The Use of Transverse Tibial Transport For Non-Healing Diabetic Foot Ulcers – A Case Study

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Statement of Purpose

The purpose of this study is to assess whether using Transverse Tibial Transport can increase angiogenesis in the lower limb to promote wound healing.

Introduction and Literature Review

Diabetic foot ulcers (DFU) can be a severe complication of diabetes mellitus, typically presented as ulcers, infection, or destruction of tissues of the foot. DFU has been the leading cause of non-traumatic lower extremity amputation (LEA) in the world. The rate of LEA in diabetes has been shown to be more than five times higher than those without diabetes (1) Factors that can lead to Lower extremity amputation include but are not limited to: decreased Ankle-Brachial index, failed revascularization, below the ankle arterial disease. (2) The Wagner staging system has been used to assess wound depth, presence of osteomyelitis, and the presence of gangrene. This staging system has a range from 0 to 5, with stage 4 the first stage where amputation may be warranted; but is not limited to negative pressure wound therapy, and vascular revascularization. (3). Revascularization procedures are commonly indicated when there is a toe is less than 30 mmHg or ankle is less than 50 mmHg or less than 0.5. When revascularization is a viable modality of surgical intervention, limb salvage rates reached 80-85%. (4). However, revascularization is not always a viable option, as there are times when there isn't any arterial target for revascularization or in cases where surgery isn't indicated for the patient, due to surgical risk based on the patient's medical history or there is an unfavorable risk-benefit to surgical intervention. (4). When there is no viable target for revascularization, offloading attempts are made from a limb salvage prospective, however the likelihood of a below the knee amputation risk increases. Recent literature has suggested that the use of the Ilizarov technique creates transverse distraction of the tibia by dispersing a rectangular bone fragment separated from the diaphysis without altering limb length, increasing the blood supply to the entire limb. (5)

Case Study

Patient presented to wound care center as a long-standing wound care patient with a chronic stump wound on the left foot. This patient has an extensive past medical history, pertinent to stage 4 chronic kidney disease, Arteriovenous fistula occlusion, Chronic osteomyelitis of left foot, Depression, Hypertension, Neuropathy due to secondary diabetes, PVD. The wound has shown significant regression over the past 5 months in which they have been offloading the wound with a knee scooter. The patient relates their current wound care is silver alginate with a dry, sterile dressing. On physical exam at this visit, the patient has a full thickness, macerated and scarred wound measuring 1.2 cm X 1.5cm X 0.5 cm. The wound has a large, serosanguinous draining wound that has been reported to be healing at -125% since the last follow-up. Previous Ankle Brachial Index were reviewed at this visit as the patient had just seen their Vascular Surgeon where triphasic waveforms with calcified vessels were found. At the time of the previous appointment, no vascular intervention was scheduled as the patient was not deemed a candidate for Vascular Intervention. They presented to the wound care center for potential surgical intervention to promote healing as they have been taken off the Kidney transplant list due to the wound. The patient related they were told they are not a candidate for revascularization or bypass by Vascular surgery as previous imaging showed triphasic waveforms with calcified vessels. The discussion of transverse tibial transport was discussed at the wound care clinic and in a subsequent clinic appointment with an Orthopedic Traumatologist, who would be surgically applying the external fixator in a combination case with the following Podiatrist, who would be applying a skin graft substitute.

Case Study Continued

The patient then elected to pursue this surgical intervention. 6 weeks later, the patient underwent surgery with a fellowship trained Orthopedic Traumatologist and a Podiatrist in which a uniplanar external fixator was applied to the anteromedial proximal tibia and the DFU was debrided, sutured close with non-absorbable suture and a skin graft substitute applied over the wound. The patient then had follow-up at one week, 3 weeks, 6 weeks, 7 weeks and 10 weeks. The first two follow-up visits included pin site checks, re-discussion of proper turning of the external fixator and pain tolerance discussion. At 6 weeks, the patient was educated that they may start rotating the external fixator counterclockwise at 0.25 mm a day. At the 7-week mark, the patient was restarted on Doxycycline and re-educated on pin site monitoring. At the 10-week mark, the patient was scheduled for surgery for removal of the external fixator. 14 weeks post application of uniplanar external fixator, the patient underwent the second stage of surgical intervention where the external fixator was then removed with a second kin graft substitute applied to the original wound. One-week post-removal, the patient was seen in the Podiatry wound care clinic, where it was documented full healing on the previous wound. Of note, the patient was able to reapply to the transplant list, where they will wait until a transplant donor is available.

Limtations

This case study was a singular patient, understanding a proximal amputation was the next step in treatment if this failed. A limitation of this study is this wound was small enough in size, where wound closure was able to be attempted at the time of the application of the uniplanar external fixator. There was also potential selection bias with this patient, as the patient was chosen to be the first patient to get this procedure with this surgeon. A large-scale study would need to assess whether wounds that are unable to be closed primarily still have the same healing potential long term than those that do not. When incorporating a large-scale study, long-term data would additionally need to show a repeat Ankle-Brachial Index's supporting the increase in vascular supply, to ensure this procedure aids in the long-term healing of a patient's wound. Finally, a longer follow-up period needs to be assessed to be able to objectively track pain scores with and without the external fixator.

Discussion

Diabetic foot ulcers are one of the many complications with Diabetes Melitus. Management of wounds requires repeated follow-ups, daily monitoring and daily dressing changes with the use of various wound care products, depending on the extent of the wound. These diabetic patients often face additional hurdles to healing due to diabetes such as decreased vascular supply to the distal lower extremity. These diabetic foot ulcers increase a patient's risk to infection, whether soft tissue or osseous infection. Management of infection depends on the extent of the infection, with some patients having the potential for local wound care with a 6-week course of antibiotics, whether oral or intravenous. Surgical management of these infections comes in the form of osseous resection or amputation. Traditionally, vascular status is assessed in patients with diabetic foot ulcers prior to any surgical intervention. This is typically done through advanced imaging modalities such as an Ankle-Brachial Indexes and a possible referral to a vascular specialist, who can deem whether there is a possible opportunity for revascularization through an angiogram and possible bypass. However, when infection spreads proximally, or patients are not candidates for revascularization, the option for proximal amputation presents itself. Recent literature as shown that mortality after a below-knee amputation is 32% at one year (6). For patients with diabetic foot ulcers, that are not candidates for revascularization by a vascular specialist, healing potential is anticipated to be low. The use of transverse tibial transport has offered a new option for patients to potentially help increase the angiogenesis in the lower extremity. By applying long-studied Ilizarov techniques, the use of a uniplanar fixator may give patients an alternative to a below-knee amputation in situations whether blood supply is inadequate for healing. However, this study achieved its purpose, showing that Transverse Tibial Transport can improve angiogenesis, and can be

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