

## CASE REPORT

# Distally Based Lateral Hemi-soleus Muscle Flap for Osseous and Soft Tissue Defects as a Complication of Total Ankle Replacement: A Case Report

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As the number of total ankle replacement implantations performed in the United States continues to increase so does the development of associated complications to ensue. One of the major complications often encountered is that of periprosthetic infections, which tend to result in significant soft tissue defects relative to the distal one-third of the lower leg. In such cases, the soft tissue defects that arise create an extremely problematic situation for both patients and physicians combined, especially given the limited treatment options available to date. With that said, local tissue reconstruction with transpositional and reverse muscle flaps should always be considered regarding options for treatment. Here, we present the case of a 64-year-old woman with a past medical history of a prior bi-malleolar ankle fracture ORIF with subsequent post-traumatic ankle arthritis. Due to the patient's post-traumatic symptoms, a total ankle replacement was performed. This case outlines how a reverse transpositional lateral hemi-soleus muscle flap was successfully implemented for the management and treatment of a distal anterior soft tissue ankle defect with exposed tendon status-post total ankle arthroplasty.

**Keywords:** total ankle replacement; muscle flap; necrosis; distal tibia; ankle joint; ankle surgery

## Introduction

Over the last decade, the number of total ankle replacements in the United States has increased significantly and thanks to the many improvements made within implant designs, rates of complications are beginning to decrease; Current literature even suggests that when assessing for complications caused by periprosthetic joint infection or wound infections status post total ankle replacements or ankle arthrodesis, total ankle replacements have proven to have a much lower rate of complication [1, 11]. However, since wound complications following total ankle arthroplasty currently range from 6.6% to 28%, other treatment modalities and goals shouldn't be overlooked by foot and ankle surgeons [3]. Reconstructive techniques for soft tissue defects from fractures or subsequent open reduction internal fixation of the lower extremity have been developed to preserve the lower extremity and

eliminate the need for amputation [6]. Rodriguez-Collazo, et al. advocated an algorithmic approach towards treatment options for post-traumatic distal tibial soft tissue and osseous defects [8]. These reconstructive techniques should also be considered for complications of total ankle replacements as retaining the ankle implant, and more importantly, the lower extremity of the patient, one can improve the overall outcome of the patient's procedure and ability to use the lower extremity, thus improving the patient's quality of life.

Historically, the use of free tissue transfer has been widely accepted as being the standard for treating soft tissue defects [9]. With that said, as the field of orthoplastic surgery continues to advance so do its practices and methods for surgical options. Within the last fifteen years, innovations made by reconstructive surgeons to perform local tissue reconstruction within the lower third of the

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leg have significantly improved and local muscle flaps have resulted in successful outcomes when dealing with soft tissue defects, provided there is good vascular supply to the muscle flap [1, 10].

One such example is that of a reverse hemi-soleus muscle flap. The soleus muscle is a bipennate muscle that demonstrates an independent blood supply to each half. By utilizing only one half of the muscle, it not only retains its function as a plantar-flexor and a stabilizer but it also increases the arc of rotation of the flap, and allows easy accessibility for coverage of wound defects [5]. Recent studies have shown supplementation of the flap and skin graft with bone marrow aspirate (BMA), platelet-rich plasma (PRP), and platelet-poor plasma (PPP) can further increase the success of tissue regeneration and increase its uses in foot and ankle surgery [2, 5].

We report a case of soft tissue defect secondary to wound necrosis following a total ankle arthroplasty with implant. By using local tissue reconstruction, a step by step approach is depicted via means of a reverse lateral hemi-soleus muscle flap for soft tissue coverage.

**Case Report:** A 64 year old Caucasian woman presents to the clinic with a chief complaint of a left anterior complex wound for one year duration secondary to epidermal necrosis from a total ankle replacement procedure. She reports the initial injury occurred during a mixed martial arts training session in October 2013 where she sustained a severe left bi-malleolar fracture and underwent an open reduction internal fixation. Subsequently, she developed post-traumatic arthritis of the left ankle and in August of 2015 she underwent a total ankle replacement. She then developed epidermal necrosis at the anterior aspect of her ankle (**Figures 1A, B**). Shortly thereafter and was treated surgically with debridement of all non-viable tissue which lead to tendon exposure and a large soft tissue deficit of her ankle (**Figure 2**). Attempts were executed for closure of the wound using a dermaclose device as well as allograft dermis, both of which failed (**Figure 3A, B**) Physical examination revealed a large anterior wound of the left ankle and distal tibia measuring 15 × 12 cm with an exposed tendon, comprised of a mixed granular and fibrotic base with hyperkeratotic borders (**Figure 4**). There was no



**Figure 2:** Post debridement of necrotic tissue; anterior ankle.



**Figure 3:** (A) Failed attempt at wound closure using a dermaclose device. (B) Failed attempt at wound closure using allograft dermis.

purulent drainage or exposed bone noted. Moreover, sinus tracts, undermining, and tunneling were all absent. Fortunately, the concerning region's neurovascular status was intact. Radiographs of the left ankle demonstrated all hardware from prior operations to be intact with noted medial malleolar fracture (**Figure 5**).

Given the above noted information, and based on the size, severity, and location of the wound, surgical intervention using a reverse hemi-soleus muscle flap was



**Figure 1:** Anterior view of ankle necrosis following total ankle arthroplasty.



**Figure 4:** Large anterior wound of left ankle and distal tibia measuring 15 × 12 cm with exposed tendon, comprised of a mixed granular and fibrotic base with hyperkeratotic borders.



**Figure 5:** AP X-ray of left ankle demonstrating all hardware from prior operations being intact with a noted malleolar fracture.

recommended. This involved not only covering and filling the defect, but also the harvest and application of a split thickness skin graft (STSG). Lastly, an external fixator was applied in order to minimize any movement of the graft site and for fixation of the medial malleolar fracture.

### Technique

Following medical clearance, a handheld doppler was used to identify the distal three perforating branches at the level of 5, 10 and 15 cm from the ankle joint, prior to incision (**Figure 6**). A 25 cm longitudinal incision was performed on the lateral aspect of the left leg (**Figure 7**). While the incision was deepened, all vital structures and nerves were identified and retracted. All bleeders were ligated and cauterized judiciously with the aid of vascular micro-clips. Blunt dissection separated the lateral soleus



**Figure 6:** Careful intraoperative identification of perforating arteries from the peroneal artery to assess flap viability and proper placement of incision to avoid a subsequent soft tissue defect.



**Figure 7:** Incision placement for Harvesting Lateral Hemisoleus flap.



**Figure 8:** Lateral Hemisoleus flap prepared for rotation over anterior ankle with care taken to preserve the distal perforating arteries from the peroneal artery.

muscle belly from the surrounding tissue (**Figure 8**). The gastrocnemius muscle belly was transposed posteriorly and the soleus was freed from all remaining attachments. Using blunt dissection, a tunnel was created to the anterior wound and the lateral hemi-soleus flap was then transposed, preserving the vascular pedicle (**Figure 9**). The surgical site was flushed with hydrogen peroxide for hemostasis. Subsequently, BMA, PRP, and PPP were injected into the area. Then, the underlying devitalized tissue of the anterior wound was sharply debrided to the level of the underlying tendon using a scalpel and cur-



**Figure 9:** The distally based rotational lateral hemi-soleus flap is placed underneath the dermal and subcutaneous tissue to cover the soft tissue defect over the total ankle replacement. The flap is adhered to the surrounding subcutaneous tissue with absorbable sutures.



**Figure 11:** Application of Split thickness Skin Graft (STSG) over lateral hemi-soleus muscle flap; Combining the muscle flap with STSG gives increased vascularity to the area and increases the chance for proper wound closure.



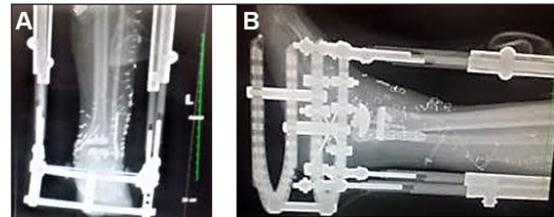
**Figure 10:** Lateral hemi-soleus is placed over the anterior ankle soft tissue defect and the incision is closed with absorbable sutures, staples and a complex closure to help avoid dehiscence and future soft tissue defects from occurring.



**Figure 12:** Lateral view of the lower extremity with multiplanar external fixator applied in order to prevent motion and preserve the vascularity of the lateral hemi-soleus muscle.

ette. An Integra™ Bilayer Matrix Wound Dressing (Integra LifeSciences Corporation, Plainsboro, NJ) was implanted under the muscle belly to protect all tendinous structures and the muscle flap was sutured into place utilizing a 5-0 Vicryl suture. A second application of Integra™ Bilayer Matrix Wound Dressing was applied over the freshly bleeding muscle flap. The surgical site was once again irrigated with hydrogen peroxide and BMA, PRP, and PPP were superficially applied to the muscle flap. Next, Bio-composite® STIMULAN Rapid Cure® (Biocomposite Ltd, Keele, Staffordshire, England) calcium sulfate beads were placed at the harvest site along with a large Jackson-Pratt drain. The tissue was re-approximated performing a simple interrupted suture technique with 2-0/3-0 vicryl. The skin was re-approximated using skin staples and a vessel loop for retention of the incision (**Figure 10**).

Lastly, following application of mineral oil, a dermatome, set at 0.018 inches, was used to harvest a 5 inch × 6 inch split-thickness skin graft (STSG) from the anterior and medial aspect of the left lower extremity. The skin grafts were meshed in a 1.5 to 1 manner and secured to the muscle flap site with skin staples (**Figure 11**). The remaining BMA, PRP, and PPP were used to coat the STSG. A non-adherent dressing was applied to the structures and stapled in place. A negative pressure wound vac was placed over the anterior aspect of the foot over the muscle flap. Next, an Orthofix® Truelok® External Fixation System (Lewisville, Texas, USA) with corresponding rings and smooth wires were applied with a half ring proximally and distally to maintain stabilization of the muscle flap and to fixate the medial malleolar fracture. All connections were secured and wires



**Figure 13:** (A) AP X-ray of the ankle postoperatively. (B) Lateral X-ray of the ankle postoperatively.

appropriately tensioned (**Figure 12**). Fluoroscopy was used to confirm proper placement of all wires and rings (**Figures 13A and 13B**).

Post-operatively, her H/H demonstrated a significant decrease from her pre-operative values (Hgb 7.9/Hct 24.5) and she was transfused 1 unit of packed red blood cells. The Jackson-Pratt drain was carefully monitored throughout her hospitalization with 160 cc output recorded on Day 1, 135 cc on Day 2, and 30 cc on Day 3. However, due to continuous anemia and drainage post-operatively, the decision was made to return to the operating room for possible hematoma evacuation and inspection of the surgical site. The negative pressure vacuum, Jackson-Pratt drain, and dressings were all removed for inspection. No active drainage was noted. BMA, PRP, PPP were then infiltrated over the muscle flap site for a second time. The surgical site was then re-dressed with sterile dressings. Afterwards, the patient's H/H was carefully monitored and she demonstrated a positive trend in her values. She reported a max pain level of 6/10 post-operatively with the aid of a *patient controlled analgesia* hydromorphone pump and



**Figure 14:** (A) Anterior view of ankle 3 months postoperatively. (B) AP X-ray of ankle 3 months postoperatively. (C) Anterior view of ankle 6 months postoperatively. (D) Anterior view of ankle 1 year postoperatively.

was transitioned to oral pain medication on post-operative day 1 with success. Physical therapy was consulted for non-weight bearing status to left lower extremity with the use of a walker. On post-operative day 3, the patient met all her post-operative milestones and was discharged home. Patients post operative course was closely monitored over a 12 month period and complete resolution of her wound defect was accomplished (**Figures 14A–D**).

### Discussion

Using a distally based hemi-soleus muscle flaps for soft tissue reconstruction was first described by Tobin in 1985 [2]. Although there were concerns regarding the reliability of these muscle flaps, recent improvements in surgical technique with meticulous dissection to preserve the vascular supply to the muscle flap have improved the efficacy of a local muscle flap in the lower extremity.

For many years a free tissue transfer was considered the standard treatment for soft tissue defects of the lower extremity [6]. Pu in his treatment algorithm regarding soft tissue reconstruction of an open tibial wound in the distal

third of the leg, describes the use of the soleus muscle for coverage of soft tissue defects  $<50 \text{ cm}^2$  [6]. Although in our case the soft tissue defect was  $>50 \text{ cm}^2$ , the benefit to the patient from this lateral hemi-soleus muscle shows the expanded use of a hemi-soleus muscle flap. The use of local muscle flaps for ankle wound coverage is well documented. Previously the most senior author has used a distally based reverse peroneus brevis muscle flap for ankle wound coverage. The benefit of a local muscle flap in comparison to a free tissue transfer is that the local muscle flap results in limited donor site morbidity and limited functional deficit [12].

When using reverse hemi-soleus muscle flaps in the lower extremity, attention to the vascular supply of the muscle flap is of vital importance. Schierle et al. described the benefits of adhering to principles of angiosomes when designing a muscle flap [4]. By capturing one full angiosome in their flap design, the patients in the study had successful outcomes with a healed wound [4].

The medial hemi-soleus muscle flap has been known as the workhorse muscle flap of the distal third of the leg [6]. The use of a lateral hemi-soleus muscle flap in the case study shows the versatility of this particular muscle in reconstructive surgery when dealing with soft tissue defects of the lower extremity. Proper surgical planning regarding adequate vascular supply and location of the soft tissue defect improve the outcome the surgical procedure [8].

When dealing with soft tissue defects the arterial flow to the area can be compromised and by using a local muscle flap as opposed to a free flap transfer we know that the arterial flow to the muscle is adequate preoperatively. In a study done by Lopez-Casero et al. the vascular patterns to the soleus muscle were observed on cadaveric limbs. In 83.3% of the limbs the arterial flow was a dominant proximal fibular and tibial segmental arterial supply to the soleus muscle [7]. This study shows the ability of the soleus muscle using either a medial or later hemi-soleus local flap to adapt to the location of the soft tissue where there is most likely inadequate arterial flow. The use of the external fixator is to stabilize the foot and ankle. In a study published in 2007, external fixators are used to stabilize free flaps and prevent equinus contractures [4]. By limiting the motion at the ankle joint, the vascular flow to the hemi-soleus muscle flap was uncompromised improving the favourable outcome of the procedure.

### Conclusion

In conclusion, the results of our surgical outcome were very satisfying. It is obvious that the need for reconstructive surgical techniques regarding complications related to total ankle replacements is growing due to the dramatic increase in the use of total ankle implants. Local tissue reconstruction should always be considered when these complications arise as opposed to strictly using free tissue transfer. By having good preoperative planning and determining a promising vascular supply to a specific muscle flap and using that proper muscle flap for a specific location within the lower extremity, virtuous outcomes are very attainable and must not be overlooked.

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### Competing Interests

The authors have no competing interests to declare.

### Author Contributions

- Study conception and design: Edgardo Rodriguez-Collazo, Arshad A. Khan, Matthew W. Cerniglia
- Acquisition of data: John Toole, Hamid A. Khan
- Analysis and interpretation of data: Edgardo Rodriguez-Collazo, Arshad A. Khan, Matthew W. Cerniglia
- Drafting of manuscript: John Toole, Hamid A. Khan
- Critical revision: Hamid A. Khan

### Guarantor

Arshad A. Khan is the guarantor.

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