The lateral supramalleolar flap as solution for lower leg, ankle and foot defects: A surgical case series

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INTRODUCTION

Defects due to tissue loss on the lower part of the leg, ankle, and the foot is often difficult to cover and thus posed a challenge to reconstructive surgeons. Anatomical features of the lower third of the leg are the primary source of challenges. The region is composed mainly by subcutaneous bone surrounded by tendons without muscles. Furthermore, the vessels are in isolated compartments with few intercommunications among them. Combined with both factors, it makes any attempt to cover wounds in the region quite challenging. Several fascia-cutaneous flaps have been proposed as solutions for skin and soft tissue defects in this region.4 Free flaps are still considered as the gold standard of wound coverage on the lower third of the leg. Free flaps can be used to cover large defects with high success rates, and its feasibility allows its use in acute situations by choosing distant recipient vessels.2,3 Perforator flaps have also been widely recommended in lower-limb reconstruction.4–6 However, the Lateral Supramalleolar Flap, a fasciocutaneous flap supplied by the perforating branch of the posterior peroneal artery described by Masquelet et al. (1988), is another reliable option particularly in the absence of a Free Flap.8

This paper aims to present our clinical experience in resurfacing skin defects of the lower third of the leg and ankle. It is intended to show the reliability of this lateral supramalleolar flap technique adopted and developed in our institution.

METHODS

This was a retrospective case-series study describing three cases that underwent lateral supramalleolar flap surgery to cover tissue defect in the lower third of the leg, ankle, and foot. Procedure and treatment were conducted by the Plastic and Reconstructive Surgery Unit of the 37 Military Hospital, Accra, Ghana. Ethical approval was granted by the Institutional Review Board of the 37 Military Hospital (37 MH-IRB IPN/NFP/389/2020) before the study was conducted.

The inclusion criteria for the procedure were patients with ulcers on the lower third of the leg, which required flap. However, patients with chronic ulcers, a wound that shows no tendency to heal after three months of appropriate treatment or is still not fully healed at 12 months were excluded.9 Patients with a history of peripheral vascular disease were also excluded.

The procedure was initiated after spinal anesthesia has been performed, and the patient laid in the supine position. The limb is exsanguinated by elevation for 5 minutes and continued by tourniquet application.
Prior to exsanguination, the surgeon attempted palpation and mark out the perforating branch of the Lateral Supramalleolar Artery. Throughout our experience, the artery was palpable in about 3 out of 4 patients and was almost always 5 cm superior to the lateral malleolus around the groove between the tibia and the fibula, consistent to the previous description by Masquelet.10 Thus, there was never the need to use the handheld doppler during this study.

Planning of the flap was always done in reverse. The upper limit of the flap is marked out no less than 8 cm from the popliteal crease and lower limit about 5 cm from the axis of the ankle joint. The lateral extent of the flap was up to the fibula, contrary to mid-calf. The dimensions of the defect are measured, and these measurements are used to plan and outline an appropriate island. The skin palette is sutured to the fascia to avoid shearing of the skin of the island. The skin is incised over the pedicle using the "lazy S incision". The thin skin flaps are reflected, sparing the rich subcutaneous vascular network to be included in the fascia-subcutaneous pedicle, which is 2-3 cm wide (Figure 1a). An effort is made to keep the subcutaneous fat on top of the pedicle in a bid to keep the vascularization safe. Dissection is then carried out between tibialis anterior and extensor digitorum longus, where the perforating branch of the peroneal artery is easily located, and the elevation of the flap is completed (Figure 1b). The dissection is stopped a finger breath proximal to the point of emergence of the perforating branch to avoid damaging it. An effort was always made to palpate and mark out the point of emergence of the perforating branch. The superficial peroneal nerve should be included in the pedicle to avoid an extensive dissection and is severed as it enters the flap. The Lazy S incision is closed primarily without tension, and the donor site grafted.

All operations were performed under spinal anesthesia with prophylactic antibiotics (1 gram of Intravenous Ceftazidime) and tourniquet control. The surgeries were all performed by the authors, who are both fellows in plastic and Reconstructive Surgery. Post-operatively, all patients were given intravenous Ceftazidime (1 gram every 12 hours) for five days. Subsequently, they were put on oral Clindamycin 300mg every 8 hours and oral Ciprofloxacin 500mg every 12 hours from post-operative day 6 to 14. Wound inspection and change of dressings were done on post-operative days 5, 7, 10, and 14.

RESULTS

Case 1
A 43-year-old man sustained an open fracture of the tibia in a traffic accident. He presented to the Trauma and Surgical Emergency Unit a few hours after sustaining the injury. He was resuscitated and had wound debridement on the day of the presentation. On the 3rd day after the presentation, he was sent to the operating theatre by the orthopedic surgeons. Under spinal anesthesia, an external fixator was placed to achieve bone union. However, due to the procedure, the patient was left with the tibia bone exposed at the medial aspect of the junction between the middle third and the distal third of the left leg (Figure 2a). He was then referred to the plastic surgery team. We used a small island flap illustration. a. The design of the skin flap. The pedicle includes the deep fascia. b. The flap is elevated with its subcutaneous pedicle.a
supramalleolar flap (Figure 2b & 2c), passed over the tibial crest via the raised skin flaps (Figure 2d) to cover the defect. These skin flaps were closed over the Island flap pedicles. Healing was uneventful (Figure 2e).

**Case 2**

This 38-year-old woman presented a painful swollen left ankle after a fall from height. She was admitted to the Trauma and Surgical Emergency Unit, started on analgesics and limb elevation. The X-rays revealed a medial malleolar fracture. The orthopedic surgeons initially managed the patient. She was sent to the operating theatre where under spinal anesthesia, Open Reduction, and Internal Fixation (ORIF) was performed. However, a few days after the operation, some skin necrosis exposed the plate (Figure 3a). The Plastic Surgery Unit was called in to assist. An island of supramalleolar flap (Figure 3b & 3c) was used to cover this defect. These skin flaps were raised and used to closed the Island flap pedicle as the flap was moved to cover the defects (Figure 3d). Healing was generally uneventful (Figure 3e). However, there was partial necrosis of the flap at the distal edge. This, nonetheless, did not affect the viability or purpose of the flap.

**Case 3**

A 37-year-old male, a pedestrian, was involved in a road traffic accident. He sustained an open fracture of the tibia and fibula of the left leg. He was brought in to the Trauma and Surgical Emergency Unit. He was resuscitated and started on analgesics and antibiotics. His left leg was splinted and dressed. In the morning after the day of presentation, he was sent to the operating theatre where wound debridement was performed under spinal anesthesia. External Fixators were placed to achieve bone stability. Unfortunately, the distal tibia was exposed. He was referred to the Plastic Surgery Unit. The defect dimension measured 12×5 cm and was initially prepared with standard saline dressing. Due to adjacent muscles and skin being traumatized, the patient had compromised vascularity of the leg. Thus, no locoregional or free flap was feasible. The use of the cross-leg flap with the contralateral
lateral supramalleolar flap was considered and used (Figure 4a).

Flap planning was done in reverse. The flap marked from the upper limit, about 8 cm from the popliteal crease, to the lower limit about 5 cm from the axis of the ankle joint. The lateral extent of the flap was up to the fibula, contrary to mid-calf. Surgery was performed under spinal anesthesia and tourniquet control. The flap was harvested in the sub-facial plane, and the donor site was grafted with a split-thickness skin graft (STSG). After harvesting the flap, both legs were fixed together in a cross-leg flap position, and a flap inset was done to the recipient area. The legs were held in the cross-leg position by Plaster of Paris back slab for both legs. The patient was able to move both legs simultaneously at the level of the knee joint to avoid pressure sore at the heel region. The cross-leg flap was divided on day-14. The patient healed well (Figure 4b)

**DISCUSSION**

Several flaps have been described as options to cover skin and soft tissue defects of the middle to the lower third of the leg and foot.1 This article highlights the operative procedure for the lateral supramalleolar flap in the lower third of the leg, ankle, and foot. The lateral supramalleolar flap comes with several advantages. With the anatomical knowledge of the vascular territory of the lateral supramalleolar artery, we know the flap has a well-defined territory and a reliable vascular axis. The donor site has a well-vascularized muscular bed and is reliably covered with a split-thickness skin graft. The skin of the lateral aspect of the leg is supplied by terminal branches arising from the perforating branch of the posterior peroneal artery (Figure 5). It has been demonstrated by Masquelet et al., that this perforating branch is constant, almost always emerges 5 cm above the lateral malleolus in the groove between the tibia and the fibula, and gives two or three ascending cutaneous branches.10 These branches perforate the fascia and continue as a vascular network in the lateral aspect of the leg. Therefore, the skin territory of the flap should not go above the middle third or extend beyond the tibial crest medially and the posterior border of the fibula laterally. Also, the origin of perforating branch of the posterior peroneal artery act as the point of rotation.3,8 It can be raised as an Island flap or a transposition flap.

Due to large skin paddle and a wide rotation arc, this flap is able to be employed to cover defects of the ankle and foot. However, for these, it is a safer option to deploy the lateral supramalleolar flap as a fasciocutaneous transposition flap. This is because the pedicle with the island flap is easily prone to kinking when the flap is swung to cover ankle and foot defects making such flaps prone to necrosis. This requires a staged procedure requiring more than one operative procedure.

Integrity of external perimalleolar area is the main factor that influences the flap reliability. To circumvent this, a lateral supramalleolar flap may be raised from the contralateral leg and deployed as a cross leg flap to cover the defect. Cross-leg fascia-cutaneous flaps have, for some time now, been considered as a lifeboat in current surgical practice.12,13 The lateral supramalleolar flap is reliable and can be employed as such a lifeboat. Cross-leg flap has stood the test of time as a highly reliable source for such complex lower limb wound reconstruction.14 Most of the time, the retrograde cross leg fasciocutaneous flap based on the perforator of the Posterior Tibial Artery and Peroneal Artery was the primary choice.14 However, in this work, the contralateral supramalleolar flap was used as a cross-leg flap. This was raised as a fascia-cutaneous flap and was based on known blood supply. From the outcome of this work, it can be said that the lateral supramalleolar flap can be reliably employed as a cross leg flap. Also, it is worth considering is the use of Flap delay technique which enhances the viability of the lateral supramalleolar flap in such situation.15

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**Figure 5** Anatomy of the blood supply to the foot and ankle showing the lateral supramalleolar artery.
CONCLUSION
The lateral supramalleolar flap is a reliable option in the resurfacing and covering of various skin defects in the lower extremity. It is particularly useful to cover the middle to lower third leg, ankle, and foot defects. It can also be used as a cross-leg flap for contralateral defects. Therefore, this flap is very dependable as it can be raised to cover both an ipsilateral or contralateral lower leg defect.

CONFLICTS OF INTEREST
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AUTHOR CONTRIBUTION
Both authors contributed to all processes in this work, including patient selection, operative procedures, post-operative management of the patient, and flap monitoring as well as drafting and seeking approval for publication of this manuscript.

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