CASE REPORT

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The use of a combined bipedicled axial perforator based fasciocutaneous flap for the treatment of a traumatic diabetic foot wound: a case report

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The axial and perforator vascularised fasciocutaneous flaps are reliable and effective treatment methods for covering lower limb post-traumatic, septic, Charcot, and diabetic foot wounds. The authors describe the unique utilisation of a hybrid flap as an axial-perforator flap combination for the treatment of a traumatic diabetic foot wound.

Keywords: *diabetic foot*; *trauma*; *calcaneus*; *fasciocutaneous flap*; *plastic surgery*

Received: 23 October 2010; Revised: 5 January 2011; Accepted: 6 January 2011; Published: 7 February 2011

The first fasciocutaneous flap was described by Ponten in 1979, and the most popular classification described based on vascular anatomy was by Cormack and Lamberty (1) Fasciocutaneous flaps include the fascia and the source vessel with its cutaneous branches. The fasciocutaneous flaps can be random skin flaps (the predecessor of axial flaps) and axial flaps. There are free and pedicled flaps and they can be axial (orthodromic or reversed flow) or perforator based flaps. A flap is termed an axial flap when it disposes an official vascularisation by a well-defined anatomical pedicle, based on a large or medium size artery. Perforator flaps can be based on septocutaneous or musculocutaneous perforators. Perforator vessels are arteries to the skin (direct or indirect) that branch from an underlying source vessel and penetrate the deep fascia vertically (1). In septocutaneous perforators (direct perforators), the vessels travel the intermuscular septa and branch out along the fascia, so the fascia is included (fasciocutaneous) during flap harvesting. In 1989, Koshima and Soeda first reported on perforator flaps, specifically describing the peri-umbilical perforator flap (2). The most reliable classification of perforator flaps was developed by Nacajima, which classified the flaps into direct and indirect muscular or septal flaps, based on the mode with which the perforator penetrates the deep fascia and arrives at the skin (1).

The axial flaps that are usually applied in clinical practice for the lower extremity are the reverse sural flap for malleolar and heel areas, the saphenous orthodromic flap for the knee area, and the medial plantar artery orthodromic flap for the heel area. The perforator based flaps that are typically used in lower limb reconstruction and that we have been performing in our department during the last decade are the anterior tibial distal perforator based flap, the posterior tibial distal perforator based flap, and the peroneal distal perforator based flap. The posterior tibial perforator based flaps we have used are the transpositional flap, the hemirotational flap (90° rotation) for covering the Achilles tendon, and the propeller flap (180° rotation) for dorsal ankle and foot defects (1–8). We have also used a unique hybrid type of flap, specifically a reversed axial perforator based flap. When only one of the above flaps (distally based sural artery neurocutaneous flap or distally based lateral supramalleolar island pedicled flap) is not enough for

 Citation: Diabetic Foot & Ankle 2011, **2**: 5749 - DOI: 10.3402/dfa.v2i0.5749

ensuring the flap's blood supply, a flap based on both of the above mentioned vascular pedicles may suffice. We describe our technique in the following case report.

Case report

A 54-year-old diabetic male presented to our outpatient facility with a history of a calcaneal osteomyelitis after a failed calcaneal open reduction internal fixation and a large post-traumatic septic defect of the Achilles tendon area. His past medical history was only significant for type 2 diabetes mellitus controlled by his oral hypoglycemics. The patient had sustained the injury and had an urgent surgical intervention 4 weeks prior to his initial visit in our facility. Pedal radiographs and wound cultures were positive for septic necrosis of the wound and also for growth of Enterococcus and Stenotrophomonas species. The patient was then admitted for initial surgical debridement and further osseous and soft tissue reconstruction (Fig. 1).

Our team's initial plan, after the bone biopsy and intraoperative cultures were obtained, was delayed coverage of the large defect with a reversed sural pedicle flap but this option was not feasible due to an intraoperative finding of a severed distal end of the sural artery. The sural artery's function was not intact and was ensured only by the supply from collateral arterial branches. The reversed flow arch that came from the lateral tarsal and anterior lateral perimalleolar vessels was interrupted. Immediately, the flap was redesigned and laterally transferred as a new flap, additionally based on the distal peroneal perforator. A partial calcenectomy was also performed, the Achilles tendon was retracted proximal in a lateral direction and reattached with two 3.5 mm absorbable bone anchors on the rest of the debrided calcaneus. The defect was also adequately covered by the additional use of a posterior tibial perforator based flap to cover subsequent marginal skin necrosis of the neighbouring flap area. In order to provide prophylactic sensation over the defect area, we also performed an end-to-end coaptation of the sural nerve with the lateral plantar nerve. The donor sites were covered with split thickness skin grafting harvested from his thigh regions. The patient was kept non-weight bearing for about 3 months after the final reconstruction and was fully ambulating at about 5 months postoperatively.

Fig. 1. Preoperative lateral radiographic (A) and clinical views (B) of the patient's initial presentation. An intraoperative view showing the harvesting of the hybrid flap (C) and the blood supply from the distal peroneal perforator (D). Clinical (E, F) and radiographic (G) views at 3 months follow-up showing the ankle range of motion and no evidence of recurrent bone of soft tissue infection. Final outcome at approximately 5 months postoperatively (H, I).

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Surgical technique

The patient is placed in the lateral decubitus position. The flap is outlined proximally at the junction of the two heads of the gastrocnemius muscle, distally 2–3 cm distal to the perforating branch of the peroneal artery, which is identified on the skin by the depression in the lower part of the tibiofibular space (or by Doppler examination), anteriorly just anterior to the lateral malleolus and posteriorly just medial to the presumed course of the sural nerve and vein.

The dissection begins from the anterior border of the skin marking, with an incision along the anterior margin of the flap continuing anteriorly to the lateral malleolus. The superior extensor retinaculum is incised and the distal peroneal perforator is exposed on the tibiofibular ligament. The anterior margin of the flap is then dissected including the fascia, which is sutured to the overlying skin to prevent sliding of both layers that may damage the perforators.

During this dissection, the superficial peroneal nerve is divided at the distal end of the flap. As the flap is raised from anterior to posterior, the sural nerve, artery, and the lesser saphenous vein are identified and raised with the fascia underneath. Small arteries arising from the peroneal artery are maintained. Proximally, with the completion of the skin incision, the sural nerve, the lesser saphenus vein, and the superficial peroneal nerve are divided. In order to provide prophylactic sensation over the defect area, one can perform an end-to-end coaptation of the sural nerve with the lateral plantar or another sensory nerve in the neighbouring area. Distally, the pivot point is 4–5 cm above the tip of the peroneal malleolus, where the most distal peroneal perforator is usually found. The width of the carrier pedicle is approximately 4–5 cm. After rotating the flap (up to 180°) to the recipient area, a split-thickness skin graft is used to cover the defect area.

Discussion

In an effort to cover large soft tissue defects of the heel and perimalleolar regions where there is lack of abundant soft tissue, we have used various kinds of flaps. The hybrid flap we describe in this article is made up of skin, subcutaneous fat, and fascia of the postero-lateral part of the leg, sural nerve/artery, lesser saphenous vein, and superficial peroneal nerve with its vascular network from the distal peroneal perforator. This flap contains two sources of blood supply, the retrograde flow of sural artery and the orthodromic flow from the distal peroneal perforator. The most significant disadvantage of this flap is that the sacrifice of the sural and superficial peroneal nerve results in large anesthetic areas over the lateral and dorsal aspects of the foot. It is a combined axial (sural artery) perforator (peroneal) flap that, due to its dimensions, can provide satisfactory coverage of the defect and due to its double blood supply is reliable enough even in cases with serious compromise to the circulation of the major arteries of the lower limb, as long as the peroneal artery is intact.

Our utilisation of a hybrid flap to this large traumatic diabetic foot wound was successful after serial debridements and also the utilisation of a posterior tibial perforator based flap to cover the medial region of the foot and ankle. A combination of a multidisciplinary health care team for the medical and surgical management of osteomyelitis, wound defect, and diabetes mellitus is essential in the overall patient's successful outcome.

Conclusion

Fasciocutaneous flaps for coverage of lower limb defects could be based on more than one vascular pedicles and a hybrid combination may be necessary for larger defects.

Conflict of interest and funding

The authors have not received any funding or benefits from industry to conduct this study.

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