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Original Research

# Foot and Ankle Reconstruction Using the Distally Based Sural Artery Flap Versus the Medial Plantar Flap: A Comparative Study

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ABSTRACT

Soft tissue defects around the foot and ankle region often present an awkward problem for plastic surgeons. The medial plantar artery flap raised from the non-weightbearing instep of the plantar foot offers a thick, sensorial, durable, and glabrous skin. The reversed sural artery flap offers a reliable option for coverage with the advantages of a wide arc of rotation, adequate dimensions, and a reliable blood supply. The present study compared the outcomes of the medial plantar artery flap and the distally based sural artery flap in foot and ankle reconstruction. The present comparative cross-sectional study included 30 adult patients with soft tissue defects in the foot and around the ankle, who were divided into 2 equal groups. One group underwent reconstruction with the proximally based island medial plantar artery flap (MPAF). The second group underwent reconstruction with the reversed sural artery flap (RSAF). The operative time and complications were carefully recorded. The surgical outcomes in terms of flap survival, durability of coverage, and functional outcome were assessed for all patients. No significant differences were found between the 2 groups in age, sex, etiology, or site of the defect. The defect size was significantly smaller in the MPAF group than in the RSAF group ($22 \pm 2.7$ cm$^2$ versus $66.2 \pm 7.7$ cm$^2$; $p < .001$). However, the operative time was significantly longer in the MPAF group than in the RSAF group ($100 \pm 2.9$ minutes versus $80.5 \pm 3.1$ minutes; $p < .001$). The flap survived in all cases in the MPAF group, but total flap necrosis occurred in 1 patient in the RSAF group. The mean follow-up period was 13.2 months. Weightbearing was significantly earlier in the MPAF group than in the RSAF group ($5.8 \pm 0.26$ weeks versus $6.9 \pm 0.19$ weeks; $p = .003$). None of the 30 patients developed recurrent ulceration. The incidence of complications (33.3% versus 80%) was significantly less in the MPAF group than in the RSAF group ($p = .01$). Significantly greater improvement was found in the functional outcomes in the MPAF group compared with the RSAF group ($p = .004$). In conclusion, the MPAF and distally based sural artery flap are the 2 flaps available for foot and ankle reconstruction. However, the MPAF offers better functional outcomes with a lower frequency of postoperative complications. Thus, the sensate MPAF is recommended for reconstruction of moderate-size defects of the foot and ankle region.



Reconstruction of soft tissue defects around the foot and ankle region represents a challenging problem for reconstructive surgeons because of the lack of locally available tissues for transposition, the relatively poor skin circulation, and the special structural characteristics of this area (1,2). The plantar skin is glabrous and thick, with solid anchorage to the deep structures. Therefore, the reconstructive aim is to restore the stability of the foot skin to adapt to weightbearing and to resist shearing forces. In addition, good sensibility should be considered in the reconstruction. Additional considerations include that the skin of the foot dorsum is thin and pliable, the ankle region has great tension during movement, and good stability is required for shoe wearing (3).

Numerous surgical reconstructive options have been described in published studies, including skin grafts, cross leg flaps, local fasciocutaneous flaps, and free flaps. Each has its merits and demerits (4). Skin grafts will break up with the repeated stress of weightbearing. Cross leg flaps have also been used for this difficult region but now are of limited use because of the difficult posture required and difficult rehabilitation for the patients (5). Reconstruction with free microvascular flaps is also very technically demanding and requires a high grade of expertise and infrastructural support. Moreover, some investigators recommend against the use of free flaps for patients with diabetes (6).

Shanahan and Gingrass (7) in 1979 described the medial plantar sensory flap for coverage of heel defects. Later, Harrison and Morgan (8) in 1981 described an island version of the flap. The medial plantar

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flap is a fasciocutaneous island flap raised from the non-weightbearing instep of the plantar foot. The dominant vascular pedicle of the flap consists of the medial plantar artery and venae comitantes. The medial plantar flap has been effectively used in the reconstruction of soft tissue defects localized to the plantar foot, forefoot, posterior heel, and ankle (9). This flap can be transferred to the defect as a proximally or distally pedicled island flap (10).

The distally based sural artery flap was first described by Masquelt et al (11)in 1992. It is a fasciocutaneous island flap taken from the posterior aspect of the middle third of the leg and fed by the lower peroneal septocutaneous perforators in reverse fashion (12). Its vascular basis is the close association between the median superficial sural artery and peroneal artery perforators. It has been frequently used for reconstruction of soft tissue defects of the lower leg, foot, and ankle (13).

Fasciocutaneous flaps are highly effective and easy to perform. The present study was undertaken to compare the outcomes of the medial plantar artery flap (MPAF) and the distally based reversed sural artery flap (RSAF) in foot and ankle reconstruction.

## Patients and Methods

The present comparative cross-sectional study included 30 patients of both sexes, with an age range of 18 to 60 years, who had soft tissue defects in the foot and ankle region. These patients were admitted to the Plastic Surgery Department of Tanta University Hospital from March 2011 to March 2014. All the patients provided written informed consent.

All the patients underwent full history taking and a detailed clinical examination. The patients also underwent radiography to assess the skeletal effects and arterial duplex scanning to assess the vascular pattern of the foot. The patients were divided into 2 equal groups: the MPAF group, with the soft tissue defects repaired with a proximally based island MPAF; and the RSAF group, with the soft tissue defects repaired with a RSAF.

The MPAF was used for patients whose defects were $\leq 5 \times 7$ cm, whose instep area of the sole of the foot was intact, and whose posterior tibial artery with its continuation into the medial plantar artery was patent. The RSAF was used for patients whose defects were $>5 \times 7$ cm, who had no injury to the lateral aspect of the lower third of the leg, which could interrupt the vascularity of the flap, and for whom the peroneal artery was patent. None of our patients had major comorbidities, and those with peripheral vascular disease or a positive smoking history were excluded from the present study.

If the soft tissue defects had resulted from trauma or neurotrophic denervation, complete debridement was performed first, and then antibiotic therapy was given. After the local wound bacterial culture had confirmed the absence of infection, a secondary flap transfer was performed for wound coverage. In the case of malignant skin lesions, wide local excision was performed until the intraoperative biopsy showed clear wound margins. At that point, the wound was covered primarily by a flap.

Surgery was performed with the patient under general or spinal anesthesia. A pneumatic tourniquet was applied to provide a bloodless field. Surface marking, preoperative photography, and injection of intravenous antibiotics were completed before tourniquet application.

### *Dissection*

The technique for MPAF surgery is shown in Fig. 1. The patient was placed in the supine or lateral position. A curvilinear line beginning 1 cm posterior to the medial malleolus and extending into first web space was drawn. Dissection was performed to expose the posterior tibial artery behind the medial malleolus up to the division into the plantar arteries. The medial plantar artery was identified, and the head of the abductor hallucis was detached to trace the medial plantar artery originating from the posterior tibial artery. To ensure the flap was sensate, the branches supplying the flap were isolated and teased out from the main trunk of the medial plantar nerve.

The flap was then raised from distally to proximally, including the plantar fascia. An incision was made at the borders of the designed flap, extending through the planter fascia between the abductor hallucis muscle and the first slip of the flexor digitorum brevis muscle. At the distal end of this incision, the medial plantar artery with its venae comitantes and medial plantar nerve were identified and dissected proximally beneath the flap. An incision was made between the flap donor site and the defect, and a proper tunnel was prepared by removing some of the subcutaneous tissue. The incision was then closed primarily at the end of the procedure. At this stage, the tourniquet was released and circulation to the flap assessed. After meticulous hemostasis, the flap was rotated to cover the desired recipient site, and loose interrupted sutures were applied to hold the flap in place without tension. The donor site of the flaps was primarily grafted with a split-thickness skin graft.

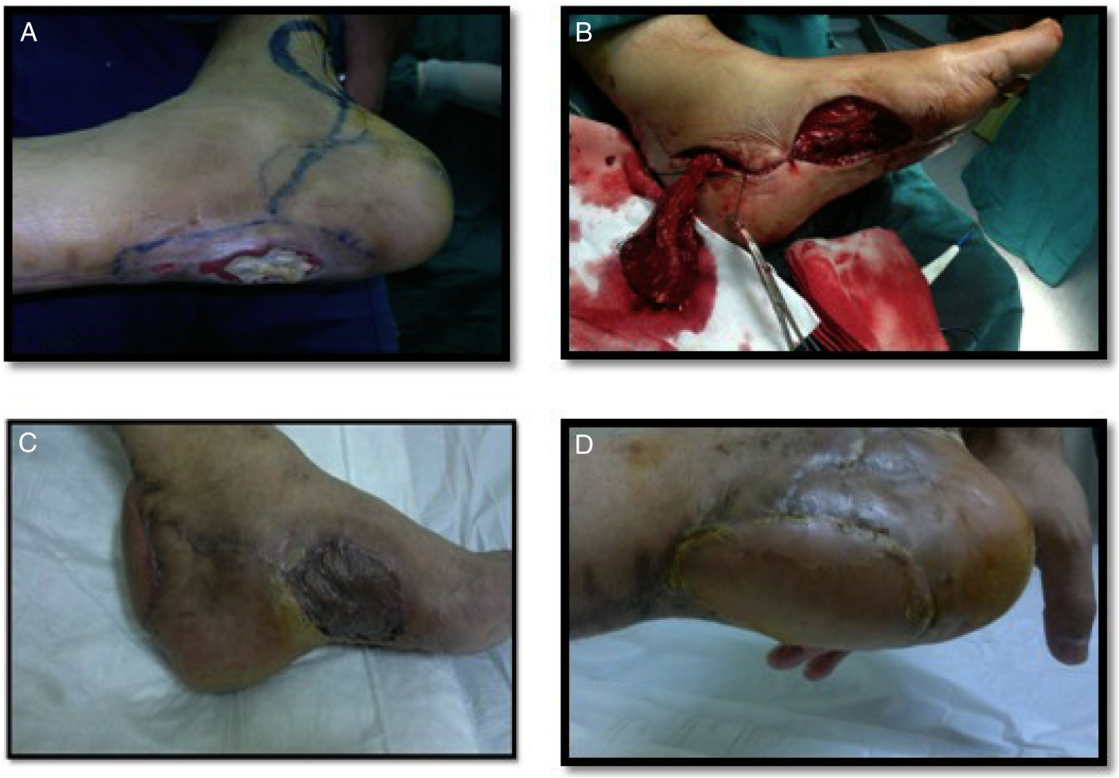


**Fig. 1.** (*A*) A 40-year-old male with post-traumatic exposure of the Achilles tendon. (*B*) Harvesting of the medial plantar artery flap. (*C*) Postoperative photography (lateral view) showing sound healing of the donor site. (*D*) Postoperative photograph (posterior view) showing sound healing of the flap.