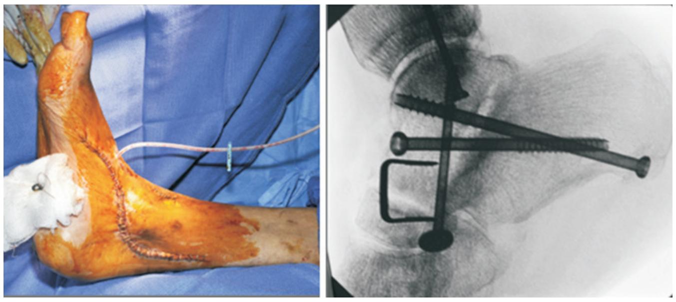

Figure 2A. Intraoperative clinical view (left) and fluoroscopic image (right) identifying the TNJ, STJ, and medial malleolar hardware.

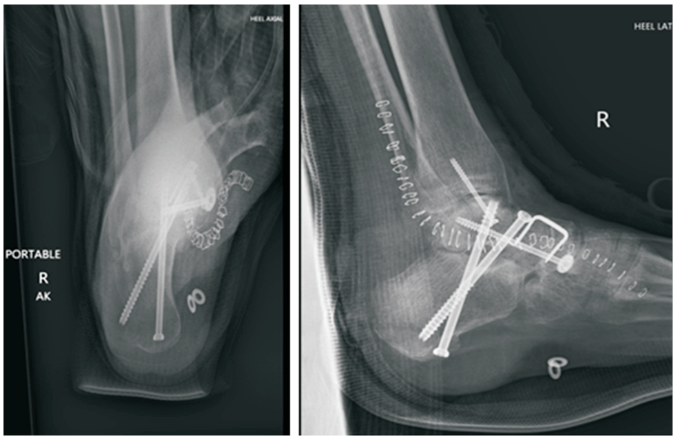

Figure 2B. Postoperative radiographs of the right foot. The equinus is reduced, the talo-first metatarsal line is re-established, and the frontal plane deformity of the hindfoot corrected.

Figure 3A.Weight bearing posterior view of both feet, after reconstruction of the right foot. Note the plantigrade right foot and adductocavovarus of the left foot.

Figure 3B.Weight bearing clinical view after reconstruction of the right foot.

Figure 3C. Preoperative radiographs of the left foot, identifying triplane deformity, adductocavovarus, and equinus

The talonavicular and subtalar joints were prepared for arthrodesis (11-19) and stabilized using a single 6.5 partially-threaded screw at the subtalar joint and a single 6.5 partially-threaded screw across the TNJ, supplemented with a single staple. The position of the foot was evaluated and deemed unnecessary to perform the tibialis anterior tendon transfer. However, in order to reduce the plantarflexed deformity of the first ray, a peroneal tendon transfer would be necessary. By performing this transfer, it would not only weaken the peroneus longus and reduce its plantarflexory pull on the first ray but would also provide more power to the peroneus brevis to counteract the supinatory pull of the tibialis anterior (17).

Attention was directed to the lateral side of the left ankle, where a linear incision was made retromalleolarly. Dissection was continued down to the level of the peroneal tendons. The peroneus brevis and peroneus longus tendons were identified and the peroneus longus tendon was sutured to the peroneus brevis tendon prior to being severed distal to the anastomosis site (10). All of the incisions were then closed in layers and the foot was dressed in the standard fashion (Figure 4). The patient was then placed in a posterior splint with a modified Jone's compression dressing. The patient was most recently seen at his 6-week appointment, and was transitioned from nonweight-bearing in a fiberglass cast to partial weight-bearing in a CAM walker. The incision sites have remained healed with exception of a minor, superficial dehiscence to the medial incision site. The patient will be changing the bandage daily with betadine and will be seen again in 6 weeks for the 3-month follow-up visit.

In conclusion, although adult cavoadductovarus deformity is a complicated and often challenging etiology, there are multiple approaches to addressing the problem. Conservative therapy including bracing, strapping, and custom shoe gear should be exhausted before performing any surgical intervention, but should these fail, there are a multitude of surgical procedures to adequately correct the deformity. If the deformity is addressed prior to becoming a rigid deformity, soft tissue procedures may be adequate. However, if the deformity persists, osseous procedures may be necessary. The most important things to consider when planning for an adult cavoadductovarus reconstruction is evaluating all planes of the deformity, the expectations of both the patient and the surgeon, and the weight bearing goals of the patient. The patient underwent both a staged approach and a single operative case approach, proving that both approaches are valid and appropriate.

Figure 4A. Intraoperative view of closure of the left foot.

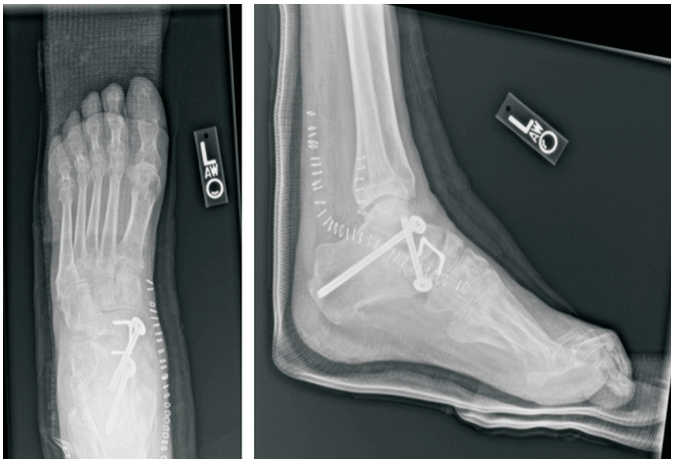

Figure 4B. Postoperative radiographs of the left foot.

Figure 4C. One-week postoperative view of the left foot. All 3 planes of the deformity have been corrected.

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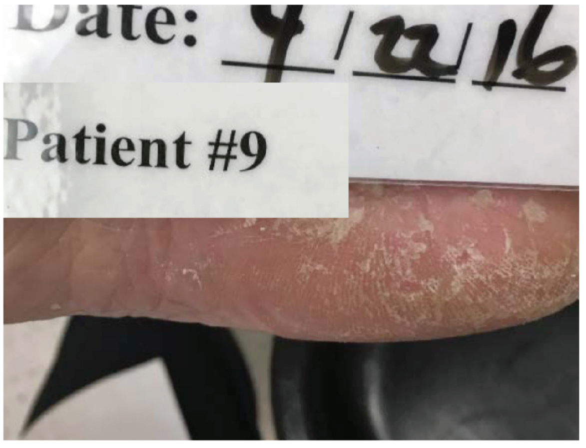
ACHIEVE SMOOTH SUPPLE SKIN AGAIN

Initial presentation, March 9, 2016
Left foot, type 2 diabetic with severe fissuring distal lateral forefoot

Subsequent visit, April 18, 2016
5 weeks marked improvement for left foot with one remaining superficial fissure

Initial presentation, March 22, 2016
Medial Right Heel – fissured, scaly, hyperkeratotic



Subsequent visit, April 22, 2016
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