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Lateral calcaneal artery perforator-based skin flaps for coverage of lower-posterior heel defects

Sui-Jiang Wang^a, Yu-Dan Kim^{b,*}, Hai-hua Huang^a,
Ze-Yong Wu^a, Ling Lu^a, Hai-Fang Chen^c, Xiao-Rui Guo^b,
Xiao-Hua Wei^d

^a Department of Plastic Surgery, Affiliated Hospital of Guangdong Medical College, Zhanjiang, Guangdong, China

^b Second People's Hospital of Zhongshan, Zhongshan, Guangdong, China

^c Department of Human Anatomy, Guangdong Medical College, Zhanjiang, Guangdong, China

^d Shilong BoAi Hospital of Dongguan, Dongguan, Guangdong, China

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Summary *Background:* Perforator-based flaps have been explored across almost all of the lower leg except in the Achilles tendon area. This paper introduced a perforator flap sourced from this area with regard to its anatomic basis and clinical applications.

Methods: Twenty-four adult cadaver legs were dissected to investigate the perforators emerging along the lateral edge of the Achilles tendon in terms of number and location relative to the tip of the lateral malleolus, and distribution. Based on the anatomic findings, perforator flaps, based on the perforator(s) of the lateral calcaneal artery (LCA) alone or in concert with the perforator of the peroneal artery (PA), were used for reconstruction of lower-posterior heel defects in eight cases. Postoperatively, subjective assessment and Semmes–Weinstein filament test were performed to evaluate the sensibility of the sural nerve-innervated area.

Results: The PA ended into the anterior perforating branch and LCA at the level of 6.0 ± 1.4 cm (range 3.3–9.4 cm) above the tip of the lateral malleolus. Both PA and LCA, especially the LCA, gave rise to perforators to contribute to the integument overlying the Achilles tendon. Of eight flaps, six were based on perforator(s) of the LCA and two were on perforators of the PA and LCA. Follow-up lasted for 6–28 months (mean 13.8 months), during which total flap loss and nerve injury were not found. Functional and esthetic outcomes were good in all patients.

Conclusion: The integument overlying the Achilles tendon gets its blood supply through the perforators of the LCA primarily and that of through the PA secondarily. The LCA

* Corresponding author. Department of Plastic and Aesthetic Surgery, Second People's Hospital of Zhongshan, Zhongshan, Guangdong, 528447, China.

perforator(s)-based and the LCA plus PA perforators-based stepladder flap is a reliable, sensate flap, and should be thought of as a valuable procedure of choice for coverage of lower-posterior heel defects in selected patients.

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With great advances in skin flap surgery, reconstruction of soft-tissue deficiencies of the hindfoot remains a challenging undertaking. The challenge is how to reconcile reconstruction of such deficiencies with rehabilitation of both function and form of the hindfoot at a reasonable donor-site cost in this "specialized" but short of skin surplus location.^{1–3}

Over the past decades, almost all techniques enumerated on the reconstructive ladder have been employed to aim at this goal,^{4,5} and free-tissue transfer still stays as the gold standard for the treatment.⁶ The fact, though, is that with an increasingly profound understanding of the vascular anatomy of the lower-leg local flaps typified by the fasciocutaneous flaps,⁷ reverse island skin flaps,⁸ and now perforator flaps,^{9,10} have been more and more used in practice; hence an attendant decrease in the use of free tissue transfer.^{5,11} Nowadays, free tissue transfer is considered more for the patients with larger or complex defects than for those in whom appropriate local alternatives are available.^{12,13} These alternatives may be sourced from the proximal ipsilateral leg,^{8,14–18} medial and lateral malleoli,¹⁹ and foot.^{4,19–22} More specifically, they are so-called random fasciocutaneous flap such as the V–Y advancement flap,¹⁴ axial fasciocutaneous flaps such as the medial plantar flap,²¹ the lateral calcaneal artery LCA flap²⁰ and its modifications,^{4,22} the traditional distally based sural flap,^{15,16} and the perforator flaps.^{10,18,19}

Perforator flaps have been increasingly welcomed since its inception in the mid-1980s²³ because of their capacity to offer defects-similar tissue(s) at a minimal donor-site cost. So far, they have been extensively applied, as pedicled or as free flaps, to the reconstruction of defects varying in site, size, and tissue component.^{6,9,24} In the lower leg, not only have pedicled perforator flaps proven to be efficacious in covering such defects as previously carried out through a mandatory usage of local muscle flap or free flap without recourse to microsurgical technique,^{3,9,24} but also by marrying the perforator flap concept with advancement or propeller principle, making primary closure of the donor site achievable and thus further reducing the donor-site morbidity.^{13,18,25,26}

In this paper, the authors reported a V–Y advancement flap based on the LCA perforator(s) in terms of anatomic basis and clinical applications in treatment of small-sized lower-posterior heel defects of eight cases.

Materials and methods

Anatomic study

Dissection was performed on 24 adult cadaver legs that had been injected with stained latex through the

femoral artery. The integument of the posterior hindfoot was elevated suprafascially from the medial midline up to the posterior intermuscular septum. Perforators passing through the septum were dissected first from distal to proximal to expose their source vessels, and then from proximal to distal to display their branches and distribution. For those whose origins were located in the range of 0.0–8.0 cm above the tip of the lateral malleolus, the outer diameter at origin and location relative to the tip of the lateral malleolus were measured using a digital caliper. Only the perforators ≥ 0.2 mm were recorded.

Surgical technique

Under pneumatic tourniquet control and with the patient in the prone position, a stepladder-shaped flap was outlined above the defect following Hayashi and Murayama's method,¹⁴ with its base lying at 4.0–6.0 cm above the tip of the lateral malleolus. The length of the flap was about triple the height of the defect and the first segment slightly wider than the width of the defect.

The medial incisions were made first and the flap was raised laterally in the suprafascial plane as far as the posterior-peroneal septum was reached. The lateral incisions were then performed, followed by flap elevation carried out suprafascially as before. Care was taken to keep the sural nerve and the lesser saphenous vein intact in the flap. To moderate their constraints on the flap movement, dissection around them was done for centimeters along their courses with a scissors along their courses superior to the flap for centimeters. When the septum was visualized again, location of the perforators relative to the center of the flap was inspected for vascular pedicle selection. As a general rule, the one situated corresponding to this center would be given priority. Usually, the first perforators of the LCA took up such a position and were therefore frequently used; if it were not the case, one more set of perforators other than the first one is recruited into flap for the sake of perfusion. The tourniquet was deflated and assessment of flap perfusion was made. On determination, the septum was dissected off and the "surplus" perforators ligated. Finally, the flap was transferred to the defect in basically the same way described previously in the literature.¹⁴

Postoperatively, the ankle was immobilized in a plantar flexion position by applying a plaster slab. Five days later, the plaster slab was removed and then the patient was encouraged to begin active and positive rehabilitation on the ankle, unless the Achilles tendon repair had been done at the same stage.

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