

**Case Report**

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# Peroneus Brevis Muscle Flap with the use of INTEGRA® Wound Matrix and Split Thickness Skin Graft in the Treatment of Full Thickness Ulcerations: Case Reports and Technique Guide

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## Introduction

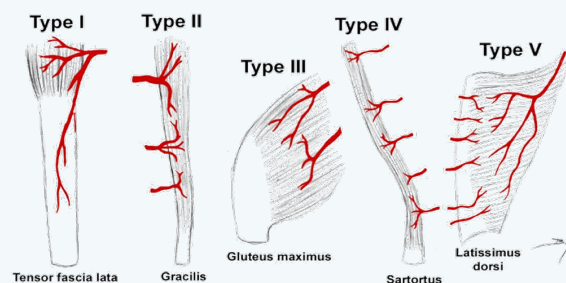
Lower extremity ulcerations are a difficult condition to treat owing to multiple etiologies. Even with the continued advancement of wound products, non-healing chronic ulcerations may not respond to particular treatments. In turn, detrimental outcomes such as soft tissue infections, osteomyelitis, sepsis and limb amputation may follow.

When non-surgical wound care fails, surgical options with advanced wound care techniques and products may be implemented. There are many reconstructive procedures that have been proposed to repair ulcerations in the lower extremity. Some of these procedures include local cutaneous flaps, pedicle fasciocutaneous flaps, pedicle muscle flaps, and free flaps.

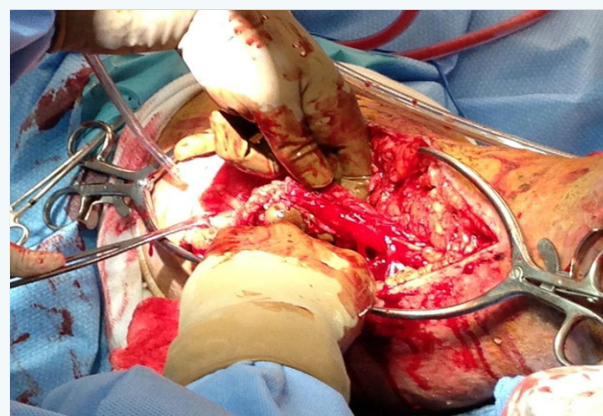
One major factor contributing to chronic non-healing ulcerations is the lack of an adequate wound base in which proliferation of the wound can occur. Furthermore, disruption of the soft tissue envelope, either by surgical or non-surgical means, can leave little to no foundation to cover vital underlying structures. For example, post surgical wound dehiscence following open reduction and internal fixation can result in exposed hardware and without viable soft-tissue to cover the exposed hardware, an adequate wound base is incapable of forming. Therefore wound proliferation will not continue.

One alternative technique, opposed to removing exposed hardware, is the use of muscle flaps to cover and maintain a viable wound environment. This surgical technique, in combination with specific advanced wound products, is a salvage procedure to avoid need for limb amputation. This article focuses on two case studies with wounds closed with a pedicle peroneus brevis muscle flap augmented with INTEGRA® Wound Matrix and a split thickness skin graft.

INTEGRA® Wound matrix is a dermal layer consisting of collagen and glycosaminoglycan in combination with a polysiloxane epidermal layer. This combined foundation controls fluid loss and acts as a scaffold for capillary growth and cellular proliferation (Figures 1-12).



**Figure 1:** Mathes and Nahai Named Blood Vessel Classification of Muscle Flaps.



**Figure 2:** Retrieval of Peroneus Brevis Muscle.



**Figure 3:** Rotation of Peroneus Brevis Muscle and Preparation of wound site.



**Figure 6:** Post-op. PB muscle and STSG are fully incorporated.



**Figure 4:** Creation of the tunnel for the Peroneus muscle flap.



**Figure 7:** Pre-op Plantar Ulceration.

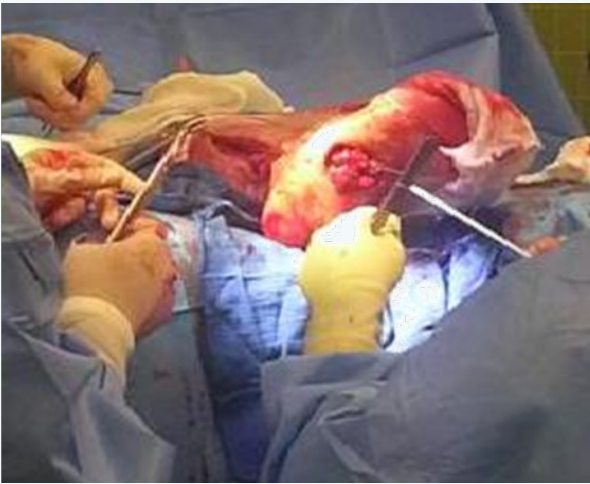


**Figure 5:** Retention sutures and STSG with applied external fixator.



**Figure 8:** Harvesting/Detachment of the Peroneus Brevis from the lateral leg.





**Figure 9:** Transfer of Peroneus Brevis through created tunnel following debridement and excision of the plantar ulceration border.



**Figure 10:** Applied STSG with Underlying Integra Wound Matrix.



**Figure 11:** Final application of external fixation.



**Figure 12:** 13 weeks post-op. PB muscle and STSG are fully incorporated.

### Pre-Operative Planning

Patient selection is an aspect of pre-operative planning which can drastically affect the surgical outcome. This author chooses to perform muscle flaps when all other conservative treatment and surgical interventions have failed. It is treated as a last endeavor in limb salvage. Educating the patient is imperative to successful outcomes as the patient must understand that all instructions and orders must be followed precisely.

Ensuring adequate blood flow to the proposed muscle flap is an important aspect to the pre-op planning protocol. Arterial doppler is utilized to determine overall blood-flow to the leg, however having the arterial flow mapped with an arteriogram is the gold standard to evaluate blood flow. Arteriograms can map all vessels feeding the muscle and provide invaluable guidance to where the most distal perforating vessels are located. The location of the most distal perforator ultimately determines the rotational length that can be achieved. This can help to ensure dissection is performed to the appropriate level, leaving adequate perfusion for a successful muscle flap. Determining what muscle is best suited to cover a particular wound, knowledge of blood supply to that muscle is crucial and categorizing under the Mathes and Nahai classification is recommended (Figure 1) [1-3].

### Mathes and Nahai Named Blood Vessel Classification of Muscle Flaps

- a. One vascular pedicle (eg, tensor fascia lata)
- b. Dominant pedicle(s) and minor pedicle(s) (eg, peroneus brevis and soleus)

- c. Two dominant pedicles (eg, gluteus maximus)
- d. Segmental vascular pedicles (eg, tibialis anterior )
- e. One dominant pedicle and secondary segmental pedicles (eg, latissimus dorsi)

### Case 1 Description – Exposed Lateral Hardware

63 year old male patient with a history of Type II Diabetes Mellitus, morbid obesity and bilateral charcot arthropathy involving the chopart and lis-franc joints. The patient presented with exposed hardware to the left lateral ankle status-post Talo-calcaneal fusion with internal fixation. The patient had undergone bracing combined with dermal dressings and non-surgical wound care for 7 months. It was determined a peroneus brevis muscle flap augmented with INTEGRA® Wound Matrix and a split thickness skin graft was indicated to salvage the limb.

### Case 2 Description – full thickness plantar ulcer

67 year old male patient with a PMH of Charcot neuroarthropathy, alcohol induced peripheral neuropathy and an evident plantar non-healing ulceration that has failed all non-surgical wound modalities (Figure 6). Patient has a previous charcot reconstructive surgical intervention. The patient had undergone bracing combined with dermal dressings and non-surgical wound care for 5 months. . It was determined a peroneus brevis muscle flap augmented with INTEGRA® Wound Matrix and a split thickness skin graft was indicated to salvage the limb (Figure 11).

### Surgical Method of Peroneus Brevis Muscle Flap

#### Harvesting Pedicled Peroneus Brevis Muscle Flap:

After general anesthesia, the patient remains in a supine position with a 10 lbs sandbag under the ipsilateral hip to provide greater exposure to the lateral leg. No tourniquet is used. Electric cautery and hydrogen peroxide are used for hemostasis. Surgical exposure is made over the midline of the fibula, beginning 7 cm proximal to the distal tip of the lateral malleolus to the level of 3 cm distal to the head of the fibular. This incision location ensures avoidance of the common peroneal nerve proximally and estimates the location of the distal most perforator distally. The deep fascia is incised to expose the peroneal compartment. A linear fasciotomy of the lateral compartment is performed. The anterior fascia flap in everted and blunt dissection is performed to identify the superficial peroneal nerve. The peroneus longus muscle is visualized on top of the peroneus brevis muscle. Blunt dissection is performed separating the peroneus brevis muscle from the peroneus longus muscle. The longus muscle is retracted posterior giving better visualization to dissect free from the fibula the peroneus brevis muscle (Figure 2). Intra-operative doppler is used to identify the most distal perforator, typically found 7cm from the distal tip of the fibula. Care is taken to keep dissection of the peroneus brevis muscle flap proximal to this location. The peroneus brevis muscle is transected at its most

proximal attachment with care to avoid the common peroneal nerve (Figure 3 & 8).

**Preparation of the Wound:** The wound is excised in full with a 0.5 cm margin. Thorough debridement of the wound bed is completed.

**Preparation of the subcutaneous tunnel:** A subcutaneous tunnel is created from the distal portion of the muscle flap incision to the proximal wound with care taken to confirm adequate volume within the tunnel so the muscle flap does not become ischemic (Figure 4 & 9). Once the flap is passed through the soft tissue tunnel, the doppler is again used to confirm that adequate blood flow was maintained during transfer. The muscle flap covers the entire wound bed and is secured with 5-0 vicryl at 4 locations 90 degrees apart. The wound bed and muscle flap are then infiltrated with bone marrow aspirate and platelet rich plasma.

**Primary closure with INTEGRA® Wound Matrix and Split Thickness Skin Graft:** INTEGRA® Bilayer Wound Matrix is placed on top of the muscle flap. A split thickness skin graft is then applied on top of the INTEGRA® Wound Matrix and secured with staples. INTEGRA® Thin Skin Wound Matrix is placed on the donor skin graft site. Prior to complete closure, a JP drain is inserted into the proximal incision. The leg incision is closed with subcutaneous sutures and skin staples. Vessel loops are stapled in a diagonal pattern to decrease tension across the incision (Figure 5).

**Protecting the Site:** A static circular external fixator device is placed onto the lower extremity to allow for offloading of the surgical site, limit motion across the flap site, and allow easy exposure for dressing changes (Figure 11). This step is essential to the successfulness of the procedure. Once the external fixator is applied the lower extremity is cleansed with hydrogen peroxide and a bulky dressing consisting of ABD pads is applied to all surgical sites. Moderate compression is applied to the graft site to facilitate graft to muscle adherence.

### Bone Marrow Aspirate (BMA) and Platelet Rich Plasma (PRP) Protocol

#### Platelet Rich Plasma (PRP)

- i. Pre-operatively, 30mL of peripheral blood is obtained from the patient, this can be done pre or post anesthesia induction.
- ii. The 30mL of blood is then place in an autologous platelet separator system to obtain approximately 3-5mL of PRP.
- iii. Platelets release various growth factors such as:
- iv. PDGF - Platelet Derived Growth Factor which propagates collagen production and re-generation of blood vessels

- v. TGF-B - Transforming Growth Factor – Beta which enhances neogenesis of epithelial cells promoting wound healing
- vi. VEGF - Vascular Endothelial Growth Factor which improves the growth of vascular endothelial cells
- vii. FGF - Fibroblast Growth Factor helps in tissue repair and collagen production
- viii. EGF - Epithelial Growth Factor which promotes angiogenesis, epithelial generation and wound healing.
- ix. All surgical sites are percutaneously injected with prepared PRP

### Bone Marrow Aspirate (BMA)

- a) Intra-operatively, 15mL of bone marrow is obtained percutaneously at the level of the proximal tibial metaphysis just distal/medial to the anterior tibial tuberosity. A syringe with approximately 2mL of heparin facilitates successful aspiration.
- b) A second percutaneous aspiration is performed at the level of the lateral calcaneus. Three directional chambers are infiltrated with the syringe; chamber located just proximal to the calcaneal-cuboid joint, redirection to a chamber located in the mid-portion of the calcaneus body, posterior tuber chamber.
- c) Bone marrow aspirate is rich in Mesenchymal stem cells (MSCs) and Hematopoietic Stem Cells (HSCs).
- d) All surgical sites are percutaneously injected with concentrated BMA.

### Wound Closure Guidelines

#### Immediate Wound Closure Protocol

- I. Application of selected muscle flap to donor site
- II. Apply thin skin Integra wound matrix to muscle flap ; 0.4mm thickness
- III. Split thickness skin graft- 0.018 inches
- IV. Fenestration of STSG performed at 1:1 ratio
- V. Adaptic is placed of STSG and stapled into place
- VI. Negative pressure wound therapy (NPWT) application at 75mmHg for 7-10 days
- VII. Apply INTEGRA Thin Skin Wound Matrix to the harvest site

### Delayed Wound Closure- Two Stage Approach

#### Stage One

- 1) Application of selected muscle flap to donor site
- 2) Apply INTEGRA Bilayer Wound Matrix; 1.2mm thickness and staple into place
- 3) Apply Acticoat non-petroleum base silver impregnated dressing
- 4) Apply NPWT to area at 125mmHg.

#### Stage Two

- A. Remove NPWT 7-10 days post-op
- B. Remove the silicone layer from the INTEGRA Bilayer Wound Matrix
- C. If the silicone layer is still adhered continue with NPWT at 125mmHg
- D. If silicone layer is removed the immediately apply a STSG with adaptic and NPWT at 75mmHg

### Conclusion

Epidermal auto-grafting may be performed to facilitate final wound closure. When used in combination, these products can promote an ideal wound environment to encourage STSG incorporation and rapid wound closure. In case report #1, the skin graft had incorporated and the lateral ankle wound was closed within two weeks from initial application. The donor site was also completely healed at this time. In certain cases, subsequent applications of STSGs are warranted along with routine wound care. For example, case report #2 required a subsequent surgical debridement with application of a second STSG. With continuous offloading, incorporation of the skin graft was noted 13 weeks post op (Figure 12). The donor site was also completely healed at this time. INTEGRA® Wound Matrix proved to be a great addition to the peroneus brevis muscle flap and split thickness skin graft.

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