A Case Report for Treatment of Osteomyelitis of the Great Toe in a Patient with Diabetes using the Extended Reverse Flow Extensor Digitorum Brevis Muscle Flap

Authors: Ron Belczyk, DPM¹; David Pougatsch, DPM²; Wenjay Sung, DPM³; Lee Rogers, DPM⁴

Abstract:
Healing open wounds using local muscle flaps for coverage over bone and deep soft tissue defects has been discussed in medical literature for several decades. We present a case of a diabetic patient with gangrene and osteomyelitis of the hallux who underwent a single incision reverse flow extensor digitorum brevis muscle flap utilizing the deep perforating artery at the 1st tarsal-metatarsal joint and subsequent split thickness skin grafting. No complications with long-term sequellae were noted. We suggest that the reverse flow extensor digitorum brevis muscle flap is a viable option to gain much needed soft tissue coverage over problematic distal foot wounds in the diabetic population.

Key words: Extensor digitorum brevis (EDB), muscle flap, diabetic, neuropathic, osteomyelitis, gangrene, wound

Level of Clinical Evidence: Level V – Case Report

INTRODUCTION

The extensor digitorum brevis (EDB) muscle flap was initially reported as an option for local soft tissue reconstruction in the 1970’s.¹ Since that time, there has been an increased utilization of the muscle for a variety of applications including the coverage of foot and ankle defects²-⁴.⁴,⁵,⁶.

Of particular interest is the extended distally based EDB muscle flap for salvage of the hallux⁷,⁸,⁹. Since the hallux is vital in maintaining normal foot function, it would be ideal to preserve it. The hallux’s main role is propulsion, allowing for transition from the stance phase to the swing phase of gait. Approximately 22% of body weight is placed on the hallux during toe-off. Lack of a hallux results in gait abnormality and redistribution of pressure along the central column of the foot. This phenomenon can lead to transfer lesions, which can develop into
ulcerations in the insensate foot. Lack of appropriate pressure distribution along the foot can also, in time, result in deformity of the lesser digits making them subject to ulceration. The inability to effectively shoe the insensate foot with a great toe or first ray amputation can yet be another cause of ulceration.

Treatment becomes difficult when there is a significant postsurgical tissue defect along the operated hallux, which is not amenable to skin grafting. Reconstruction of the distal foot, especially the toe, has posed a challenging problem. There are few local flap options available for distal forefoot and toes such as the “fillet of toe”, dorso-metatarsal first web flap, and the distally based dorsalis pedis flap. However, these options have significant donor site morbidity and limited arc of rotation.

The proximity and advantages of the EDB muscle make it an attractive option for coverage of the toes. The flap is useful due to muscle size and thinness, consistent vascular anatomy, large vessel size, ease of dissection, minor donor site morbidity, arc of rotation and length of the pedicle. The limited bulk of the muscle allows for primary closure of the donor site. Since the muscle is a secondary toe extensor it is expendable without functional deficit. The arc of rotation and length of the pedicle permits coverage of defects of the toes. Muscle flaps are preferred in the management of complicated wounds involving exposed bone. They are pliable, contour to defects, fill dead space, provide improved tissue ingrowth, enhance local delivery of antibiotics, and revascularize underlying bone.

This article demonstrates the use of the extended distally based EDB muscle flap for limb salvage in a patient with diabetes and osteomyelitis of the great toe.

MATERIALS AND METHODS

Case Report

The patient is a 55 year-old Caucasian female who presented with a history of minor trauma resulting in an infection of the right hallux. She related that the process had been ongoing for 10 days with gradual worsening of the gangrenous changes, and with increased malodor and drainage for the preceding four days. She was newly diagnosed as having type 2 diabetes mellitus. The patient had nothing significant in her past medical history except for diabetes.

On presentation, she complained of increased darkening of skin color to the right hallux for approximately 6 days followed by a period of the toe turning white, with subsequent purulent drainage for the prior 4 days. She did not complain of any pain to the foot, but had fever and chills. Physical examination revealed an oral temperature of 100.5° F, pulse 92 and blood pressure 122/60 mmHg.

She had a severe hallux valgus deformity of the right foot with gangrenous changes to the distal aspect of the toe. There was purulent drainage associated with fecal malodor and cellulitis of the forefoot. Protective sensation was absent by monofilament exam. Vascular examination revealed 4+ superficial femoral pulses, 4+ popliteal pulses, 4+ dorsalis pedis pulses, and 4+ posterior tibial pulses. Triphasic signals were obtained on Doppler assessment of the pedal pulses (Figures 1a and 2b).

Initial laboratory data was significant for an elevated white blood cell count of 12,100/L with 82% neutrophils, hemoglobin and hematocrit of 12.1 g/dL and 31.9% respectively, BUN 35, creatinine 4, and a glucose of 385 mg/dl. She was later determined to have a hemoglobin A1c (glycosylated hemoglobin) of 11.6%. Blood culture was negative and urine culture was positive for candida species.
X-ray findings revealed hallux valgus deformity with degenerative disease of the 1st metatarsophalangeal joint. Chest X-ray and electrocardiogram revealed no abnormal findings. Preoperative MRI reported the following:

1. Diffuse cellulitis of the forefoot affecting the digits, particularly the first digit with exposed distal phalanx.

2. 2.2 x 1.4 x 3 cm phlegmonous/abscess collection tracking along the plantar/medial border of the first digit. A small phlegmonous collection is considered along the medial border of the second digit.

3. Marrow edema affecting the first proximal and distal phalanges consistent with osteomyelitis.

4. First MTP joint osteoarthritis as described with hallux valgus angulation and joint effusion. Please note marrow edema in this location may be degenerative in nature and may be followed up for stability.

5. 8 mm sclerotic focus within the first proximal phalanx is identified. This likely relates to the aforementioned process/osteomyelitis with lateral cortical erosion.

On admission the patient had been placed empirically on broad-spectrum antibiotic coverage with vancomycin and piperacillin/tazobactam. Due to the severity of the infection, an initial bedside incision and drainage was performed and soft tissue cultures were obtained. Initial cultures revealed:

- Organism: 3+ Streptococcus agalactiae, group B
- Method: Vitek MIC
- Penicillin G: <=0.12 Susceptible
- Clindamycin: <=0.25 Susceptible
- Vancomycin: <=0.5 Susceptible
- Cefazolin: Susceptible
Once medically stable, the patient was taken to the operating room for a debridement of non-viable soft tissue and bone associated with her right great toe pathology. The hallux interphalangeal joint was incised and disarticulated. The distal phalanx and surrounding soft tissues were visibly necrotic. Further incision was made along the plantar aspect of the toe coursing with the flexor hallucis longus tendon to explore if the infection had tracked proximally. The tendon was transected as far proximally as visualized, until no further signs of necrosis were seen. The adjacent second toe was also noted to have questionable viability at the proximal aspect with exposure of the extensor digitorum brevis muscle. This was subsequently debrided of all non-viable tissues. The wound was left open for drainage.

One week later revisional debridement was performed. At that time, the infection appeared eradicated. Due to the exposed proximal phalanx there was a concern regarding further osteomyelitis and/or desiccation of tissues and bone. Given the patient’s adequate vascularity and need for accelerated closure, a muscle flap was performed. Using a handheld Doppler, the course of the first dorsal metatarsal, dorsalis pedis, and lateral tarsal arteries were identified. A linear incision was made dorsally from the proximal aspect of the toe incision to the origin of the extensor digitorum brevis muscle. Care was taken not to disrupt the underlying neurovascular structures. The origin of the muscle was incised and carefully reflected distally. The muscle flap was then elevated with respect to the deep perforating artery at the level of the tarsal-metatarsal joint. Rotation of this flap occurred at the axis of the deep perforating artery at the 1st tarsal-metatarsal joint. Once the muscle belly was freed, it was advanced distally to the hallux (along the 2nd metatarsal phalangeal joint) and dorsal and medial aspects of the 2nd toe, covering the hallux proximal phalanx and all other exposed soft tissue structures. The donor incision along the dorsal foot was closed with the same non-absorbable sutures. Petrolatum gauze was used to cover the flap and was bolstered with a negative pressure wound therapy dressing set on low continuous suction (Figures 2a and 2b).

Figure 2a and 2b. Intraoperative pictures of a distally based EDB muscle flap supplied by the first dorsal interosseous artery. A partial toe disarticulation had been performed at a prior operative setting.
The patient was noted to have increasing creatinine levels and was recommended by her nephrologist to start hemodialysis. Two days postoperatively our vascular surgery colleague placed a Quinton catheter in her right common femoral vein. Her kidney function improved and she was subsequently discharged on a six-week course of vancomycin for treatment of possible residual osteomyelitis.

Following hospital discharge, the patient had weekly outpatient consultation for her wounds, continuation of negative pressure wound therapy along the flap site and was immobilized in a controlled ankle motion (CAM) boot.

**RESULTS**

The patient had weekly postoperative visits following skin grafting. Negative pressure dressing was discontinued after 48 hours. A complete skin graft take occurred and all wounds were determined healed at 8 weeks postoperatively (Figures 3a and 3b). At a 4-month follow-up, all wounds remained closed and she is ambulating in custom diabetic shoes with plastizote insert and filler. There were no significant postoperative complications.

Following completion of her antibiotics, a decision was made to cover the healing muscle flap with split thickness skin graft. A hypertrophic scar developed at the donor site which became symptomatic and required excision with revisional closure.

A split thickness skin graft was harvested from the ipsilateral thigh and meshed 1.5:1. The graft was applied to the defect site at the hallux and 2nd toe, and secured with a combination of 4-0 nylon suture and skin staples. The recipient site was dressed with petrolatum gauze and bolstered with silver foam dressing.
The EDB muscle is a thin muscle located on the dorsum of the foot. It originates from the sinus tarsi and dorsolateral surface of the calcaneus. It courses distally and medially, terminating on the base of the hallux and along the lateral aspect of extensor digitorum longus tendons of the 2nd through 4th digits. The muscle shape is trapezoidal and its dimension is typically 5 cm x 6 cm with a surface area 19-34 cm².

The dorsalis pedis artery (DPA) is a continuation of the anterior tibial artery, which courses inferior to the extensor retinaculum. The medial and lateral tarsal arteries (MTA and LTA) branch from the DPA. The MTA travels medially and deep to the abductor hallucis muscle to anastomose with the medial plantar artery. The LTA runs laterally and situates itself along the deep surface of the EDB muscle. Anatomical variations exist where additional muscular branches stem from the DPA to the EDB muscle. In some individuals, the perforating branch of the peroneal artery supplies the EDB muscle. Once the DPA reaches the first intermetatarsal space, it gives off a deep plantar branch and continues on as the first dorsal metatarsal artery (FDMA). The FDMA then courses distally towards the first web space where it passes over the deep transverse intermetatarsal ligament, branches into two dorsal digital arteries, and communicates with the plantar arterial network.

The EDB muscle has a type 2 vascular pattern, which means its dominant vascular pedicle is near the muscle origin and it has minor vascular pedicles. Typically, the dominant vascular pedicle is supplied by the LTA or DPA. There are three ways to provide blood supply for a distally based flap: based on the medial tarsal artery, based on the connection between the first dorsal interosseous artery with plantar artery. The most reliable option is at the pivot point at the tarso-metatarsal joint since it has the most reliable vasculature and venous return. The extended distally based EDB muscle flap is based on the FDMA.

The presence of retrograde flow should be confirmed preoperatively using a Doppler and/or angiogram before committing to this procedure. If the dominant vascularity is based on the peroneal artery or DPA is a single vessel run-off to the foot, then other options should be considered.

The main limitations to this flap include limited muscle size and sacrifice of a major blood vessel. Additionally, the muscle may not cover the entire defect. In situations where the muscle is smaller than anticipated and cannot cover the vital structures, then a back up plan may be necessary (such as using a free-flap). In the situation with a 1-vessel run-off to the foot, the flap may be unreliable and/or the donor site may not heal.

In summary, the extended distally based EDB muscle flap may be an alternative limb salvage option, in select cases, in patients with diabetes.
References


Additional Reading