

Microdissected thin anterolateral thigh perforator flaps with multiple perforators

A series of case reports

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Abstract

Introduction: The study aimed to explore the effect of microdissected thin anterolateral thigh (MTALT) perforator flap with multiple perforators on patients with complex defects on the hand, elbow, heel, or knee.

Methods: From March 2012 to February 2013, 5 patients with complex defects on the hand, elbow, heel, or knee were included. During the flap preparation, 2 to 3 perforators penetrating the fascia of the anterolateral femoral area were initially detected, and the deep fascia was incised. The superficial fascia layer of the flap and the deep adipose were then dissected, and removed after verifying the distribution of the blood vessels using an operating microscope. The whole flap was then elevated, and transposed to the recipient areas for microsurgical reparation.

Results: Two cases of post-burn scar contracture and 3 cases of traumatic tissue defects were successfully reconstructed with these multiple-perforator MTALT flaps. No complication was reported, and secondary operative procedure was not needed in any patient in the follow-up.

Conclusion: MTALT perforator flap with multiple perforators is safe and reliable for patients with complex defects on the hand, elbow, heel, or knee.

Abbreviations: ALT = anterolateral thigh, MTALT = microdissected thin anterolateral thigh.

Keywords: free flap, microsurgical reconstruction, multiple perforator

1. Introduction

Free thin flaps have been developed as a useful technique for various reconstruction of soft-tissue defects, such as post-burn contracture of the neck,^[1] dorsum of the hand,^[2] foot, and ankle.^[3] This technique overcomes the drawback of the ordinary free flap which needs a secondary defatting procedure.^[4] Previous studies have reported a microdissection method of free thin flaps with which a thin perforator flap can be elevated accurately in 1 stage by intra-adipose dissection of the pedicle vessel under an operating microscope.^[5–8]

Because the shape of the skin and soft tissue defect is often irregular and complex, partial necrosis and venous congestion may occur after the thin flap transfer due to insufficient blood

supply from 1 perforator.^[9–11] Additionally, the defatting procedure by microdissection may sacrifice some networks from the suprafascial layer to the subdermal plexus, which may possibly decrease the safe area compared with the ordinary flap.^[12] As a solution, more than 1 perforator should be included in the pedicle whose location is readjusted according to the form of the flap and the vessel anatomy of the anterolateral thigh region.^[13]

Although thin anterolateral thigh (ALT) perforator flap with microdissection of perforators has been proven reliable in previous studies,^[14,15] studies specifically focused on microdissected thin anterolateral thigh (MTALT) perforator flaps with multiple perforators are scarce. This study reported our experience of treating 5 cases who had complex and large defects on the hand, elbow, heel, or knee using MTALT perforator flaps with multiple perforators. Compared with previous studies of Kimura et al,^[6,7] the sequence of microdissection was modified so as to more conveniently and safely obtain perforators with a long pedicle. The MTALT perforator flaps with multiple perforators survived well in the 5 cases. The series of case reports may provide useful guidance for clinical treatment of patients with complex and large defects on the hand, elbow, heel, or knee.

2. Materials and methods

2.1. Subjects

The 5 patients (4 males, 1 female) with complex defects on the hand, elbow, heel, or knee underwent reconstruction with MTALT perforator flaps with multiple perforators in our

Editor: Giovanni Tarantino.

The authors have no conflicts of interest to disclose.

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Medicine (2018) 97:4(e9454)

Received: 9 May 2017 / Received in final form: 1 December 2017 / Accepted: 5 December 2017

<http://dx.doi.org/10.1097/MD.00000000000009454>

hospital from March 2012 to February 2013. The mean age was 41 years (range, 24–55 years). The study was in accordance with the Declaration of Helsinki, and was approved by Ethics Committee of The General Hospital of Shenyang Military Area Command (Shenyang, China). Written consent to participate in this study was obtained from the participants.

2.2. Operative procedure

The operation procedure was similar to the method described elsewhere.^[5–8] But the sequence of microdissection of a perforator was slightly modified: exposure of the trunk, dissection of the root, islanding of the flap, and microdissection of the branch. At first, a line was drawn between the rectus femoris and the vastus lateralis muscles and its mid-point was marked. The cutaneous perforators were then detected using a Doppler flow meter (Bidop ES-100V3, Hadeco Inc., Kawasaki, Japan) near the mid-point. The perforators were usually lateral to the line and 2 to 4 perforators were detected. A template of the defect was then placed on the anterolateral thigh region and the general outline of the flap was designed. The center of the flap was adjusted according to the skin vessels markings.

The medial incision, approximately 15 cm in length, was made and the flap was elevated suprafascially. The dissection preceded laterally toward the septum between the rectus femoris and the vastus lateralis muscles in a suprafascial plane. At the septum level or lateral to it, several perforators penetrating the deep fascia were observed. A total of 2 to 3 sizable and pulsating perforators were selected. The deep fascia around the perforators was incised and careful dissection was carried out so that the perforators could be traced from the points where they pierced the deep fascia. The septocutaneous perforators were dissected intraseptally and the musculocutaneous perforators were incised with unroofing of the muscle covering the perforators. Once traced to the main branch of the lateral circumflex femoral artery, the descending or oblique branch, the fascia layer covering the pedicle was dissected. The part of the main branch distal to the perforator-joining point was then ligated and divided. After dissection of the posterior aspect of the perforators and ligation of the muscular branches, the flap was islanded with the connected lateral part. In case of pedicle gap, an end-to-side vascular anastomosis was performed between 2 arteries, and an end-to-end vascular anastomosis was performed for veins and small vessels.

For making thin flap, the adipose tissue within 1 to 1.5 cm around the perforators in the deep adipose layer was removed after confirming the distribution of the blood vessels using an operating microscope. The deep adipose lobule, larger, and flatter

than the superficial one, is attached to and partially merged into the loose connective tissue over the deep fascia. Therefore, the loose connective tissue should be excised sharply before the deep adipose lobule is removed. The superficial adipose layer was left intact to preserve a thin network of vessels, which were considered to be the terminal branches of the perforators. Special care was taken to preserve the lateral femoral cutaneous nerves during the process. If damaged, the nerves were coapted under an operating microscope.

With using a template again over the microdissected area, the actual design of the flap was outlined based on the distribution of perforators. The whole flap was then elevated in a plane between the superficial adipose layer and the deep adipose layer, preserving the microdissected vessels. Circulation of the flap was confirmed before the pedicle was severed, and the flap was transposed to the recipient areas for microsurgical reparation.

3. Results

Five cases who had complex defects on the hand, elbow, heel, or knee were the subjects of the treatment (Table 1). Two cases were caused by scar contracture occurring after general burns and 3 cases were traumatic tissue defects. The defects were irregular in shape. Among them, 1 patient had MTALT flaps with 3 perforators and the other 4 patients had MTALT flaps with 2 perforators. The flap size ranged from 15 × 6 cm to 25 × 6 cm and the thickest flap was 6 mm. The mean pedicle length was 78.5 mm (range: 65–92 mm). The average flap dissection time was 90 minutes (range, 70–120 minutes). The mean duration of hospital stay was 20 days (from 14 to 28 days). The follow-up period ranged from 12 to 18 months.

No complications were reported in any patient. All transfers of the perforator flaps were achieved successfully and the results were acceptable without secondary operative procedures.

4. Case reports

4.1. Case 1

A 36-year-old man suffered a burn injury on both upper extremities. The meshed split-thickness skin grafts were harvested from the thigh and applied to the burned area on the right hand. Scar contracture in the first web of the right hand influenced the function of the thumb greatly. A 24 × 5 cm MTALT flap with 3 perforators was transferred to the web space after scar contracture release with the vessels anastomosed to the radial artery and its accompanying vein (Fig. 1). Skin grafting was not chosen because the graft contraction would limit the activity of

Table 1

Patient summary.

Patient	Age/Sex	Etiology	Defect	Length of the pedicle, mm	Flap thickness, mm	Flap size, cm	N	Follow-up, months
Case 1	36/M	Post-burn contracture	First web of hand (L)	75	5	24 × 5	3	18
			First web of hand (R)	73	4	20 × 5	2	18
Case 2	28/F	Trauma	Elbow fossa	81	5	23 × 5	2	16
Case 3	24/M	Trauma	Achilles tendon	85	5	19 × 6	2	14
Case 4	55/M	Post-burn contracture	Knee joint	92	6	25 × 6	2	12
Case 5	30/M	Trauma	Medial malleolus	65	4	15 × 6	2	15

None complication occurred in all the cases.

N=number of perforator flaps.

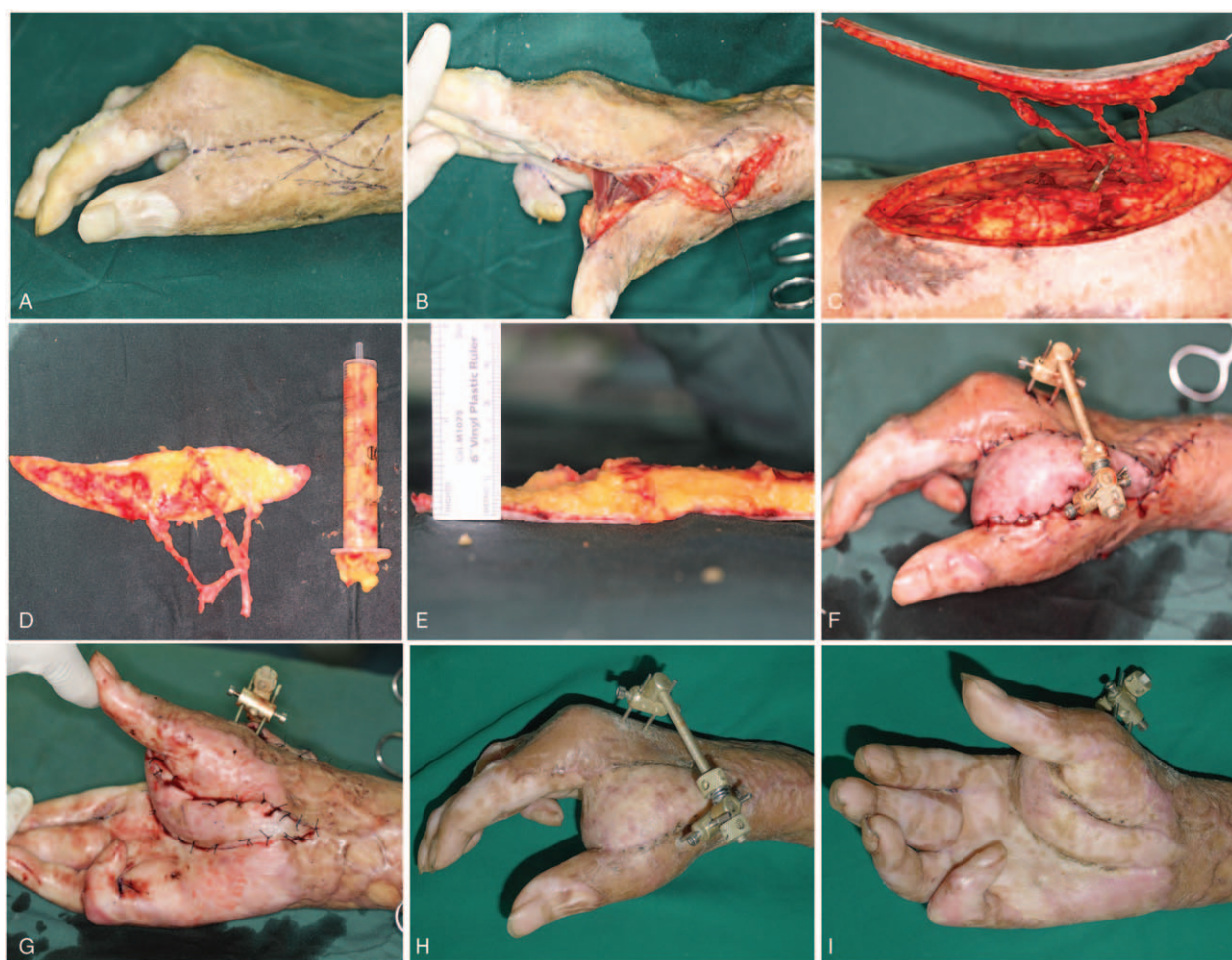


Figure 1. (A) A 36-year-old man with adduction contracture of the thumb because of a burn injury. (B) Releasing the contracture. (C–E) A microdissected thin anterolateral thigh (MTALT) perforator flap measuring 24×5 cm with 3 perforators is harvested and transferred to the defect. (F and G) Postoperative appearance. (H and I) Appearance 1 month postoperatively. MTALT= microdissected thin anterolateral thigh.

thumb-index web. A local skin flap was not chosen because of a lack of large recipient area for the surgery.

4.2. Case 2

A 28-year-old woman suffered from a work-related avulsion on her right elbow joint involving the underlying muscles. A 23×6 cm MTALT flap with 2 perforators was transferred to the avulsed area over the underlying muscle with vessel anastomosis to the radial artery and its accompanying vein at the flexor side of the elbow. The flap survived completely and the elbow's motion and appearance recovered well (Fig. 2). Skin grafting was not chosen for the patient since the graft contraction might limit the activity of the elbow joint. A local skin flap was denied by the female patient because of poor aesthetic outcome.

4.3. Case 3

A 24-year-old man had skin loss over his Achilles tendon after a traffic accident. A MTALT perforator flap with 2 perforators measuring 19×6 cm was prepared. The perforator flap survived completely, and the bulkiness of the flap required no additional secondary procedures 3 months postoperatively (Fig. 3). Skin grafting was not chosen for the patient since the activity of the

Achilles tendon might be limited by the graft contraction. A local skin flap was denied by the patient because of poor aesthetic outcome.

5. Discussion

As most of the traumatic skin defects are attributed to burn contracture or trauma, it is essential to cover the defect as soon as possible with a well-vascularized flap to achieve early rehabilitation for restoration of the skin function. The current study presented 5 cases with complex and large defects on the hand, elbow, heel or knee, whose recipient sites were irregular. For the purpose of providing sufficient blood supplying the flaps, MTALT perforator flap with multiple perforators was performed for the 5 cases. As a result, all transfers of the flaps with 2 or 3 perforators were successful without complications. The results of the flaps were acceptable, and secondary operative procedure was not needed in the follow-up.

It has been shown that the mean flap survival area of double perforators is remarkably larger than that of single perforator in rat models.^[16] If the design of the flap is beyond the range of blood supply of a single perforator, the addition of 1 or 2 perforators increases the blood supply; if problems occur in 1 perforation, the other can serve as a substitute. Fluorescence

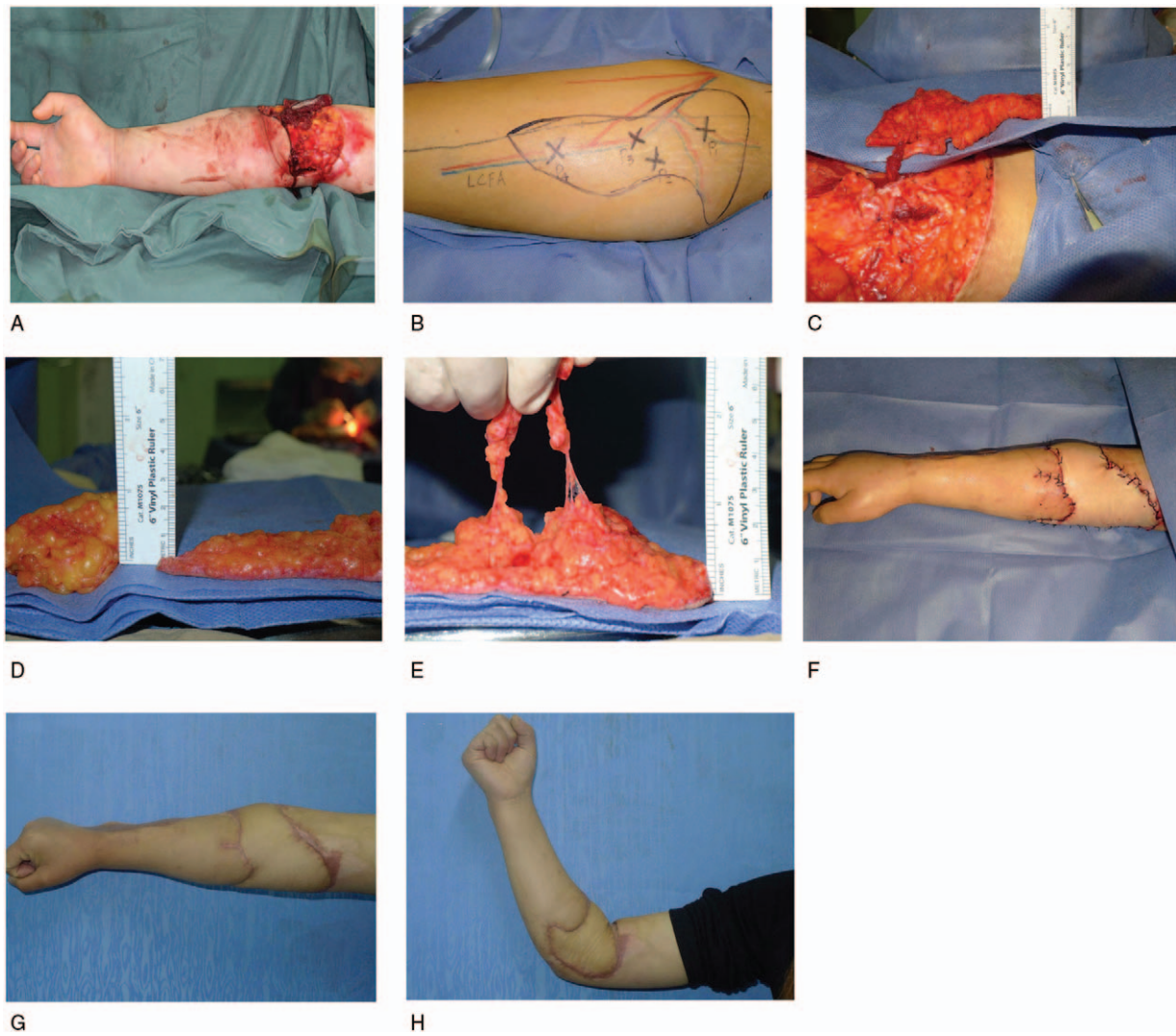


Figure 2. (A) A 28-year-old woman suffered skin and soft tissue defects because of a crushing injury by a machine at work. (B) Flap design with multiple perforators on the left thigh. (C–E) Completion of elevation and microdissection of MTALT perforator flap with 2 perforators. (F) Postoperative appearance. (G and H) Appearance 5 months postoperatively. MTALT = microdissected thin anterolateral thigh.

angiography has revealed that flaps with 2 and 3 perforator arteries have increased perfused area than the flaps with a single perforator artery.^[17] Moreover, there is evidence that it is efficient to prevent vascular insufficiency of unreliable flaps by including extra perforators.^[18] These results indicate that increased number of perforators could be included in the pedicle to improve blood supply. Location of the vascular pedicle of the flap is readjusted according to the form of the flap and the vessel anatomy of the anterolateral thigh region. By ultrasound detection and clinical microdissection, 2 to 4 perforators could be found easily in the anterolateral thigh region. In the present study, 1 patient had the flap based on 3 perforators and the other 4 patients had the flap based on 2 perforators. These studies indicate that compared with one-perforator thin flap, the multiple-perforator thin flap has enhanced blood supply, improves vein drainage and boosts flap circulation, which might improve the survival rate of the flaps and reduce ischemia-related complications. In previous studies, patients treated with flaps based on 1 perforator might develop distal necrosis.^[19,20] In the present study, no complication was reported in any of the 5 cases

in the follow-up. By ultrasound detection and clinical microdissection, 2 to 4 perforators could be found easily in the anterolateral thigh region. Anatomical position of vessels in the deep fascial layer or the subcutaneous layer varies considerably among individuals, thus it is necessary to adjust the circulation center after the microdissection. The method of preserving multiple perforators makes this adjustment more flexible. On the other hand, lateral femoral cutaneous nerve was carefully preserved during the operation. If the nerve is damaged, it will be anastomosed under an operating microscope.

With regard to thinning flaps, in the study, the adipose tissue with 1 to 1.5 cm around the perforators in the deep adipose layer was removed using an operating microscope. The loose connective tissue should be excised sharply before the deep adipose lobule is removed. But the superficial adipose layer was left intact to preserve a thin network of vessels, which were considered to be the terminal branches of the perforators. If the flap is too thin, flap necrosis might occur.

Because of its versatile nature, MTALT perforator flaps have been described as an ideal soft tissue flap to cover abundant and



Figure 3. (A) A 24-year-old man experienced skin loss over his Achilles tendon. (B) Flap design with 2 perforators on the left thigh. (C and D) Completion of elevation and microdissection of MTALT perforator flap with 2 perforators. (E) Postoperative appearance. (F) Appearance 3 months postoperatively. MTALT = microdissected thin anterolateral thigh.

complex defects in various regions of the body.^[21–23] Kimura et al.^[5–7] have suggested that the microdissection procedure of a perforator includes sequential dissection of the trunk, the branch, and the root. However, the trunk of the perforator is usually very short and thin. Therefore, it is not convenient to dissect the trunk vessels first. In our study, the sequence was modified to be exposing the trunk, dissecting the root, islanding the flap, and microdissecting the branch sequentially. With this modified sequence, it is safer and more convenient to harvest the perforator flap with multiple perforators. Thus, the study is of significance for guiding the treatment of patients with complex and large defects.

A long pedicle can be obtained by microdissection procedure.^[24] In the present study, the mean pedicle length was 78.5 mm (range: 65–92 mm), which was similar to previous data. Additionally, the thickness of the flaps was 4 to 6 mm after MTALT perforator flaps thinning, which was similar to a previous study reporting the flaps of 4 to 5 mm thickness.^[25] Additionally, MTALT perforator flap can also be applied in obese patients. Our clinical experience revealed that in obese patients the subcutaneous tissue on the anterolateral region is thicker and the vessels often have minor calibers. Therefore, the vessels would be more vulnerable to microdissection-related injury, and intramuscular dissection of perforators might take a longer time in obese patients. With microdissection, the adipose tissue between the deep fascial layer and the subdermal plexus vessel could be removed in 1 stage. However, MTALT perforator flaps might not be suitable for the restoration of the dorsum of the hand and foot, ankle, or neck because of their fatty and clumsy postoperative appearance.

As mentioned above, the multiple-perforator thin flaps have notable advantages compared to the standard as they provide enhanced blood supply, improve postoperative wound healing, and are with strong anti-infection ability and less risk of developing

distal necrosis. However, MTALT perforator flaps with multiple perforators still have some shortcomings. With these multiple perforators as the vascular pedicle, the area of donor site will be increased, and consequently, the function of muscle in the donor site might be affected. Moreover, the operation time is increased because of dissection of multiple perforators. In the present study, the averaged flap dissection time was 90 minutes (range, 70–120 minutes). Based on our experience, dissection of an additional perforator usually costs approximately 30 more minutes. Additionally, microdissection of multiple perforators is technically more difficult than microdissection of only 1 perforator for surgeons. It is very important to mention that the vessel anatomy of the anterolateral thigh region is complicated and varies in individuals. Preoperative design based on ultrasound and computed tomography (CT) images might be needed for surgeons. With regard to the indications of the present flaps, we suggest that it may be suitable for the parts with thin soft tissue (such as hands, feet, and joints) and defects with irregular shape (narrow or polygonal shape, etc.). Furthermore, for harvesting thin ALTs, we are trying to combine 3D imaging and endoscopy for preoperative evaluation and intraoperative assistance, and we may also use mixed reality (MR) technology to achieve intraoperative surgical precision in future. For the evaluation of blood perfusion, it is relatively reliable to use indocyanine green intraoperatively and laser Doppler postoperatively.

6. Conclusion

MTALT perforator flaps with multiple perforators are safe and reliable for patients with complex defects on the hand, elbow, heel, or knee. MTALT flaps with multiple perforators should be considered when the recipient area is large or in an irregular

shape. The study only described 5 cases. More cases are in need to test the efficacy of multiple-perforator thin flaps.

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