

The Anterolateral Thigh Perforator Flap is a Versatile Resource for Reconstructive Surgery

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Abstract

The Aim of Work: The aim of this study was to increase the efficiency of reconstruction of extensive soft-tissue defects of various localizations by differentiated use of the anterolateral thigh (ALT) perforator flap. **Methods:** We have retrospectively reviewed 39 patients, who had undergone soft-tissue reconstruction using pedicled and free transposition of ALT flaps. **Results:** In this series, all cases ended with a complete recovery of patients with adequate restoration of integumentary tissues. In the postoperative course, we encountered complications during free flap transplantation in nine cases (23%), two of which were associated with arterial insufficiency (5.1%) and seven – with venous thrombosis (17.9%). Most of these complications were not critical, and the problem was resolved by conservative treatment; in two cases, partial tissue death required a secondary suture. In three cases (7.7%), the complications were critical and led to the loss of the flap. **Conclusions:** The unprecedented versatility and the minimal trauma of the donor area make the ALT perforator flap one of the most demanded skin flaps. Despite the variable vascular anatomy, the ALT flap is the most adaptable plastic resource for extensive soft-tissue coverage of abdominal, perineal, and hip joints as a transposition flap on the vascular leg and for closing distant defects in any area of the body using it as a free microsurgical transplant. Other advantages include its variability in size and the ability to harvest multiple tissue components in different combinations depending on the desired outcome.

Keywords: Anterolateral thigh flap, flap surgery, injury, microsurgery, perforator free flaps, perforator pedicled flaps

INTRODUCTION

Treatment of patients with large and deep wound defects is currently a significant challenge from the standpoint of reconstructive plastic surgery, due to the desire to achieve better clinical results in one surgical stage and with minimal damage in the donor area.^[1-3] Thus, in cases of skin and soft-tissue defects, especially when deep anatomical structures are open in the wound, there are absolute indications for plastic vascularized flaps.^[4-6] Localization of such injuries on the lower extremities complicates the task for reconstruction – the more distal the wound is, the fewer options for plastic with local flaps there are.^[4,7] Recently, the flaps which are fed by arteries that vertically penetrate the cover tissues up to the skin – perforators – have become more and more popular.^[4,6-8] One such flap that is actively used in reconstructive surgery is the anterolateral thigh (ALT) flap.

ALT flap was first described by Song *et al.* in 1984.^[9] Later, Xu *et al.*^[10] and Koshima *et al.*^[11] described the anatomical

features of the donor area on the thigh, and developed most of the options for the use of this flap. However, at the same time, aspects of practical application both in the version of the propeller and in the version of free transfer are still discussed in the scientific literature.^[1,3,6,12]

The aim of work

The aim of this study was to increase the efficiency of reconstruction of extensive soft-tissue defects of various localizations by differentiated use of the ALT perforator flap.

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METHODS

We have retrospectively reviewed 38 patients (7 women and 31 men between the ages of 11 and 69 years) who had undergone soft-tissue reconstruction using pedicled transposition ALT and transplantation to the distant areas by microvascular anastomosed ALT flaps between March 2014 and April 2022 with the goal of identifying potential efficiency of different applications of ALT flaps. The following aspects of each case were reviewed: patient age and sex, flap destination and size, clinical follow-up, and postoperative complications.

Vascular anatomy and surgical technique, design and the technique of marking on the skin of the donor thigh area, as well as the sequential dissection of ALT flap are described in detail in the fundamental books.^[4,7] Aspects of the flap used and instrumental diagnostics to determine the features of the course of perforators in soft tissues are also described.^[4,12,13]

To mark the flap, the patient is placed in a supine position. A vertical line is made connecting the anterior superior iliac spine with the upper, lateral edge of the patella, which roughly corresponds to the septum between m. rectus femoris and m. vastus lateralis. At the midpoint of this line, a circle with a radius of 3 cm is drawn, representing an approximate area where skin perforators can be found most often [Figure 1a]. With the help of audio Doppler, a search for significant perforators is done and this point is marked too.

Carrying out computed tomography angiography provides more information about the required perforator – in particular, it indicates the course of the vessel in soft tissues, which simplifies the dissection [Figure 1b].

The ALT flap raised on the pedicle can be moved to close the wounds in the regional aspect (7 cases), or it can be completely separated and included in the bloodstream in any location far from the donor area (31 cases).

Clinical cases

Case 1

Patient K., 48 years old, a man, was hospitalized with an unhealed wound on the lateral surface of the left thigh

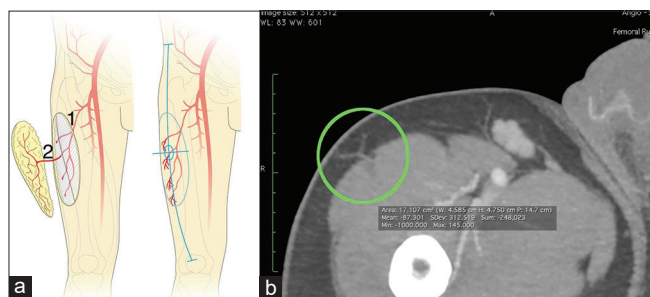


Figure 1: (a) The scheme of marking and formation of the ALT flap. Notes: 1. Descending branch of the lateral artery encircling the femur, 2. Skin perforators of the descending branch, which feed the formed ALT flap. (b) The result of computed tomography angiography shows position and vessel course in the soft tissues of skin perforator (green circle) for ALT flap formation. ALT: Anterolateral thigh

after a mine blast injury. Before admission to the clinic, the patient had undergone primary surgery for three times with mobilization of the wound edges and suturing, but the wound did not heal. At hospitalization, the size of the wound was 6.5 cm × 12.0 cm, and it had torn edges and “pockets” on periphery up to 3 cm deep; the bottom was made of uneven pathological granulations with plaque. Bacteriological examination revealed multidrug-resistant *Acinetobacter baumannii* [Figure 2]. After radical removal of pathological tissues and mechanical debridement of the cavities, the wound defect, measuring 8.5 cm × 15 cm, was prepared to be closed with the vascularized transposition flap on the leg. On the anterior surface of the thigh, we performed preoperative location of Doppler perforators and “cold” areas according to dynamic thermometry; the design of the vertically oriented ALT perforator flap was applied [Figure 3]. The ALT flap was raised and moved to the wound defect by rotation around the feeding leg [Figure 4]. The donor area was closed with linear suture. Observation after 4 weeks shows complete wound healing and satisfactory quality of restored skin and soft tissue [Figure 5]. Lower-limb function is fully restored.

Case 2

Patient B., 41 years old, a man, was hospitalized for a mine blast injury. At admission, there was a wound on the right forearm, size 26 cm × 12 cm, with the exposure of deep anatomical structures of the forearm [Figure 6], a fragmentary fracture of the forearm bones with the absence of fragments of the radial and ulnar bones [Figure 7]. The limb was fixed with Ilizarov device. After radical removal of pathological tissues and careful debridement of the contaminated wound, the defect was prepared for closure with a free transfer ALT flap. The donor wound was sutured with a straight linear suture. Postoperative course had no complications. Observation after 3 weeks shows complete wound healing and satisfactory quality of the restored cover [Figure 8]. A well-vascularized skin and soft-tissue coupling creates the preconditions for



Figure 2: Long-time unhealed wound size 6.5 cm × 12 cm of the lateral surface of the left thigh at hospitalization to the clinic



Figure 3: The wound defect on the left thigh, size 8.5 cm × 15 cm, after radical removal of pathological tissues and debridement. On the anterior surface of the thigh, preoperative marking of a vertically oriented anterolateral thigh perforator flap on the vascular leg was performed

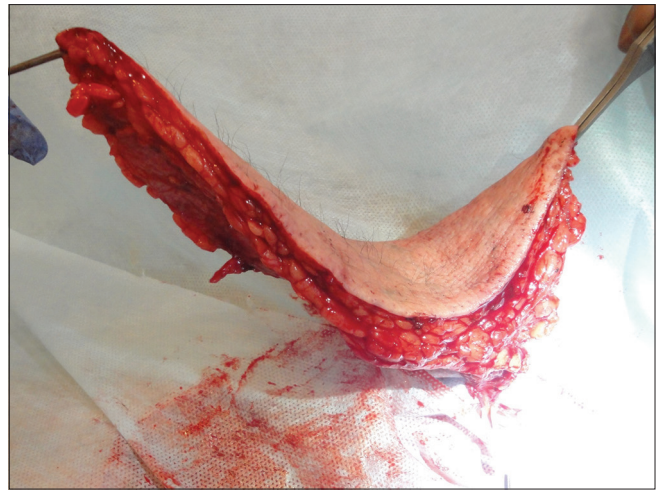


Figure 4: Anterolateral thigh perforator skin-fascial flap, size 8 cm × 17 cm with vascular feeding leg. Perforators of the descending branch of the lateral artery encircling the thigh, 2 mm in diameter, mobilized intramuscularly for 8 cm (a), the flap is raised as an islet and prepared for transposition by the type of propeller in the area of the wound defect

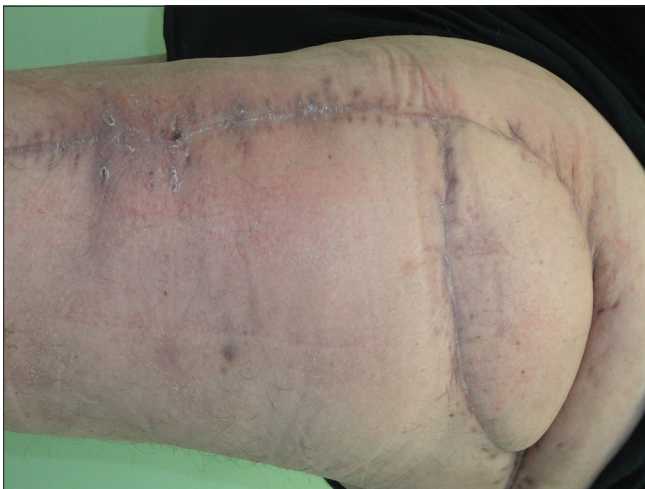


Figure 5: The wound defect completely closed with islet anterolateral thigh flap; view 4 weeks after surgery. Lower-limb function is fully restored, physical activity without restrictions



Figure 6: The view of a mine blast injury on the right forearm, size 26 cm × 12 cm, with the exposure of deep anatomical structures at hospitalization to the clinic

successful bone grafting and complete restoration of upper limb function.

Case 3

Patient J., 28 years old, a man, was hospitalized for an extensive posttraumatic wound in the lower third of the left leg with a fragmentary fracture of the bones of 3B degree (according to Gustilo and Anderson) and an open foot joint in the wound. At admission in the clinic, the extremity was fixed by the rod device [Figure 9]. Free ALT flap was moved to the wound defect, and it was included in the bloodstream by applying microanastomoses with a. tibialis posterior and ventricular vein. Granulating part of the wound of the back of the foot was closed by the split skin graft. The postoperative period was without complications, the flap took root in the recipient area where it restored the lost skin, soft-tissue volume, and

revascularization of the fracture area [Figure 10]. Under the created conditions, it became possible to restore the missing part of the tibia by distraction osteogenesis, where a bone regeneration 11 cm long was obtained, and the supporting function of the lower limb was restored. On examination after 5 years [Figures 11 and 12], it was found that the result is stable. The patient uses ordinary shoes and walks without aids.

RESULTS

Flap details show that in the presented series, the ALT flap had an average size of 17.5 cm × 9.0 cm, had an average area of 157.5 sq cm², and was used as a regional pedicle in 7 cases (18.4%) and as a free flap in 31 cases (81.6%). Of all the cases that were analyzed, in one case, we encountered the absence of skin perforators on the right thigh, although Doppler

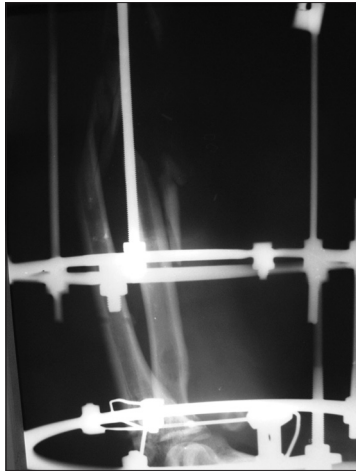


Figure 7: The result of an X-ray examination of the right forearm. A fragmentary fracture of the forearm bones with the absence of large fragments of the radial and ulnar bones was found

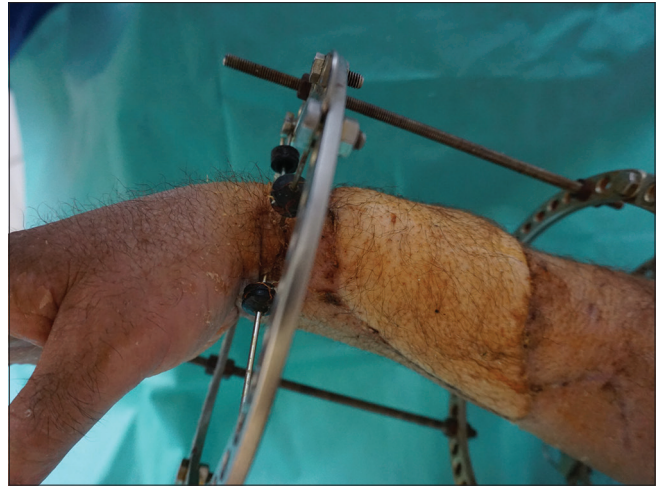


Figure 8: The forearm wound defect completely closed with islet anterolateral thigh flap; view 3 weeks after surgery. Cover tissue is fully restored, a well-vascularized skin and soft-tissue coupling creates the preconditions for successful bone grafting and complete restoration of upper limb function

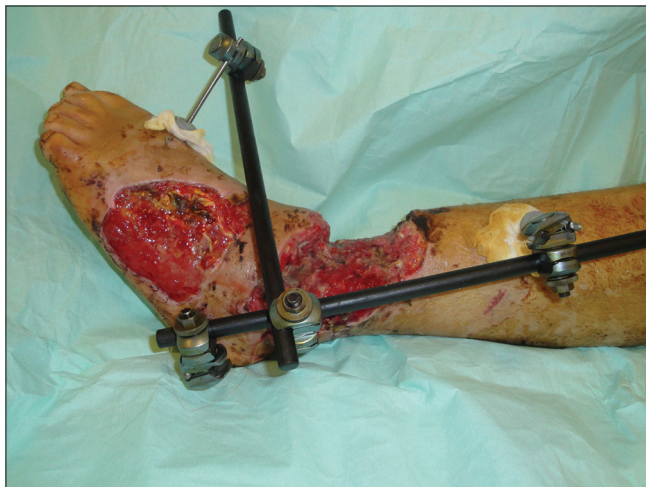


Figure 9: View of a posttraumatic extensive wound in the area of the lower third of the left leg with a fragmentary fracture of the shin bones of 3B degree (according to Gustilo and Andersen)



Figure 10: View of the left foot and lower leg 3 months after surgery. Skin grafts adequately cover the back of the foot, which is not pressure load, anterolateral thigh flap created a soft-tissue vascularized cuff under which the restoration of 11 cm of the tibia was performed by distraction osteogenesis

before surgery showed a satisfactory pulsation signal. Then, we turned to the contralateral limb and there successfully raised the ALT flap. In another case, we encountered an abnormal perforation loop extending almost to the pupal ligament, where it anastomosed with numerous other vessels. The latter were ligated with clips and the flap received a rather long vascular pedicle, more than 17 cm. In the postoperative course, we encountered complications during free flap transplantation in eight cases (21%), two of which were associated with arterial insufficiency (5.2%) and six – with venous thrombosis (15.8%). Most of these complications were not critical, and the problem was resolved by conservative treatment; in two cases, partial tissue death required a secondary suture. In two cases (5.3%), the complications were critical and led to the loss of the flap, which required resurgery with a free ALT flap from the contralateral limb and in one case – using an alternative technique. Thus, the above series of cases ended with a

complete recovery of patients with adequate restoration of integumentary tissues in their properties as close as possible to the lost ones. Despite the inherent rate of complications, our analysis demonstrated the versatility of pedicled and free ALT flaps in a variety of indications.

DISCUSSION

In cases of deficiency of integumentary and soft tissues at the local level, or when these tissues have significant pathological changes and cannot be used as a donor resource for flap formation, the surgeon proceeds to select a donor site in other distant sites.



Figure 11: View of the lateral side of the left foot and lower leg 4 years after surgery. Implanted the anterolateral thigh flap covers the area of the tibia and the distal part of the leg without violating the contours of the limb

After the ALT flap reported by Song *et al.* 1984,^[9] clinical application immediately began in Japan. In 1985, the Japanese Society of Plastic Surgery, Koshima *et al.*^[11,14] reported its usefulness. Over the past 20 years, our colleagues^[8,15-17] have intensively studied this flap and used it for various purposes, which allowed us to better understand its anatomy. During this time, they gained experience while working with more than 2000 perforator flaps of this type and recognized the anterolateral flap of the thigh as a universal donor resource. The ALT flap was first introduced as a free flap and since that time has gained popularity as a pedicled flap. Pedicled perforator ALT flaps have become a contemporary alternative to muscle flaps for soft-tissue reconstruction as they reduce donor site morbidity, allow to avoid the need for microsurgical transfer, and proved to be versatile and reliable.^[6,15,16] Our experience allows us to confirm this thesis.^[2,3,7]

Based on this analysis, the pedicled ALT flap provided adequate coverage of voluminous defects in groin, trunk, perineal, and thigh regions and achieved the ultimate aim of restoring shape and function for desired outcome. At the same time, the popularity and stability of the flap perforator as a free variant remains quite high. The discussion in the literature is aimed at optimizing the harvest of the flap by creating a better preoperative image of the perforator course in the soft tissues.^[3,7,13,18] This is an actual problem, since even in a relatively small series of cases, we met with one case of abnormal anatomy of vessel course in soft tissue and one case of false-positive Doppler signal when searching for perforator for anterolateral flap formation.

CONCLUSIONS

The unprecedented versatility of the described reconstructive method and the minimal trauma of the donor area make the ALT perforator flap one of the most demanded skin flaps.



Figure 12: View of the medial side of the left foot. The patient uses ordinary shoes and walks without aids

Despite the variable vascular anatomy, the ALT flap is the most adaptable plastic resource for extensive soft-tissue coverage of abdominal, perineal, and hip joints as a transposition flap on the vascular leg and for closing distant defects in any area of the body using it as a free microsurgical transplant.

Other advantages include its variability in size and the ability to harvest multiple tissue components in different combinations depending on the desired outcome.

Consent

Informed consent was obtained from all individual participants included in the study.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patients have given their consent for their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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