SHORT COMMUNICATION

Reverse medial plantar artery flap

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Introduction

Coverage of soft tissue defects of the sole has been one of the major challenges of reconstructive surgery. The sole is a specialized structure, with thick skin and septae in the subcutaneous tissues which make it especially resistant to damage from shear forces and high pressures typical of the sole.1,2 Replacement by non-sole skin such as by dorsalis pedis, reverse sural and free flaps will be more prone to recurrent ulceration due to the less resistant skin in these donor areas. The medial plantar artery flap has become the standard method of soft tissue replacement of the heel.1,2 The forefoot, however, remains a challenge. Options include:

1. V-Y plasty
2. Digital artery web or lateral great toe flaps3
3. Filleting flaps3
4. Laterally based transposition flaps5
5. Free flaps
6. Cross-leg flaps
7. Skin grafts

The above methods will suffice in many situations, but for those with large soft tissue defects, especially without toes available for transfer, a suitable donor site remains a problem. The reverse medial artery flap has been described in soft tissue replacement in burn contractures and following excision for malignancy.6–8 This report describes its use in resurfacing of chronic plantar ulceration in leprosy affected patients.

Materials and methods

Three patients with a long history of recurrent ulceration of the forefoot were selected for a reverse medial plantar artery flap. These patients had large areas of ulceration and had no toes suitable for filleting or island flaps. Provision of orthotic footwear and excision of underlying bony prominences had been carried out previously without success in preventing ulceration.
SURGICAL TECHNIQUE

The medial plantar artery (MPA) is marked using a Doppler. Figure 1 demonstrates the vascular anatomy. The defect to be replaced is measured and a template is marked on the posterior instep centred on the medial plantar artery. With tourniquet control, the flap is cut down through the plantar fascia until the MPA is included with the flap and the flap isolated from surrounding tissues. Retrograde blood flow is now checked by temporary occlusion of

Figure 1. The vascular anatomy and design of the reverse medial plantar artery flap. The flap is supplied by communications from the first three plantar metatarsal arteries, which are branches of the deep plantar arch. The deep plantar arch receives contributions from both the lateral plantar artery and the deep plantar artery. (Reprinted with permission from Baker GL, Newton ED, Franklin JD. Fasciocutaneous island flap based on the medial plantar artery: clinical applications for leg, ankle and forefoot. Plast Reconstr Surg, 1990; 85: 47–58.)
the MPA to assess bleeding from the flap with the tourniquet released. If adequate perfusion is seen, the MPA is divided just distal to the bifurcation of the posterior tibial artery and again retrograde blood flow is assessed. The pedicle is then dissected anteriorly, progressively raising the flap with its pedicle until the flap can easily reach the defect. The perivascular fat surrounding the pedicle was preserved with the vessels. The subcutaneous tissues are widely opened to allow for compression-free placement of the pedicle. The flap is then sutured in place with a drain, and any pedicle that cannot be easily covered by skin is covered with a split thickness skin graft. The donor site is likewise skin grafted. Any revisions of the pedicle should wait until at least three weeks following the original operation.

Patient 1

A 60-year-old lady had a 10-year history of recurrent ulceration under the first metatarsophalangeal joint with 10 previous admissions (Figure 2a). After excision of the ulcer and surrounding scar tissue there was a remaining 4 × 4 cm defect. A reverse medial plantar artery flap was carried out. Much of the pedicle had to be covered by skin graft due to its bulk and the scarring in the tissues proximal to the ulcer. The skin grafts healed well. Four weeks postoperatively the pedicle was reduced in size to reduce the area covered with skin graft. The wound was well healed at 2 months following the revision (Figure 2b) and the patient was able to ambulate. The patient was discharged 3.5 months postoperatively.

Patient 2

A 56-year-old man had a 16-year history of recurrent ulceration under the second and third metatarsal heads with seven previous admissions. After excision, a residual 3 × 4 cm defect was left. A reverse MPA flap was carried out with skin grafting to the donor site. Part of the pedicle was covered with skin graft as well. The flap healed well and he was scheduled for pedicle reduction 1 month postoperatively. The patient signed himself out of hospital prior to surgery and was last seen dancing outside the hospital gates.

Patient 3

A 73-year-old man had a history of recurrent ulceration under the second and third metatarsal head area for 12 years with three previous admissions, including a previous Y-V plasty and an unsuccessful plantar skin graft. The ulcer measured 3 × 5 cm. He underwent a reverse MPA flap and the pedicle was covered without a skin graft. The flap healed well but a small revision of the flap was carried out 3 weeks postoperatively at the site of pedicle insertion (Figure 3). This healed well and he was discharged walking at 8 weeks postoperatively.

Discussion

The reverse medial plantar artery flap has proved to be a useful adjunct in the management of soft tissue defects of the forefoot. Areas as large as 5 × 8 cm have been successfully
covered by this flap. Its use in covering areas of chronic ulceration in neuropathic feet has been recently described by Gravem.\textsuperscript{2} For patients with small ulcers and intact toes a digital artery or filleting flap will often be the best option if the patient consents. Medial ulcers can often be covered with laterally based fasciocutaneous flaps.\textsuperscript{5} However, for large defects or in those without toes these flaps would not be an option, and a reverse medial plantar artery flap would be a good solution. It uses skin from a non-weight bearing area of the sole, providing excellent quality sole replacement with minimal donor morbidity. The plantar septal flap recently described is another good option for defects in the first metatarsophalangeal joint area although it is technically more challenging with very small supplying vessels.\textsuperscript{9}

\textbf{Figure 2}. (a) Preoperative photo of the plantar ulcer of patient 1. (b) Following healing of flap.
Disadvantages reported with the reverse MPA flap are the lack of sensibility, possible lack of adequate arterial supply or venous return and poor donor site cosmesis. The lack of sensation is not an issue in neuropathic feet in whom restoration of sensation in the forefoot is not an option at present. Retrograde blood flow can be checked following temporary inflow occlusion by observation, Doppler, or intravenous fluorescein. The author has not encountered problems with venous return, although Butler and Chevray reported the need for venous supercharging in one patient. If retrograde blood supply is inadequate at the time of clamping of the vessels without improvement following application of topical vasodilators, the procedure can just be abandoned or converted to a free flap. The donor site initially is quite deep, but the contour fills in with time with contracture of the site as well (Figure 4).

Butler and Chevray give several recommendations to improve the reliability and success of this operation.

1. Confirmation of adequate retrograde flow prior to division of the vessels proximally.
2. Consideration of supercharging or conversion to free-tissue transfer in the case of inadequate retrograde blood flow.
3. Preservation of perivascular fat of the pedicle.
4. Skin grafting of the pedicle if required to avoid compression of the pedicle from tight skin closure.
5. Temporary K-wire fixation of the toes in flexion if the metacarpo-phalangeal joint is crossed to reduce tension.
6. Maximization of pedicle length by posterior placement of the flap and dissection of the pedicle right up to the pivot point.

Keeping these principles in mind this flap should have a high success rate, and can be safely performed without magnification. The surgeon should expect and inform the patient about the frequent need for revision of the pedicle, and prolonged time before ambulation appears to be the norm. In the author’s experience pedicle coverage is much easier and wound healing is quicker in soft tissue defects secondary to cancer as chronic scarring is not present. However in all of our cases the ulcers healed quicker than if left to heal by secondary intention, and there should be a much lower risk of recurrent ulceration with this technique, provided that the patient adopts proper preventative measures such as the use of adequate footwear.

References

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