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Outcomes of using a modified anteromedial thigh perforator flap for repairing the anterolateral thigh free flap donor site

A retrospective clinical review

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Abstract

The anterolateral thigh (ALT) flap plays an essential part in plastic and reconstructive surgery. However, repair of the anterolateral donor site has not been the focus of the clinicians.

To assess the clinical value and feasibility of using a modified anteromedial thigh (AMT) perforator flap for repairing the ALT free flap donor site.

In this retrospective study, 16 ALT flaps were transferred to resurface large soft-tissue defects (ranged from 7 × 5 to 13 × 8 cm) in the foot or hand from June 2012 to March 2013. The donor sites were repaired with an advancement flap pedicled with an AMT perforator. Sensation within the advancement flap, return-to-work (RTW) time, the aesthetic appearance of the donor sites, and functional recovery were measured.

All 15 flaps survived completely without necrosis. One flap developed partial necrosis in the tip but healed with dressing changes after 1 week. The medain follow-up period was 3.5 months (range, 3–6 months). The average median time was 9.5 weeks (range 8–13 weeks). There was no numbness of the advancement flap. Additionally, there was no specific complication at both the recipient and donor sites. Thigh quadriceps muscle strength and activities of the knee were normal. All patients were satisfied with the aesthetic outcome postoperatively at the 3-month to 6-month follow-up.

The modified advancement flap pedicled with an AMT perforator is an ideal option for repairing the anterolateral donor site.

Abbreviations: ALT = anterolateral thigh, AMT = anteromedial thigh, CTA = computed tomographic angiography, RTW = return-to-work, VSD = vacuum sealing drainage.

Keywords: anterolateral thigh flap, donor site morbidity, modified anteromedial thigh, perforator

1. Introduction

The anterolateral thigh (ALT) flap was first described by Song et al.[1] Since the flap has a large vascular pedicle and sensory nerve in an obscure site, it has quickly become one of the most popular flaps.[2] Although many reports have been published on the use of ALT free flaps, few report has discussed repair of donor site. Skin grafting is usually used when the incision cannot be sutured simply, but patients complain about the result of skin grafting (e.g., its pitting shape, scar hyperplasia, and lack of feeling or numbness). We repaired large soft-tissue defects in the donor site with a modified advancement flap pedicled with an AMT perforator describe the clinical outcomes herein.

2. Patients and methods

All of this research is done in our organization. From June 2012 to March 2013, 16 patients with large soft-tissue defects in the foot or hand underwent reconstructive procedures with ALT flap transfers. In this retrospective study, 11 patients were men and 5 were women, with a median of 45 years (range, 25–58 years). The causes of the injury included 8 traffic crashes and 8 traumas due to massive machinery. The injured sites included the palm or dorsum of the hand in 6 patients, and sole or dorsum of the foot in 10. The size of the soft-tissue defects ranged from 7 × 5 to 13 × 8 cm.

All patients received debridement and vacuum sealing drainage (VSD) treatment during emergency surgery, and 5 to 7 days later, they underwent reconstructive procedures with ALT flap transfers ranging in size from 8 × 5 to 12 × 9 cm. Remaining wounds in the donor sites ranged from 4 × 2 to 10 × 3 cm, and they were repaired with a modified advancement flap pedicled with an AMT perforator simultaneously (Table 1).

3. Ethical statement

This clinical study was approved by the ethical committee of our institution, and all participants signed an exhaustive informed

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Table 1

Patient demographics and surgical details.

Case	Age, years	Gender	Side	Type of injury	Defect size, cm^2	Flap size, cm^2	Advancement flap size, cm^2
1	51	M	R	Traffic crash	9×6	10×7	5×2
2	47	M	L	Machinery trauma	13×8	13×9	10×3
3	48	M	R	Machinery trauma	7×5	8×6	4×3
4	25	M	R	Traffic crash	8×5	10×6	5×2
5	47	M	L	Machinery trauma	12×6	12×8	10×3
6	45	F	L	Traffic crash	11×7	11×8	9×3
7	39	M	R	Machinery trauma	9×8	10×8	5×3
8	48	M	L	Traffic crash	9×7	10×8	5×3
9	39	F	R	Traffic crash	10×6	11×7	8×3
10	39	F	L	Machinery trauma	10×6	11×7	8×3
11	34	M	L	Traffic crash	12×8	12×9	10×3
12	58	M	L	Traffic crash	13×7	12×8	10×3
13	48	F	L	Machinery trauma	11×8	11×9	9×3
14	45	M	L	Machinery trauma	7×5	8×6	5×3
15	52	F	R	Traffic crash	9×7	10×8	5×3
16	55	M	L	Machinery trauma	13×7	12×9	10×3
Median	46				10.2×6.6	10.7×7.7	7.4×2.9

consent form after being informed of the benefits and risks of the procedure (no. 2018-01-10-1)

4. Regional anatomy of AMT perforator flap

The saphenous artery originates from the descending genicular artery, and it travels distally toward the knee joint within the adductor canal.[1,3] The saphenous artery and its venae comitantes supply the supragenicular fasciocutaneous perforator and its venae comitantes, which supply the inferiorly based AMT flap. The saphenous artery travels distally into the subcutaneous tissue between the sartorius and gracilis. In this course, the saphenous artery is accompanied by the saphenous nerve and supplies 2 to 5 direct fasciocutaneous perforators and 2 to 6 musculocutaneous perforators. These perforators supply the overlying skin and underlying sartorius muscle. The supragenicular perforator divides into ascending and descending branches. The ascending branch anastomoses with subcutaneous branches arising from other perforators of the saphenous artery, thus, forming a subcutaneous vascular plexus to supply the skin overlying the inferiorly based AMT flap.[1]

5. Surgical technique

The reconstructive procedure was performed by 2 teams. All patients underwent multidetector-row computed tomographic angiography (CTA) for preoperative perforator localization. Surgery was performed by one team using a standard thigh tourniquet and general anesthesia. Then the wound in the foot or hand was treated surgically with thorough irrigation and debridement. According to the area and shape of the wound defect, the ALT flap was designed on the lateral thigh. The flap should be enlarged by 5% compared with the defect area to avoid venous crisis when the flap swells. The ALT flap was elevated according to a previously described method.[4] After the skin flap was obtained, anastomosis was performed in the recipient area of the hand or foot wound. Meanwhile, the donor site was minimized using absorbable suturing performed by the second team. According to its size, careful dissection of the perforator vessels in the AMT was conducted to obtain a relatively thicker pedicle that was used as the center of the advancement flap. The flap was dissected along the planning line, and the great saphenous vein and saphenous nerve in the medial aspect of the thigh were protected. All fascial tissues, except the thigh perforator, great saphenous vein, and saphenous nerve of the medial femoral skin were cut away, and then the flap was elevated. The great saphenous vein and saphenous nerve should be dissected properly to increase the distance of flap advancement. Unlike the traditional V-Y flap anatomy, we retained a wider bridge in the bottom of the advancement flap, which increased blood supply to flap. In this study, 10 cases of advancement flaps were based on 1 pedicle, and 6 cases were based on 2 pedicles. The donor site was resurfaced with the advancement flap, and the flap was sutured without too much tension.

6. Results

All perforators were confirmed intraoperatively. All ALT flaps survived, the modified advancement flap pedicled with an AMT perforator survived entirely in 15 cases, and 1 flap developed partial necrosis in the tip but healed with dressing changes after 1 week. The follow-up ranged from 3 to 6 months. All advancement flaps pedicled with an AMT perforator showed good texture matches and contour. No patient complained of the loss of walking ability or jumping power, or of numbness in the donor site during the extended follow-up (Table 2).

7. Case reports

7.1. Case 1

A 34-year-old man involved in a severe motor vehicle crash sustained a 12 × 8-cm soft-tissue defect in the right dorsum of his hand with comminuted fractures of the first fingertip. Debridement and VSD treatment were performed primarily, and his first fingertip was fixed by Kirschner wires (Fig. 1A and B). Seven days later, the right thumb developed necrosis, so dactylolysis spontanea developed. We designed the modified advancement flap pedicled with an AMT perforator to repair the donor site

Table 2

Follow-up outcomes.

Cases	Follow-up, months	Motion function		RTW, weeks	Aesthetic satisfaction	Possibility of walking or jumping
		Quadriceps femoris strength	Knee joint			
1	4	5	Normal	10	No	Normal
2	3	5	Normal	9	E	Normal
3	3	5	Normal	13	G	Normal
4	3	5	Normal	12	E	Normal
5	5	5	Normal	11	G	Normal
6	3	5	Normal	12	G	Normal
7	5	5	Normal	12	E	Normal
8	3	5	Normal	9	E	Normal
9	4	5	Normal	9	G	Normal
10	5	5	Normal	9	G	Normal
11	6	5	Normal	8	E	Normal
12	3	5	Normal	8	G	Normal
13	5	5	Normal	8	G	Normal
14	3	5	Normal	10	G	Normal
15	4	5	Normal	11	G	Normal
16	5	5	Normal	10	G	Normal
Median	3.5	5	–	9.5		

(Fig. 1C and D). Then the ALT flap was transferred to cover the soft-tissue defects (Fig. 1E). The modified flap pedicled with an AMT perforator was used to repair the donor site (Fig. 1F). Postoperatively, no venous congestion was observed, and the 2 flaps survived uneventfully. After the 6-month follow-up, the flap maintained a good texture match and good cosmetic results, and basic function of the foot was recovered; the patient complained of no functional loss of the leg (Fig. 1G–I).

Figure 1. (A, B) A 34-year-old man experienced a vehicle accident resulting in a 12 × 8 cm soft-tissue defect. Debridement and vacuum sealing drainage (VSD) treatment were performed primarily, and his first fingertip was fixed by Kirschner wires. (C) The minimal donor site after anterolateral thigh (ALT) flap was transferred, and a advancement flap was designed. (D) The modified advancement flap was elevated. We retained a wider connection pedicle (arrow). (E) Soft-tissue defects in right dorsum of hand covered by ALT flap. (F) The donor site was repaired by the modified advancement flap pedicled with anteromedial thigh (AMT) perforator. (G–I) Six-month follow-up view. The flap healed uneventfully. Notice that thigh contour is preserved and a very good color and texture match has been achieved. ALT = anterolateral thigh, AMT = anteromedial thigh, VSD = vacuum sealing drainage.

Figure 2. (A) A 55-year-old man experienced a massive machinery injury to the left hand resulting in a 13 × 7 cm soft-tissue defect. (B) The ALT flap was designed on the homonymous thigh. (C) The minimal donor site after ALT flap was transferred. (D) Soft-tissue defects in the left hand covered by ALT flap. (E, F) The modified advancement flap was elevated. A wider connection pedicle was retained (arrow). The donor site was repaired by the modified advancement flap pedicled with AMT perforator. (G–I) The 2 flap sites healed uneventfully at 3 month follow-up. And the flap obtained a good texture match and good cosmetic results, and basic function of the thigh was recovered. ALT = anterolateral thigh, AMT = anteromedial thigh.

7.2. Case 2

A 55-year-old man experienced an injury to the left hand due to massive machinery, which resulted in a comminuted fracture of the second finger and the absence of the third to fifth fingers. There was a 13 × 7 cm soft-tissue defect after debridement and VSD treatment (Fig. 2A). Five days later, the conventional ALT flap was transferred to cover the soft-tissue defects (Fig. 2B and D). The donor site remained 10 cm long and 3 cm wide (Fig. 2C). We designed the modified advancement flap pedicled with an AMT perforator to repair the donor site (Fig. 2E and F). The 2 flaps survived, and no complications were reported at the final follow-up. The patient was satisfied with the aesthetic outcome and did not feel pain while walking postoperatively (Fig. 2G–I).

8. Discussion

The ALT perforator flap, with its long pedicle, ease of modification, and acceptable donor site morbidity, has been widely used in various reconstructions. With accurate preoperative perforator mapping by CTA, we can harvest a targeted ALT perforator flap safer and faster with less donor site morbidity. A modified operative procedure can improve the survival rate of the flap.

Microsurgery has entered a new stage of pursuing artistic and aesthetic outcomes in the 21st century. The repair of wound deficits no longer meets the needs of wound coverage and flap survival, but it aims to achieve the function and shape of donor and recipient areas with the least trauma. The ALT flap was widely used in the clinic after being first described.[1] The small-to-medium width ALT flap donor site is generally closed directly. However, when the flap is >6–7 cm wide, the suture tension increases obviously and will result in a local scar. Skin grafts were traditionally harvested to cover the defect of the donor site of the ALT flap.[5] However, skin grafting the donor site is generally associated with worse scarring, contour defect, numbness, and a higher rate of limitation in the hip and knee range of motion.[6] Although various techniques have been reported in the literature for avoiding these complications,[7–10] controversies remain. Zhao et al[11] reported that using a groin flap to improve conventional repair of the donor site achieved a satisfactory result, but it cannot repair a large donor area because of its small size. According to Wang's study, a reverse superficial epigastric artery flap for covering the donor site of the ALT decreases morbidity of the donor site. However, it is limited to repair of the distant donor site. Visconti and Salgarello[9] reported that using an ALT perforator to cover this donor site achieved good results, which was roughly in line with our study's finding. A medially based keystone advancement flap for closure of the ALT donor site can also be used to achieve primary closure in the ALT flap donor area, but is a big injury to the adjacent tissue and remain a obvious scar.[12] Deng et al[13] published a series of various

surgical techniques based on the oblique branch increased the complexity of the design and required sophisticated surgical skills. In our study, we successfully reconstructed the large soft-tissue defects in the foot or hand and achieved primary closure of the ALT donor site in a relative constant and simple manner. Additionally, the following improvements have been made: a wide skin bridge decreased the risk of malunion compared with typical V-Y flap anatomy procedure;[14] using CTA for planning we harvested an ALT perforator flap; we successfully confirmed in more cases. Sensory function recovered well in the follow-up which successfully improved sensation recovery, and returned to work after a short time (median 9.5 weeks). All patients were satisfied with the esthetic outcome and motion function.

Several indications and contraindications must be considered intraoperatively. The soft tissue must be dissected carefully to protect the perforating vessels, which are the vital factor of arterial supply and venous return. During the procedure of ALT flap harvesting, the adipose tissue in the flap margin should be made as small as possible, and left in situ to ensure the appearance of the ALT flap and to restore the thin shape of thigh after AMT flap suturing. The great saphenous vein and saphenous nerve also should be protected when dissecting the AMT flap medially to avoid numbness of the surgical area. The subcutaneous tissue of the AMT flap should be sutured with the donor site in a layer-by-layer manner to avoid the high tension that leads to flap necrosis. Lastly, systemic postoperative rehabilitation training guarantees functional recovery. In our study, all patients were treated with physical therapy at an early stage, active and passive training at 3 weeks, and self-adhesive bandage for tissue patterning at 1 month. The shape and function of the affected limb recovered well during the follow-up.

There are limitations in the present study. We advanced the flap about 3 to 4 cm without high tension, so the distance to the donor site was limited; additionally, the sample size was small. Our technique needs to be confirmed in a larger study population. Further anatomic and clinical studies are necessary to improve our findings.

9. Conclusion

Our study's findings indicated that the modified advancement flap pedicled with an AMT perforator is an ideal option for repairing the anterolateral donor site.

Author contributions

Data curation: Xiao Zhou.
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Writing – review & editing: Yongjun Rui, Mingyu Xue.

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