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Free conjoined or chimeric medial sural artery perforator flap for the reconstruction of multiple defects in hand

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Summary *Background:* One-stage coverage of multiple or jumping defects in the hand remains a great challenge in reconstructive surgery. A medial sural artery perforator-based conjoined or chimeric flap can be a potential candidate for reconstruction and a versatile donor site for tendon and nerve grafts.
Methods: Between September 2009 and December 2012, two free conjoined and three free chimeric medial sural artery perforator flaps were transferred to reconstruct multiple soft tissue defects in the hands. Only patients with more than two perforators in the preoperative Doppler analysis were admitted to this surgical approach. The anatomy, surgical technique, and clinical follow-up for up to 24 months are described.
Results: A variation of two to four perforators was found during dissection. All the flaps survived completely, and one patient developed wound dehiscence, which healed after continuous dressing changes. Two patients received tendon and nerve grafts simultaneously. Three donor sites received an additional free skin graft from the groin region. Follow-up of the five patients ranged from 6 to 24 months (mean 13 months) postoperatively. No obvious donor-site morbidity was observed. The patients were satisfied with the single-stage procedure and the aesthetic outcome of the hands.
Conclusion: The free conjoined or chimeric medial sural artery perforator flap can provide a single-stage solution for multiple defects in the hand. The versatile donor site also provides

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the option to harvest a segment of a tendon or nerve graft for single-stage composite tissue reconstruction.

Introduction

A chimeric flap is defined as a combination of multiple independent flaps that retain their own vascular supply connecting to one common source vessel, while a partially split conjoined (Siamese) flap shares a common skin boundary.[1,2] Anatomically, any musculocutaneous perforator flap that is perfused by more than one perforator can be split into multiple cutaneous flaps, based on the number of the perforators. Each unique flap is nourished by at least one single musculocutaneous perforator, yet all perforators derive from the same trunk vessel.

Chimeric flaps are further classified into two types, perforator-based chimeric flaps and branch-based chimeric flaps, according to the vascular relationship between the supplying vessels and the main trunk.[3] Perforator-based chimeric flaps mainly refer to fasciocutaneous flaps, while the latter can be combined with muscle and bone tissue for versatile reconstructions.

The medial sural artery perforator (MSAP) flap was first introduced by Cavadas et al., in 2001,[4] and it has become one of the most popular perforator-based flaps currently used during clinical practice. With developing anatomical study of the vasculature of MSAP, Sano used split-cutaneous MSAP chimeric flaps to increase the available total flap size for defects of the distal forearm and lower limb, which allowed primary donor-site closure.[5] We have used this technique in a small series for the treatment of irregular or "jumping" defects of the hand.

Surgical anatomy and technique

The medial sural artery originates from the popliteal vessels and enters the medial gastrocnemius muscle. Before giving off any perforators, the medial sural artery usually bifurcates into two main branches (medial and lateral) and it allow the formation of a muscle and perforator combined flap or the so-called branch-based chimeric flap. Within the muscle, the medial and lateral branches of the medial sural artery are accompanied by the motor nerve to the gastrocnemius muscle, and they give off a variable number of musculocutaneous perforators to the medial posterior calf. The detailed topography of the MSAP flaps has been well documented.[6] In general, the number of cutaneous perforators of the medial sural artery varies from one to five, and there are usually two major perforators. The most sizable musculocutaneous perforators are located within the upper one-fifth to one-third of the lower leg,[7] 8.5—15 cm from the popliteal crease and 3.71 $\pm$ 0.35 cm from the posterior median line of the leg.[8] No perforator is found either $<$6 cm or $>$18 cm below the popliteal crease.[7] The length of the vascular pedicle ranges from 9 to 16 cm. The thickness of the flaps usually is as thin as 5 mm (range, 4—8 mm). The arterial diameter of the vascular pedicle is approximately 3 mm.[9] The diameter of the accompanying vein is slightly larger than the arterial diameter (about 3.5 mm).[7] The lesser saphenous vein can be included in the flap for venous drainage if necessary.

All the operations were carried out under general anesthesia and tourniquet control. The patient was placed in the supine position. The hip joint was kept in abduction with the knee flexed. A line was drawn between the midpoint of the popliteal crease and the center of the medial malleolus indicating the trajectory of the medial sural artery in the lower leg. Preoperatively, the emerging points of perforators were carefully localized over the medial gastrocnemius muscle with the aid of a handheld Doppler ultrasound device based on the anatomical descriptions. Patients were only admitted to this approach if a minimum of two perforators could be detected by Doppler analysis. If there is vacancy of the perforators, an alternative flap will be the backup. The design of the chimeric flap was centered on the perforators individually. The operation was facilitated under pneumatic tourniquet control without limb exsanguinations and under loupe magnification.

We preferred to incise the flap from the lateral boundary to spare the sural nerve. After verification of the perforators, we were able to harvest the chimeric flap in two ways: (1) we raised the perforator-based flap individually. (2) All the perforators were included in one flap, and the flap was split into subflaps after harvest. The intramuscular dissection was performed under loupe magnification with careful hemostasis and motor nerve protection. The isolation was carried out retrogradely toward the source vessel to obtain the desirable pedicle length and vascular caliber. After the elevation, the tourniquet was deflated and the vascular perfusion of the flap was checked. Selection of the recipient vessels was determined by the location of defects.

Materials and methods

Between September 2009 and December 2012, 25 free MSAP flaps were transferred to reconstruct soft tissue defects in the hands, of which five cases were chimeric flaps. Only patients with more than two perforators were included in this study. Informed consent was obtained from each patient. The patients' clinical data are summarized in Table 1. All the patients were male with a mean age of 28 years (range 19—38). The etiology of the defect varied: one patient sustained a high-pressure molten plastic injection injury to the volar palm of the right hand, one patient