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Distally based sural neuro-fasciocutaneous perforator flap for foot and ankle reconstruction: Surgical modifications for flap pedicle and donor site closure without skin graft



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Received 14 July 2017; accepted 13 October 2017

KEYWORDS

Modification;
Neuro-fasciocutaneous flap;
Perforator flap;
Pedicle;
Donor site

Summary Background: The conventional procedure of the sural neuro-fasciocutaneous flap enables the supply of blood and venous drainage by increasing the width of the adipofascial tissue and preserving tiny venous return routes. Moreover, skin graft is a common method for donor site closure, which may lead to some complications and influence the aesthetic appearance. We report modifications for a distally based sural neuro-fasciocutaneous perforator flap and a relaying flap for donor site closure without skin graft.

Methods: Twelve patients undergoing the modified flap for foot and ankle reconstruction were included in this study between 2014 and 2016. A peroneal-based perforator, a superficial vein, and the vascular axis of the sural nerve were included in the pedicle. A Z-shape skin incision was performed to explore the perforator vessels and a relaying island perforator flap was used to close the donor site.

Results: All flaps survived completely without necrosis. The area of the flaps ranged from 16 × 8 cm to 30 × 15 cm. The diameter width of the pedicle ranged from 1.0 to 2.0 cm. A relaying perforator island flap was used in 10 cases for donor site closure and no skin graft was performed. There were no serious donor site complications. All patients were satisfied with the aesthetic outcome postoperatively at the final follow-up.

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Conclusions: The distally based sural neuro-fasciocutaneous perforator flap is considered a reliable method for foot and ankle reconstruction. The modification for flap pedicle and donor site closure method without skin graft should be recommended.

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Reconstruction of soft-tissue defects of the foot and ankle is a common but challenging problem. Appropriate therapy should use local tissue whenever possible, preserve the aesthetic appearance, provide reliable coverage in important anatomical regions, and minimise donor site deformities. Since Masquelet et al.¹ first described the concept of distally based neuro-fasciocutaneous island flap supplied by the accompanying vascular axis around sural nerve, the popularity of this flap has increased noticeably, and various reports describe favourable results in association with its use for foot and ankle reconstruction.²⁻⁸ However, the accompanying vascular axis around sural nerve, the perforator vessel with its cutaneous branches chain, and the perivascular fascia tissue, are still poorly understood. On the other hand, many procedures ignored the donor site morbidity after flap harvest. It cannot be too excessive to enable preservation of the aesthetic appearance in order to improve patient satisfaction.

The main complications consist of partial or complete flap failure, flap congestion, and donor site morbidity.⁹⁻¹¹ Many studies have recognised the potential risk factors and focused on flap pedicle modification and dissection technique to increase the success rate.^{4,12-17} However, these improvements are frequently achieved by increasing pedicle width to ensure reliable blood supply and venous return. A hypertrophic adipofascial pedicle requires a wide skin paddle to be placed on it or for a skin graft to be performed for its coverage. This will inevitably increase the area of the invalid region and damage the donor site.

We believe that the increase of fascia pedicle width makes no contribution to improvement of the flap survival; on the contrary, it will reduce the flexibility of flap rotation and transfer. In our study, we present modifications for the pedicle of distally based sural neuro-fasciocutaneous flap and report its clinical applications in foot and ankle reconstruction. The flap can obtain abundant blood supply through both axial perforator and longitudinal chain-linked vascular plexuses, and overcome the venous reflow problem. The closure method and protection for the donor site is also a major modification and will be discussed in our study.

Patients and methods

Patients

Twelve patients (7 male and 5 female) with an average age of 37.9 years (range, 25 to 54 years) underwent the modified sural neuro-fasciocutaneous perforator flap reconstruction between 2014 and 2016. The causes of defects were crush or avulsion injuries in 7 patients, ulcers in 3, and resection of tumors in 2. These constructed defects were located in the ankle in 2 patients, the posterior heel in 6, and the dorsum of the foot in 4. With the patient in the prone

position, a preoperative Doppler probe was used in all cases to spot the perforators in the area posterior and proximal to the lateral malleolus. If the cause is high energy injuries with serious skin degloving and local perforator injury, a free flap (e.g. free anterolateral thigh flap) is mostly employed rather than a local perforator flap. The size of the soft tissue defects ranged from 12 × 6 cm to 28 × 13 cm. The donor site was closed primarily in 3 of 12 cases (25%) or with a relaying island perforator flap for the secondary defect covering in 9 cases (75%). Details of these patients are listed in [Table 1](#).

Anatomical basis

The longitudinal chain-linked sural neuro-fasciocutaneous vascular plexus was well-described in the existing literature.^{1,4,18,19} The nutrient vessels around the sural nerve have been confirmed to be the key to the success, so the flap is designed along the sural nerve and can receive high reliability. A wide and thick adipofascial pedicle is necessary to maintain venous drainage ([Figure 1](#)). To increase arterial blood supply and venous drainage, a peroneal-based perforator, a superficial vein (usually a branch of the small saphenous vein), and the vessel links between the perforator and the vascular axis of the sural nerve should be identified and included in the pedicle ([Figure 2](#)). The perforator vessels with at least one communicating branch to the accompanying vascular axis around the sural nerve should be intact and protected during the operation. Otherwise, the perforator vessels without communicating branches have no significant effect on survival for the distal part of a flap ([Figure 3](#)). The critical steps of surgical procedures and the modifications of pedicle were validated through fresh cadaver.

Surgical technique

The procedures were performed when patients were under general or continuous epidural anesthesia. The patients were positioned in a lateral decubitus position. A longitudinal line roughly representing the course of the sural nerve in the postero-lateral aspect of the lower leg was drawn from the mid-point of popliteal fossa to the mid-point between the Achilles tendon and lateral malleolus.

Four points of modification should be considered. First, we designed a large Z-shape exploratory skin incision from the defect area to the distal part of the flap instead of a traditional straight long incision or a small fasciocutaneous blade. A triangular flap was formed and the perforator vessel was confirmed beneath the triangular flap ([Figure 4](#)). This incision is used to release the pressure on the vessel pedicle after the flap transferred and skin sutured, while the traditional linear incision often produces more pressure on the pedicle which affects blood supply.

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