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Original Article

Simultaneous soft tissue coverage of both medial and lateral ankle wounds: Sural and rotational flap coverage after revision fixation in an infected diabetic ankle fracture

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ABSTRACT

Aims: To describe a case of simultaneous medial and lateral soft tissue coverage for exposed orthopaedic implants in the setting of revision fixation of a non-united ankle fracture. This was achieved using a sural flap as well as a propeller flap.

Methods: Case report.

Results: Both the sural and posterior tibial artery based rotational propeller flap healed without incident. The underlying fracture healed successfully and the patient returned to normal shoe wear.

Conclusions: The sural flap in conjunction with the posterior tibial artery based rotational flap is effective in providing simultaneous medial and lateral soft tissue coverage to the ankle.

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1. Introduction

Soft tissue coverage for ankle fractures is integral to fracture healing.¹ In the setting of revision plating of diabetic ankle fractures, it is not always possible to close the native tissue over the plate construct. Traditionally, soft tissue defects of the distal third of leg overlying tendon, bone, or metallic

implants have been covered with free flap soft tissue grafts.² In these cases, the use of soft tissue flaps has been described to provide adequate soft tissue envelope which is mandatory for fracture healing.

Tobacco use is a known risk factor for both wound complications and delayed fracture healing.³ In several large series of free flaps tobacco use has been shown to be a risk factor for

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superficial and deep wound infection.^{4–6} In the setting of open reduction and internal fixation of ankle fractures, tobacco use is associated with increased postoperative complication, especially superficial or deep wound infection.^{4,7,8} The rates of complication are increased when tobacco abuse is combined with diabetic patients.⁷

Previous options for coverage soft tissue coverage of the distal third of the leg have included free flaps, pedicle (rotational) flaps, and skin grafting.⁹ The condition of the surrounding tissue and the location of the tissue defect dictate the type and size of flap available to the surgeon. Free flaps are technically demanding because of the need for microsurgery and often require anticoagulation and intensive care unit monitoring, making them a significant undertaking. Free flaps also have a significant failure rate with a recent study of free flap for lower extremity coverage having a 13% failure rate.¹⁰

The sural artery based flap is based on Masquelet's work on skin island flaps and the concept of the neuroskin flap.¹¹ By using the superficial sural artery that runs along the sural nerve in the distal leg, a fasciocutaneous flap can be raised and transferred to the distal third of the ankle with predictable success.¹² This flap has become highly utilized in ankle soft tissue coverage when a unilateral defect is present. In cases where coverage is needed both medially and laterally, an additional coverage method must be employed.

However, with improved understanding of angiosomes and the vascular supply to the skin and fascia, local fasciocutaneous flaps are becoming more common. Recently, the success of rotational flap has been described in the orthopaedic literature, based on fascial perforators.¹³ These "propeller" flaps can be rotated 180° around the perforating vessel, facilitating coverage of soft tissue defects.

In this case report we describe the use of both a sural and rotational propeller flap to achieve simultaneous coverage of both the medial and lateral malleoli, leading to both successful fracture healing and soft tissue coverage.

2. Case report

A 51-year-old woman who sustained a right trimalleolar ankle fracture (AO/OTA classification 44-B3.1),¹⁴ underwent open reduction and internal fixation with one third tubular plate fixation over medial, lateral and posterior malleoli. The patient was non compliant with her non-weightbearing status and smoked one pack per day of tobacco cigarettes throughout her recovery. Three weeks postoperatively she was noted to have both medial and lateral wound drainage and was started on oral antibiotics. Due to continued poor wound healing, she underwent irrigation and debridement, hardware removal and negative pressure wound therapy. Her intraoperative tissue cultures revealed two different varieties of gram positive cocci. Sixteen weeks after the original operation, revision fixation was accomplished with plating of both malleoli and placement of syndesmotomic screws. However, working in a compromised soft tissue envelope (Fig. 1), this fixation resulted in a medial wound measuring 8 cm long 3 cm wide, with a lateral wound measuring 11 cm long and 2 cm wide.

This presented the challenge of covering two sizeable wounds in the distal third of the leg. The decision was made to use pedicled fasciocutaneous flaps: a propeller flap based on a perforator from the posterior tibial artery to cover the medial wound, and a sural fasciocutaneous flap for the lateral wound. Due to her age and heavy smoking history, it was decided to perform the sural flap in a staged fashion to improve flap viability. In the first stage, the patient was placed in the prone position and irrigation and debridement of the two wounds was performed. Next, a 9 cm long by 4 cm wide flap was marked on the posterior aspect of the calf, arising from the middle third, utilizing the standard reflection point of 5 cm from the tip of the lateral malleolus. The fascia was dissected circumferentially and the sural vessel and nerve were

Fig. 1 – A 51-year-old female diabetic smoker sustained a trimalleolar ankle fracture. Radiographs show mortise (A) and lateral (B) views of the definitive revision construct.

transected proximally, leaving a 2 cm skin bridge proximally to allow local perfusion of the skin while stimulating the retrograde flow through the sural vessel. The skin was then closed loosely with staples and medial and lateral wound VACs were applied. Two days later, the patient returned to the operating room. Preoperatively, a fascial perforator, just proximal to the medial ankle wound, arising from the posterior tibial artery was identified and marked using colour Doppler ultrasound with the aid of a vascular surgeon. With the patient in the supine position, the posterior tibial perforator based propeller flap was drawn out and dissection was undertaken. A 12 cm long by 6 cm wide flap was dissected to the fascia in a proximal to distal fashion until the entire flap was freed and the pre-identified fascial perforator vessel was located. The tourniquet was deflated to ensure vascularity of the flap by identifying robust bleeding edges. The flap was then rotated 180° to cover the medial wound and sutured in place over the defect.

Once medial coverage was achieved the lateral ankle was covered by completely dissecting the skin bridge in the previously created sural flap. The flap was passed through a subcutaneous tunnel and sewn in place. The final step in the procedure was to harvest split thickness skin grafts from the posterior/lateral aspect of the right thigh to cover both flap donor sites as well as the pedicle of the sural flap. The patient was then placed in a short leg plaster splint, covering both flaps and their donor sites.

3. Follow-up

The patient successfully healed her revision ankle procedure without evidence of infection, wound dehiscence or flap failure. Both flaps healed without incident. There was no evidence of tip necrosis. At her 4-month (Fig. 2) follow-up appointment she was ambulating without an assistive device and her wounds had completely healed. The thinness of the flaps has allowed for normal shoe wear. She is highly satisfied with the results.

4. Discussion

Soft tissue coverage in the distal third of the leg presents a significant problem to orthopaedic surgeons who must operate on complex ankle deformities and fractures. Several viable options exist for covering the distal leg, including skin grafts, pedicled rotational flaps, and free tissue transfer. Often several of the options must be used concurrently to fully cover a complex defect.

Numerous studies show that nicotine abuse alters the biology of wound healing.³⁻⁵ Fracture healing and time until union are adversely affected by tobacco.⁷ This is compounded by the soft tissue complications associated with smoking; posing a special challenge to the treating surgeon who must achieve both bony union as well as a viable soft tissue envelope. This underscores the importance of both adequate internal fixation constructs as well as tailored selection of soft tissue flaps.

Free flaps have a place in distal leg soft tissue coverage for large complex wounds, but they require microsurgical skills and often costly ICU monitoring to ensure success. In patients with compromised tissue and host healing environment secondary to diabetes and tobacco use, the efficacy of free flaps decreases.^{6,15} In this setting it is vital to choose a method of soft tissue coverage that will allow for an adequate soft tissue envelope while being robust enough to sustain the patients compromised biological environment.

Several studies show that in comorbid patient populations, utilizing a staged application of the sural flap leads to greater flap viability.^{16,17} The staging procedure helps improve venous outflow, which is the limiting factor in large sural flaps, especially in comorbid patients. Delaying the flap causes local vascular dilation, leading to hyperplasia and an increase in the capacity of the local circulatory system.¹⁶ We chose this option given our patient's age and extensive smoking history. In addition, the second surgical procedure allowed prone positioning in the first operation to perform the sural fasciocutaneous flap and supine positioning for elevation of the propeller flap.

Fig. 2 – (A and B) Clinical photographs of the medial (A) and lateral (B) soft tissue defects after revision fixation. (C and D) Clinical photographs of the healed medial (C) and lateral (D) wounds after flap coverage.

Here we present a case where both medial and lateral ankle wound coverage is needed to develop an adequate soft tissue envelope around revision fixation of a malleolar ankle fracture. This was accomplished in two shorter operations without the need for microsurgery or anticoagulation. Using both a sural based lateral flap and a rotational medial flap this complex wound was successfully covered with minimal donor site morbidity. We feel these two pedicled flaps performed by an orthopaedic surgeon without the need for microsurgery offer excellent options for supplying well vascularized tissue for wounds of the malleolar ankle region.

5. Summary/conclusion

Using two pedicled fasciocutaneous flaps, a sural flap in conjunction with a posterior tibial artery perforator rotational flap, soft tissue coverage of both medial and lateral ankle wounds can be obtained without the need for microsurgery, systemic anticoagulation or intensive care unit monitoring.

Conflicts of interest

All authors have none to declare.

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