Original Article

A new operative technique for dissecting perforator vessel in perforator flap: a better way to minimize donor-site morbidity

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Background: The purpose of this paper was to introduce our experience on a new operative technique for dissecting perforator vascular in the perforator flap and explore its clinical outcome.

Methods: Between June 2013 and December 2016, 119 patients underwent soft tissue defects reconstruction with anterolateral thigh perforator flaps (ALTPs) were included in this study. Ninety-eight patients were male, and twenty-one patients were female. The average age of those patients was 40.58 years.

Results: The ALTPs were successfully elevated to reconstruct soft tissue defect for 119 patients. The size of skin paddle was 120.59±59.31 cm2. A total of 148 perforators were included in the ALTP (84 percent was musculocutaneous perforator, 16 percent was septocutaneous perforator). The mean flap elevation time was 60.85±20.25 minutes. The success rate of flap elevation was 98%, only three perforators were injured and one perforator occurred vasospasm during the operation. Five cases, including three venous crisis and two artery crisis, presented with vascular crisis after flap transfer. The rate of vascular crisis was 4.2%. All of flaps were completely survived except one flap had partial flap necrosis. The mean follow-up time was 13.32±8.9 months. No muscular weakness was displayed in this group.

Conclusions: Orderly retrograde dissection of the perforator vessels in the perforator flap can provide with less donor site morbidity, shorter operative time and safer than the traditional methods. It is a reliable operation for elevating the perforator flap.

Keywords: Perforator flap; flap dissection; operative techniques; microsurgery; donor site morbidity

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Introduction

Perforator flap consists of skin and/or subcutaneous fat. The vessels that supply blood to the flap are isolated perforator vessels. Those perforators may pass either through or in between the deep tissues (mostly muscle) (1). The perforator flap has enabled to avoid sacrifice of the muscle, the main vessels and deep fascia and to minimize donor site morbidity by meticulous dissection and anastomosis (2). Perforator flaps have been performed in increasing numbers since Koshima and Soeda first described perforator flaps in 1989 (3). The main advantage of this technique is that it achieves better accuracy in reconstruction and at the same time minimizes donor-site morbidity. Numbers of clinical series have been reported that perforator flap can be used to realize the really defect replace “like with like” (4-6).

However, the application of perforator flap requires a skillful microsurgical technique and a steep long learning curve, which limits the application of perforator flap (7-9). The elevation of the flap requires meticulous attention to

detail and a high degree of flexibility of the operative plan according to the position, size, and presence of vascular pedicle (10,11). The disadvantages of perforator flaps depend on their technical demands and lead to potential increase in operative time. In additional, dissection of the perforator vessel may be difficult because of anatomical variability of vascular pedicle (6,12).

The dissection of perforator vessels is the key role of success elevation flap (13). Anterograde approaches and retrograde approaches are the main two operative procedures for the perforator dissection (14-16). However, Anterograde dissection needs to explore the main trunk vascular, and then along those vessels to dissect the perforator, this procedure is blindness and often results in a perforator and nerve injure (15,17). Although retrograde dissection has been exhibited in most of literature, both blunt dissection and cutting off the muscle were adopted in the procedure of the conventional retrograde dissection. This procedure often results in higher donor site morbidity, such as a sensory deficit, muscle weakness and limitation of limb activities (13,16).

To overcome the limitation of traditional retrograde dissection of perforator vessel, we have modified the technical tips basing on our 15 years of experience on application of perforator flap. The purpose of this study was to introduce our experience on a new operative technique for dissecting perforator vascular in the perforator flap and explore its clinical outcome.

Methods

From June 2013 to November 2016, 119 patients with soft tissue defects underwent reconstruction with the anterolateral thigh perforator flaps (ALTPs). All patients in this series had exposure of underlying vital structures including vessels, nerves, bones, and tendons. The procedures were performed by a senior author (J Tang) at Hand & Microsurgery department of Xiangya Hospital of South Central University. Clinical data were collected based on our institutional database. The study followed the ethical guidelines of the Hospital Ethical Committee of the Xiangya Hospital. The individuals in this manuscript have given written informed consent to publish these case details. Demographics were recorded, including patient age, sex and length of follow up. Data were also collected on flap-related characterize, flap success rate, re-exposure rate, postoperative flap-related complications and donor-site morbidity.

Preoperative planning and flap design

It is essential procedure for perforator flap surgery with an accurate preoperative planning (10,14). Preoperative planning begins with evaluation of the soft defects to provide a specific customized reconstruction (*Figure 1*). On the one hand, the surgeon should consider both the dimensions and constituent component of the defect; on the other hand, the most appropriate donor site, the location of perforator vessels and the length of vascular pedicle need to be meticulous consideration. We usually used the tomography-assisted angiography (CTA) scan to assess the vascular anatomy of the recipient site (18,19). A hand holder Doppler was used to locate the perforator in the donor site. After debridement, a paper template with the same dimensions as defect was created. According to the shape of the wound, the laxity of the skin over the anterolateral aspect of the thigh and the location of perforator vessels, the perforator flap was outline on the donor site.

Operative technique

The surgical technique was showed through elevating an ALTP flap in the paper. Patients were placed in the supine position with the leg straight in a neutral position. Based on the perforators mapped and three-dimensional features of the wound, the flap was outlined on the anterolateral aspect of the thigh. Initially, only one paddle side is incised to avoid the flap elevation failure, because the position of perforator maybe varied, and it is enable to permit alteration of the skin paddle according to the location of vessels selected. The flap was harvest at the suprafascial plane. The surgeon should preserve several additional perforator vessels until the main perforator was identified (*Figure 2*). And then, opening the deep fascia was performed to explore the deep perforator vessel course. It is necessary to incise the deep fascia with enough wide in order to explore the vessels in the surgical, because an adequate exposure can reduce the risks damaging of the perforator vessel.

Dissecting the intramuscular course of perforator vessel is the most difficult procedure. The surgeon should use loupe magnification to assist in dissection the perforator vessels at this step (*Figure 3*). In a first phase, the side of the perforator vessel, which is adjacent the surgeon, was dissected to expose the course of the pedicle through the muscle (*Figure 4*). This step is preferentially performed in the same direction as the underlying muscle fibers and toward. The muscle fibers were split by sharp dissection.

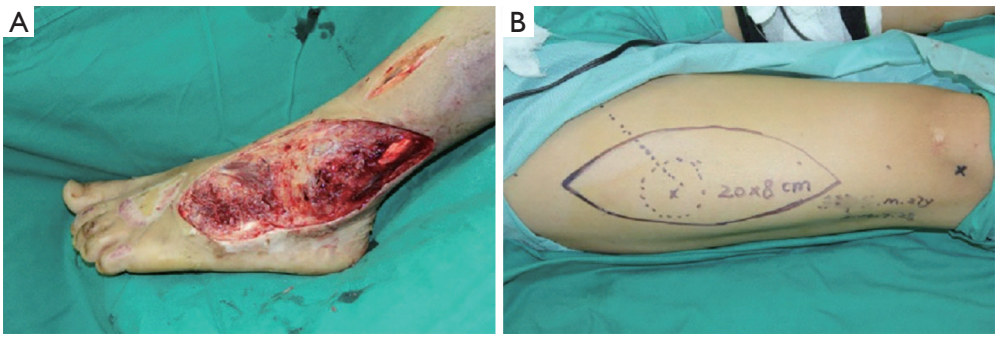

Figure 1 Preoperative view. (A) Preoperative of the view in the recipient site; (B) design the ALTP on the donor site. ALTP, anterolateral thigh perforator flap.

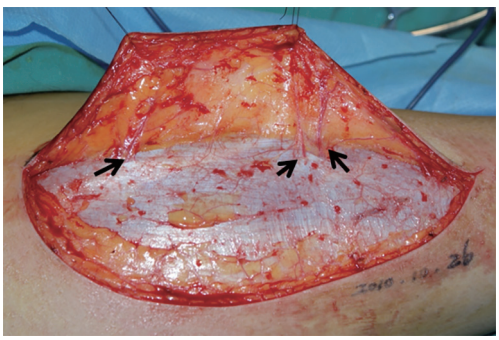

Figure 2 The flap was dissected at the suprafascial plane. Several additional perforator vessels were preserved until the main perforator was identified.

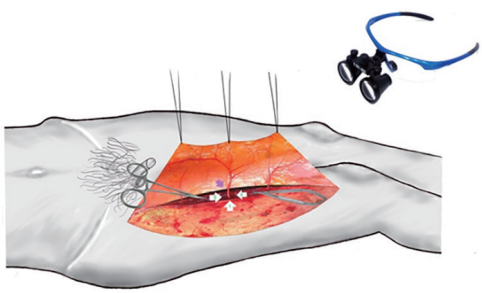

Figure 3 A schematic diagram showed the orderly retrograde four sides dissection of the perforator vessels.

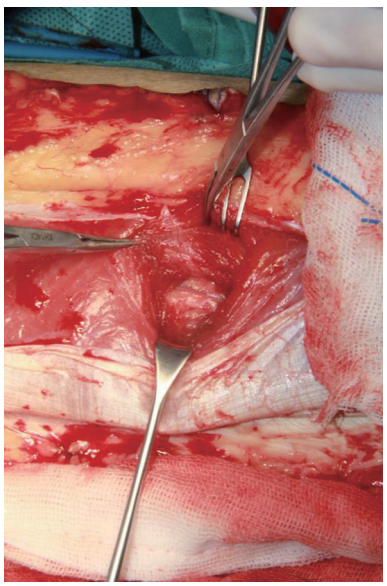

Figure 4 The first side of the perforator vessel, which is adjacent the surgeon, was dissected to expose the course of the pedicle through the muscle.

According to the loose connective tissue cuff around the perforator vessels, the path was indicated to through the muscle and where the muscle fibers need to be split. We did not cease to dissect and trace the perforator vessel until identified the source vessels.

The next step, the left and right side of the perforator vessel was dissected. 3mm width facial tissue surrounding the perforator should be retained to avoid perforator injury (*Figure 5*). And then, the medial edge of the flap was incised, and the flap dissection proceeded in a medial to lateral direction at the superficial fascia plane. The incision was ceased until encounter the perforator vessel. The fourth sides of the perforator vessel then was dissected and traced to the main trunk vascular (*Figure 6*). Every side branch should be taken careful to coagulated, ligated, or clipped to prohibit a hemostasis. Notable, at least 1 to 2 mm away from the perforator should be preserved to avoid to injure the perforator vessel and allow hemostasis to be rescued if

there is continued bleeding.

The perforator was traced back to the main trunk of the descending branch of the lateral circumflex femoral artery (LCFA), which was dissected according to pedicle length requirements. Once the dominant perforator vessel supplying the flap was completely dissected, a vascular clamp was used to identify blood supply of the flap. After the flap was transferred to the defect, the wound of the donor site was closed directly after complete hemostasis and reliable drainage (*Figure 7*).

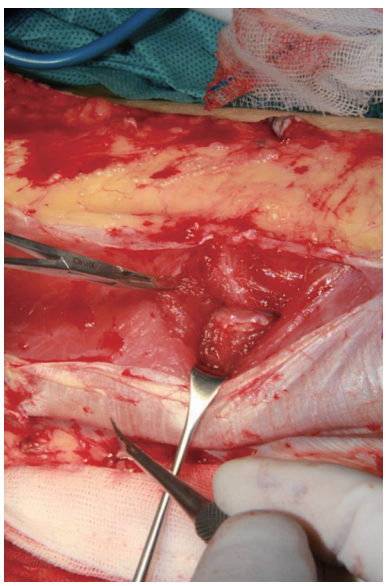

Figure 5 The left and right side of the perforator vessel was dissected. 3 mm width facial tissue surrounding the perforator should be retained to avoid perforator injury.

Results

The ALTP flaps were successfully elevated to reconstruct soft tissue defect for 119 patients, including 98 males and 21 females. The average of the years was 40.58. The size of skin paddle was 120.59±59.31 cm^2. A total of 148 perforators were included in the ALTP flaps (84 percent perforators were musculocutaneous perforator, 16 percent perforators were septocutaneous perforator), the average of number of perforators were 1.24. The mean flap elevation time was 60.85±20.25 minutes. The success rate of flap elevation was 98%, only three perforators were injured and one perforator occurred vasospasm during the operation. The addition of papaverine was used to alleviate the problem. Five cases, including three venous crisis and two artery crisis, presented with vascular crisis after flap transfer. The rate of vascular crisis was 4.2%. The vascular crisis was alleviated by re-exploration. All of flaps were completely survived except one flap had partial flap necrosis. The mean follow-up time was 13.32±8.9 months, most of cases showed satisfactory contour, and there was no excessive bulk. No muscular weakness was displayed in this group.

Discussion

Complex soft tissue defect reconstruction always is a challenge problem for the plastic and reconstruction surgeon (4,10). Conventional flap transfer often displayed bulking contour, unsatisfactory color match, unstable mobile surface, poor function recovery and higher donor site morbidity (10). In the past decades, more and more perforator flaps have been performed for defect

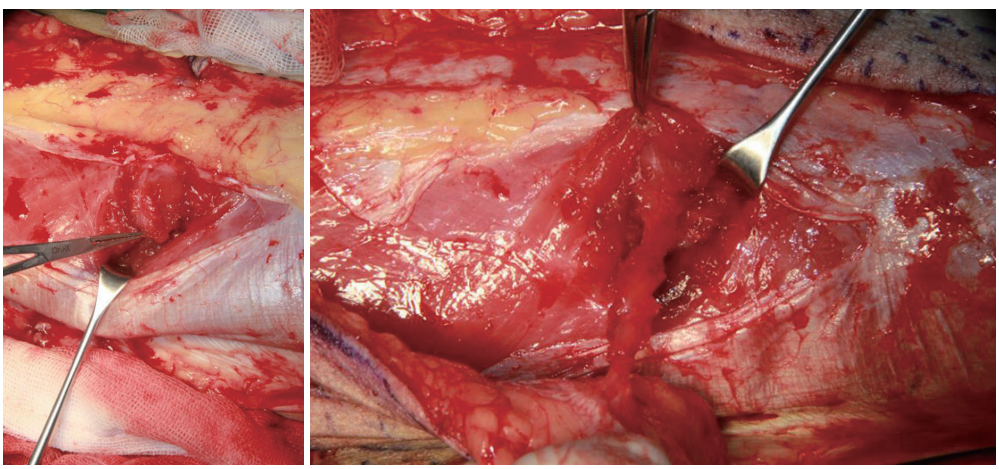

Figure 6 The fourth sides of the perforator vessel then was dissected and traced to the main trunk vascular.

Figure 7 Postoperative view. (A) Intraoperative view of the flap after was harvested; (B,C) postoperative view of the donor site and recipient site.

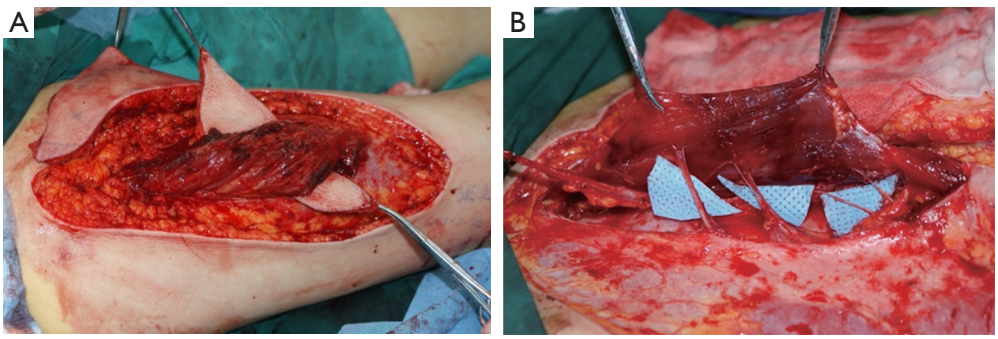

Figure 8 This procedure facilitates the pedicle manipulation and improves the visualization of all side branches and motor nerves. Muscle fibers and nerves can be preserved.

reconstruction due to achieve the defect replace "like with like" and minimize the donor site morbidity (1,20). Perforator flap have become the workhorse procedure in the soft tissue reconstruction (21,22). However, ALTP flap is known for variations of its vascular pedicle. Failure to understand its variability can easier lead to vascular flap embarrassment and tissue loss (23). Several authors described that 5 to 6 percent of patients absent suitable cutaneous perforator for free ALTP transfer in the thigh (24,25). Many surgeons have found that it is very difficult to elevate a perforator flap because of variations in the size and location of the cutaneous perforators (5,26). Meanwhile, it is known that the type of perforator vessel usually belongs to musculocutaneous and not septocutaneous perforators (27,28). Consequently, elevation flap frequently requires meticulous intramuscular dissection. In our series cases, the results displayed that 84 percent perforators were musculocutaneous perforator. Therefore, application of the perforator flap requires long learning curve and skillful microsurgery technique. In the present study, we introduced a new dissection technique for harvesting flap by orderly retrograde four side dissection.

We found that this technique was easier and safer than the conventional technique. In our present study, 148 perforators were included in the paper, only three perforators were injured and one occurred vasospasm. Donor-site morbidity of the perforator flap can be produced with multiple factors, including damage to the muscle fiber or nerve, closure with skin grafts and injure to the deep fascia. Comparing with the conventional dissection technique, orderly retrograde four side dissection technique has presented number of advantages. On the one hand, fewer muscle fibers are sacrificed and the dissection is smoother with this operative technique; on the other hand, this procedure facilitates the pedicle manipulation and improves the visualization of all side branches and motor nerves (*Figure 8*). It reduces the risk factor for perforator avulsion during manipulation. Furthermore, It is known that the motor nerves often be encountered at the level of the deeper vessels, often just underneath or within the deeper part of the muscle. This dissection technique can explore clearly visualization to avoid damage the nerve.

Although many advantages of the dissection technique have been demonstrated in this paper, some technical

tips and disadvantages also should be taken care. Firstly, Perforator selection is based on the type of perforator vessels, location within the flap, vessel diameter, and flap zones to be used. Intramuscular septa perforator vessel always is preferentially choose for the perforator flap. Secondly, the deep fascia should be incises enough wide to explore the deeper vessel and avoid to damage the perforator. Thirdly, the perforator flaps was spared with deeper structures to reduce the donor site morbidity. The small perforators are more likely to produce vasospasm and twisting. Therefore, the dissection procedure should be flexible as much as possible. In additional, the intramuscular dissection should be performed in the same direction as the underlying muscle fibers and toward. The loose connective tissue cuff around the perforator vessels can indicate the path to through the muscle.

Conclusions

Orderly retrograde four sides dissection of the perforator vessels in the perforator flap can provide with less donor site morbidity, shorter operative time and safer than the traditional methods. It is a reliable operation for elevation the perforator flap.

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Footnote

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Hospital Ethical Committee of the Xiangya Hospital (No. 201403117) and written informed consent was obtained from all patients.

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