British Journal of Plastic Surgery (1987), **40**, 241–245

A new approach to heel ulcers: dorsalis pedis neurovascular trans-interosseous island flap

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Summary—The most important requisite in the care of ulcers in the heel region is replacement skin cover with adequate sensation.

The dorsalis pedis flap appears adequate, but the anterior subcutaneous approach gives a pedicle of inadequate length to enable the flap to reach the most important posterior weight-bearing area. It was therefore decided to short-circuit the course of the pedicle by passing the whole flap through the interosseous membrane between the tibia and the fibula to enable the flap to reach the weight-bearing area without tension.

After 10 meticulous cadaver and two post-traumatic limb dissections with angiographic confirmation, it appeared that such a flap was feasible and would satisfy all basic requirements. Clinically this technique was tried in two patients who were provided with sensate, well padded skin cover for the whole of the heel region.

The heel and the posterior region of ankle are common regions for indolent ulceration, the former because it is a major weight-bearing area and the latter because it is a mobile area over a tendinous insertion into a bony prominence, which heals with difficulty.

The heel, being a major pressure-bearing area, requires a sensory flap cover to provide protective sensation and padding.

To provide sensory cover to the heel various techniques have been described, *viz.* free sensory skin graft (Maquieira, 1974; Lister, 1978), free sensory lateral intercostal neurovascular flap (Badran *et al.*, 1984), first web neurovascular island flap (Gulyas *et al.*, 1984), median plantar neurovascular flap (Shanahan and Gingrass, 1979) as well as the dorsalis pedis flap, extended by interposing a vein graft to increase the pedicle length (Caffee and Hoefflin, 1979). We felt that a local (ipsilateral) dorsalis pedis neurovascular flap could satisfy all the requirements if it could reach the posterior pressure-bearing area on the heel. After 10 cadaveric, two post-traumatic limb dissections and two angiographic studies, we found it possible to reduce the distance between donor and recipient sites by transferring the flap through the interosseous membrane.

Operative technique

With the patient in the supine position and under general or epidural anaesthesia, the dorsalis pedis flap is raised as a true axial pattern island flap. The size of the flap will depend on the requirements for cover of the heel and often includes skin with a random pattern of blood supply. A delay is done to be sure of the survival of the random pattern component.

The standard method of dissection and elevation of the flap is employed. Care is taken to identify the distal and proximal parts of the dorsalis pedis artery prior to ligation and division of its deep branch.

An incision is then made starting from the midpoint anteriorly between the two malleoli and going vertically up for 6 inches, the lower 2 inches of the incision being dermis deep initially to preserve the superficial peroneal nerve. Further dissection is carried over the deep fascia and the superficial peroneal nerve is identified in the lateral compartment and completely freed.

After incising the deep fascia between extensor hallucis longus and tibialis anterior tendons, the structures in the anterior tibial neurovascular bundle (ATNV) are identified and elevated from

their bed. The extensor retinaculum is then incised. After severing the rest of the vascular connections of the ATNV the skin island flap is lifted off with its neurovascular pedicle. During this dissection the extensor hallucis brevis muscle slip is severed from extensor digitorum brevis, to be included in the flap (Fig. 1).

After completing this anterior dissection, the patient is turned into the lateral position and another incision 6 to 7 cm in length is placed 2 cm behind the posterior fibular border 5 cm above the lateral malleolus. At this level the tendinous peroneus longus and the musculotendinous peroneus brevis are isolated from flexor hallucis longus which is a bipennate muscle. This is then separated from the fibula to expose the interosseous membrane. The membrane is then pierced bluntly and slit upwards and downwards to the inferior tibiofibular ligament. An adequate opening is made in the interosseous membrane and the island flap is brought through it into the posterior compartment (Fig. 2).

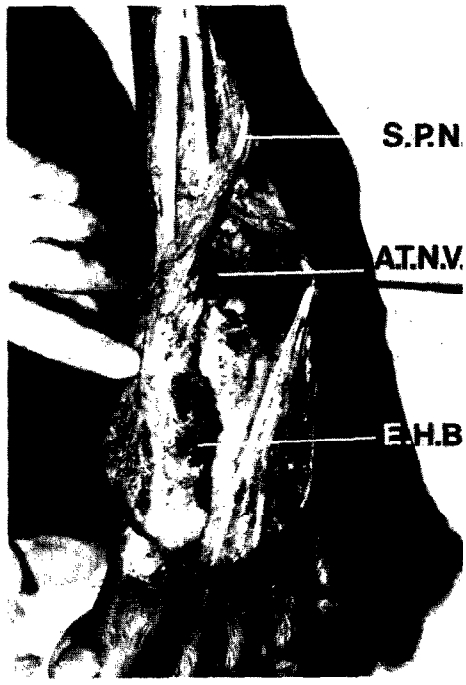

Fig. 1

Figure 1—Cadaver dissection showing the flap elevated from the bed on its neurovascular pedicle with superficial peroneal nerve (SPN), extensor hallucis brevis (EHB), 1st dorsal interosseous muscle, and anterior tibial artery and venae comitantes (the only drainage vessels used in this flap) with deep peroneal nerve (ATNV).

It is important to go only through this plane (Fig. 2A) lest one may damage the posterior tibial artery which now remains the sole vascular supply of the foot.

To reach the defect the pedicle is then passed

Fig. 2

Figure 2—(A) Flap passed through the interosseous gap into posterior compartment. The pedicle (ATNV) is shown by haemostat. SPN is also shown at the upper end of the incision. (B) Transverse section of the (Rt) ankle 5 cm above malleoli. Note the route of the ATNV through the interosseous membrane and then between flexor hallucis longus and the fibula, to come out behind peroneii. The posterior tibial neurovascular bundle is well protected and away from the plane of dissection. The peroneal artery is also safe if no sharp dissection is used.

Fig. 3

Figure 3—Cadaver dissection. Flap coverage achieved through trans-interosseous migration. Almost the whole heel is covered.

either subcutaneously or, after extending the posterior incision, directly to the wound edge (Fig. 3).

Since the drainage vessels are the anterior tibial venae comitantes, the great saphenous vein may be sacrificed to gain additional length if the flap has been delayed, as in both our cases.

The flap is sutured into the defect without tension. The donor area is skin grafted and the foot is placed in plantar flexion with a dorsal slab.

Case reports

This paper is based on our successful use of trans-interosseous transfer of dorsalis pedis island flaps in two patients who required sensory flap cover over the heel. One was a 45-year-old man with a large defect following a failed split skin graft (Figs 4 and 5). The other case was a 19-year-old boy with a neurological disorder resulting in an intractable ulcer, though with good dorsal skin sensation (Figs 6 and 7).

In both patients flap healing was complete and pre- and postoperative two point discrimination of the flap skin was (i) 17 to 21 mm and (ii) 16 to 25 mm respectively at 6 weeks. Both these patients were re-educated easily to comprehend pain on the dorsum as excessive pressure on the heel, to be relieved by elevating the foot.

Fig. 4

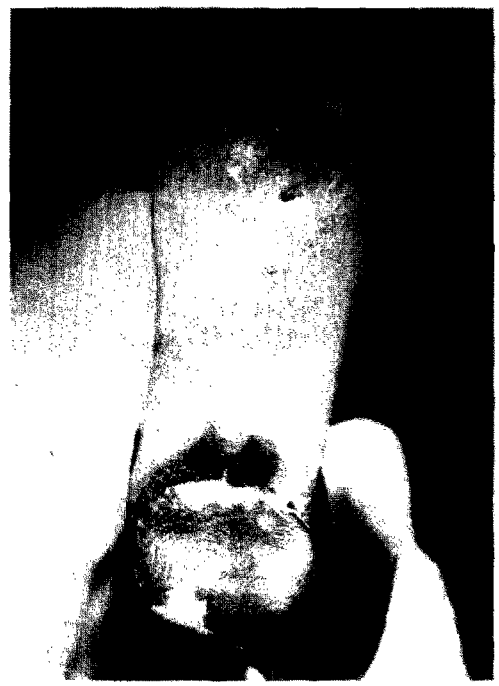

Fig. 5

Figure 4—Case 1. Defect after excision of ulcer. The dark skin at the periphery is a previous split skin graft. Figure 5—Case 1. Postoperative result.

Fig. 6

Fig. 7

Figure 6—Case 2. Another case of heel ulcer with calcaneal osteitis. The patient had developed talipes equinus deformity.
Figure 7—Case 2. Flap coverage of the same area, after excision of ulcer and removal of involved bone.

The complications recorded were dorsal graft loss in one case and some oedema of the flap in the early postoperative period. Postoperative footprints of both these patients are shown in Figures 8 and 9A, B.

Discussion

Defects of the heel have long challenged the skills of reconstructive surgeons. Successful repair requires a flap with the best possible sensation to provide the padding to withstand pressure and protect from trauma.

Skin grafts in this major weight-bearing area fail because of their inadequate resistance to repeated wear and tear and because of their insensitivity and lack of padding.

Multi-staged procedures like cross leg and other distant flaps and tube pedicles require awkward positioning and still lack adequate sensation. Most are quite bulky and give a feeling of slippery insecurity whilst standing on the heel.

Free neurovascular flaps, whilst satisfying most criteria for adequate cover, require microsurgical expertise.

Fig. 8

Figure 8—Postoperative footprint of Case 1 showing posterior weight-bearing area covered by the flap.

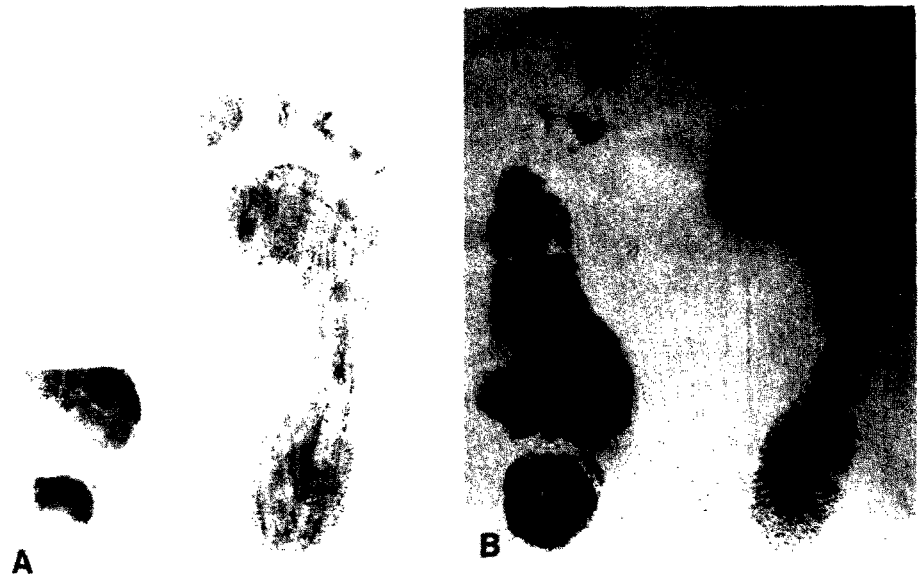

Fig. 9

Figure 9—(A) Postoperative footprint of Case 2 on the 40th day. The weight being borne by the flap covered area (maximum darkening) and the tip of the great toe. (B) Case 2. Eightieth postoperative day—note the improvement in weight-bearing, with flattening of the high longitudinal arch of the foot. Still maximum concentration of dye is on the flap covered area.

The dorsalis pedis neurovascular island flap appears to be very suitable for heel cover if it is made to reach the area without any tension by the trans-interosseous route described above.

Acknowledgements

We thank Dr N. J. Pandya, Honorary Assistant, Department of Plastic Surgery, Dr D. R. Trivedi, Head, Department of Surgery, Dr (Mrs) V. D. Trivedi, Department of General Surgery, Dr J. S. Kalgutkar, Head, Department of Anatomy, and Dr S. Parikh, Department of Radiology, for their help and guidance.

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Paper received 21 July 1986.
Revised 21 October 1986.