Application of the distally pedicled peroneus brevis: Technique, case study, and pearls

by Chad Seidenstricker DPM¹, Megan L. Wilder DPM², Byron L. Hutchinson DPM, FACFAS³

Soft tissue defects of the distal leg and hindfoot are difficult to eradicate. Avascular structures become exposed through seemingly superficial wounds rather quickly. The present case describes a surgical technique for the peroneus brevis muscle flap for coverage of a postoperative lateral heel wound following a lateral extensile approach for ORIF of a calcaneal fracture. Nonoperative and operative wound care modalities failed over the course of several years, and a peroneus brevis rotational flap was attempted for wound coverage. Although several minor complications occurred, the wound had successful epithelialization at 3 months. The distally pedicled peroneus brevis muscle flap offers a good option at wound coverage in difficult to heal wounds of the distal leg and hindfoot.

Key words: muscle flap, peroneus brevis, soft tissue defect, ankle, foot

This is an Open Access article distributed under the terms of the Creative Commons Attribution License. It permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. ©The Foot and Ankle Online Journal (www.faoj.org), 2016. All rights reserved.

Soft tissue defects of the foot and ankle present a significant challenge. There is little soft tissue coverage and exposed tendon and bone can easily occur following elective reconstruction or trauma, requiring surgery. Skin grafting is often not an option in this region as bone and tendon are not suitable as a recipient bed. Rotational muscle flap techniques for foot and ankle wound closure are gaining popularity and have proven effective. Muscle flaps offer pliability and can eradicate dead space, can overcome residual bacterial infection in bone, improve blood flow, and will provide a vascular recipient bed for split thickness skin grafting [1]. While negative pressure wound therapy devices are excellent at promoting expedited closure of deep wounds, they should not be placed directly over bone or tendon and especially not in the setting of residual infected tissue.

Indications for rotational muscle flap wound closure may include exposed bone with osteomyelitis, traumatic wounds, non-healing wounds over the lateral ankle and hindfoot after Achilles tendon procedures, surgical wound dehiscence recalcitrant to nonoperative therapies after calcaneal fractures, ankle fractures, and total ankle arthroplasty. In a systematic review, Yu et al, demonstrated a wound complication rate of 13.5% in calcaneal fractures after ORIF [2]. There has been a movement toward minimally invasive techniques, but the lateral extensile incision is still routinely utilized. Raikin et al demonstrated an 8.5% incidence of wound complications following TAR with anterior midline incisional approach that required at least one secondary visit for surgical wound debridement [3]. Wound dehiscence after TAR requires immediate definitive treatment to avoid catastrophic deep space infection.

1 - Podiatry Resident at Swedish Medical Center PGY-3, Seattle, WA
2 - The Everett Clinic, Marysville, WA
3 - Director, Franciscan Foot and Ankle Institute; Medical Director, Foot & Ankle Service, CHI Franciscan Health, Federal Way, WA.

* - Corresponding author: chaddpm14@gmail.com

doi: 10.3827/faoj.2016.0903.0003
The distally pedicled peroneus brevis muscle flap offers a relatively simple, reproducible and reliable option for wound closure with complication rate equal or reduced compared to other techniques. In general the muscle flap should not be used as a first line procedure, but is used in limb salvage situations and has very little downside. The peroneus brevis muscle flap also has the advantage of low donor site morbidity and heals with minimal scar. Lower extremity surgeons can easily perform the peroneus brevis flap closure if it is acceptable in the foot and ankle specialist’s region to perform this type of procedure.

### Rationale & Background

Attinger described the role of various intrinsic muscle flaps for small wound closure of the foot and reported a 96% success rate [4]. The abductor hallucis muscle flap has been reported to provide excellent outcomes in planter heel defects [4,5]. While intrinsic flaps have proven efficacy for small wounds about the foot, they are not sufficient for larger wounds of the hindfoot, ankle and lower leg. Larger wounds in the distal third of the leg and hindfoot are amenable to the peroneus brevis flap. The peroneus brevis muscle is classified as a type IV muscle flap by Mathes and Nahai, which represents a muscle flap with segmental blood supply provided by branches of equal importance (Table 1) [6]. Ensat et al evaluated the blood supply of the peroneus brevis muscle flap identifying constant blood supply by segmental branches of the peroneal and tibial arteries and also supported Yang’s finding of the most distal pedicle being provided between 4-5 centimeters proximal to the tip of the fibula [7,8]. Ensat also recommended a pivot point at least 6-cm above the tip of the fibula to assure there is an intact vascular pedicle, however, this should always be evaluated intraoperatively [7]. The muscle length available for rotation is close to 20-cm, but due to distal flap necrosis, the most proximal 2-cm should always be removed, providing a muscle approximately 18-cm in length [9,10,11].

The arc of rotation is determined by the most distal vascular pedicle, which should allow an average of 12-cm from the pivot point.

We present a case in which a chronic lateral heel wound following ORIF of calcaneus was treated successfully with a distally pedicled peroneus brevis flap. Our scenario is similar to Rodriguez who recently reported success of the peroneus brevis flap following wound dehiscence after ORIF of a lateral malleolar fracture with subsequent surgical wound dehiscence [12].

### Case report

In this case report, a 63 year old male non-smoker sustained a closed intra-articular calcaneal fracture. The records from previous surgeons were not retrieved so the exact timeline is unknown but the following events occurred over the course of several years prior to his definitive operation and closure. The patient had an ORIF through a lateral extensile approach with dehiscence at the apex of the incision which never fully healed. He had hardware removal and local wound care which failed. He then had a small rotational flap which failed, followed by an advancement flap which resulted in re-opening of the sinus tract and a chronically draining wound with exposed bone. He presented to a local plastic surgeon for consultation who felt a free flap was not a good option. He then presented to the author’s clinic for a preoperative evaluation. On arrival to clinic the patient had a small wound at the apex with a sinus tract and suspected osteomyelitis of the lateral calcaneal wall, which was draining minor amounts of serous fluid (Figure 1). A distally pedicled peroneus brevis rotational flap was planned.

### Table 1: Mathes & Nahai [6] classification of muscle and myocutaneous flaps

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>One vascular pedicle</td>
</tr>
<tr>
<td>II</td>
<td>Dominant pedicle(s) and minor pedicle(s)</td>
</tr>
<tr>
<td>III</td>
<td>Two dominant pedicles</td>
</tr>
<tr>
<td>IV</td>
<td>Segmental vascular pedicles (ie Peroneus Brevis)</td>
</tr>
<tr>
<td>V</td>
<td>One dominant pedicle and secondary segmental pedicles</td>
</tr>
</tbody>
</table>

Copyright © 2016 The Foot and Ankle Online Journal
Figure 1 Chronic lateral hindfoot wound recalcitrant to several operative debridements, antibiotics, local wound care, and local skin flaps.

Figure 2 Lateral incision over the fibula, with the peroneus longus retracted inferiorly and the peroneus brevis muscle belly and tendon origin exposed.

Figure 3 Peroneus longus in the right hand, and peroneus brevis muscle belly held in the left.

Figure 4 Peroneus brevis muscle belly being elevated off the fibula, moving proximally.

Surgical technique

After skin preparation, and exsanguination of the limb, a pneumatic thigh tourniquet was inflated to 350mmHg. An incision was made overlying the lateral heel wound in a curvilinear fashion extending a few centimeters proximally and a few distal to the wound. The scar tissue was bluntly dissected through down to calcaneus, and the skin was elevated in a single layer as a flap. There was a loose portion of cement that was noted in the lateral wall of the calcaneus which had been left from a prior surgery and this was removed.

The calcaneus was debrided to good, healthy bleeding bone that appeared without signs of infection. Attention was then directed to the lateral leg where a standard incision was made as described by Eren [13]. The incision connected with the lateral heel wound incision. The crural fascia overlying the peroneals was incised (Figure 2). The peroneus brevis was followed up its muscle belly proximally until the origin was released (Figure 3,4,5). Segmental pedicles were ligated from proximal to distal until approximately 6-cm proximal to the lateral malleolus.
Utilizing ultrasound, a vascular pedicle was identified at this level (Figure 6). Care was taken to not violate the pedicle. The peroneus brevis was folded from proximal to distal into the wound and overlying the exposed calcaneal wound (Figure 7). It was loosely secured in place overlying the lateral wall of the calcaneus. The wound was then closed in layers proximally, leaving the distal wound overlying the lateral wall of the calcaneus open with the muscle flap secured within the wound (Figures 8, 9).

An Integra bilayer wound matrix was then placed and trimmed to the appropriate size overlying the muscle flap (Figure 10). It was secured in place around the rim of the wound utilizing staples with a single staple in the middle of the flap. The membrane was then fenestrated to allow drainage. The site was then dressed with negative pressure wound therapy (Figure 11). A monorail external fixator was applied to the medial calcaneus and medial tibia with half pins to establish stability while being able to access the wound for local wound assessment and care in the early wound healing phase (Figure 12). Proper alignment was confirmed under fluoroscopy. Sterile dressings were then applied. Tourniquet was deflated.
Figure 9 Closure of the incision along the lateral leg down to the original defect site. The original defect site should be left open, and ideally is covered with a biologic dressing.

Figure 10 Securing an Integra graft over the exposed peroneus brevis in the chronic wound site with staples.

Figure 11 Wound vac secured over the Integra graft after fenestrating the integra graft.

Figure 12 Unilateral External fixator applied to the medial tibia for stabilization of the muscle and the wound to allow for incorporation.
Follow up care

About 2 weeks later, he presented to the emergency department with fever and chills and was noted to have a pin tract infection, requiring removal of one of the pins in the ED. The following week he returned to the operating room for removal of the external fixator and debridement of a small portion of muscle flap necrosis. Following debridement, the split-thickness skin graft (STSG) was secured with staples and negative pressure wound therapy was applied (Figure 13). The patient presented to clinic for follow-up seven days post-skin graft application and negative pressure wound therapy was removed. Four days later he returned to clinic and reported a visit to the ED for fever and previous talar pin site irritation and pain with two centimeter diameter of surrounding erythema. He was started on IV rocephin for a few days and then transitioned to a two week course of Keflex. He had resolution of infection. His donor site incision healed without incident. He was discharged with instructions to remain NWB to his surgical limb until complete incorporation of graft, about two months. At final three-month follow-up he had completely healed (Figure 14).

Discussion

There are several key points to discuss regarding this case report. First, there was partial flap necrosis, which required repeat debridement in the OR. For the case presented, the most proximal aspect of the peroneus brevis muscle belly was not debrided, which has been recommended by multiple authors [9,10,11]. Other potential ways to improve wound closure may include the use of bilayer membrane which, after it takes, will provide a superior surface for a STSG. Negative pressure wound therapy can be applied at 50-125mmHg [12]. It has been proposed that higher vacuum settings may be damaging to skin grafts, but this theory was not upheld [13].
Recently it was found that wound vac application at 75mmHg applied for seven days post-operatively significantly reduced partial flap necrosis and skin graft necrosis, and they concluded that prolonging the period of wound vac application may further reduce complications by eliminating shear force, improving neovascularization of the muscle, and reducing edema and venous congestion [14]. There is debate whether to perform the transfer of the brevis through a subcutaneous tunnel or whether to connect the harvesting incision to recipient site. It is not absolutely necessary to connect the incision with the recipient site, but there should not be excessive tension within the subcutaneous tunnel as this may obstruct venous outflow resulting in flap failure. If there is question, one should connect the recipient bed with the donor site incision.

A few other obstacles occurred which can be avoided. While pin track infections are common when using external fixators, rarely catastrophic infection develops. Minor infections can be managed with local wound care and oral antibiotics oftentimes. As long as there is not failure at the bone-pin interface with loosening, fracture with nonunion or malunion, or chronic osteomyelitis, it should not compromise your end result. Placing a unilateral fixator to stabilize the extremity offers several advantages. It offers stability to the extremity and the wound bed in the immediate postoperative phase while also permitting wound care and wound observation for the first few weeks after index surgery. The external fixator can be removed at the three week mark as this is when you can return to the operating room, remove the silicone layer from the bilayer membrane, and harvest and apply the STSG. Other options include applying a posterior splint for immobilization, but this doesn’t offer an easily accessible portal for wound evaluation and wound care and, makes continued care with a wound vac particularly difficult. If the recipient site is prone to shear forces, ie lateral malleolus, be sure to utilize a bulky soft dressing to protect the graft site. Although several publications [14,15] have advocated for single stage procedure, it is prudent to wait for application of the STSG until muscle flap viability is assured. This prevents unnecessary repeat skin grafting.

It has been demonstrated that the peroneus brevis muscle flap provides a reliable means for treating bone infections, providing blood supply, and a suitable recipient bed for skin grafting [1]. Preoperatively the patients should be evaluated for vascular insufficiency. As foot and ankle experts, sacrificing the primary evertor of the foot may seem uncouth, but these are limb salvage situations. One can perform a tenodesis of the the peroneus brevis to the longus to enhance eversion power if it is possible. However, it has been shown that eversion and plantarflexion are maintained following the procedure even without ancillary procedures and patients do not report lateral ankle instability [16]. The donor site is rarely problematic, and can be closed primarily without issue [10-12,16-18].

The peroneus brevis has a consistent blood flow [7,16,17]. The maximum number of vascular pedicles should be maintained as possible, but one can elect to ligate all pedicles leaving only the most distal intact approximately 6-cm proximal to the tip of the fibula. To ensure adequate blood supply will be provided by each successive pedicle, a vascular clip can be placed temporarily to ensure the next pedicle maintains adequate perfusion. Ensat et al demonstrated in a cadaveric model that there were an average of 5.1 segmental branches to the muscle. This included branches from both the peroneal and the anterior tibial artery, however, most branches were derived from the peroneal artery [7]. The most distal vascular branch was derived from the peroneal artery in 100% of cadavers at a distance about 4.3cm proximal to the tip of the lateral malleolus. There is also retrograde flow provided from the posterior tibial artery [7]. This is important in gaining a muscle flap with the most potential length. The pivot point should be at least 6-cm proximal to the lateral malleolus to ensure there is a vascular pedicle attached distally to supply the muscle when performing rotational flaps. The diameter of the pedicle must be at least 0.5mm, while the average size pedicle is 1.1mm this is rarely a problem [7]. The average length of the muscle is 19.8cm, but the most proximal 2-cm should be resected as this area of the graft is expected to undergo necrosis.
In conclusion, many studies have found reliability in this muscle flap. It offers great utility to cover defects in the distal leg and hindfoot. It can cover defects of the anterior ankle, lateral ankle and hindfoot. Despite some authors reporting an unfavorable success rate, the majority of reports found high rates of success and this should be considered in the reconstructive ladder for complex lower extremity wounds [10,11,18,19].

References