


Clinical application of free inguinal flaps with retrograde blood supply anastomotic to repair soft tissue defects of extremities

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Abstract

To observe the clinical efficacy of free inguinal flaps with retrograde blood supply anastomosis to repair skin and soft tissue defects in the limbs. A total of 25 patients with soft tissue defects of the limbs treated from January 2019 to December 2021 were selected and repaired with free inguinal flaps anastomotic with retrograde blood supply. All 25 skin flaps survived; 1 patient had skin flap infection and the wound healed gradually after symptomatic treatment, and 1 patient had venous embolism and the skin flap survived after re-anastomosis. The patients were followed up for 6 to 18 months after the operation. After healing, the patient recovered satisfactorily, and the flap had a good appearance, texture, and flexibility; a reoperation was not required. The patient was satisfied with the effect of the treatment. Retrograde vascular anastomosis with the anterolateral femoral perforator flap is safe and reliable for repairing the soft tissue defects of the limbs. It is convenient for micromanipulation and can achieve satisfactory clinical results, and thus is an ideal repair method.

Keywords: clinical effect, free inguinal flap, repair, soft tissue defect

1. Introduction

In daily life, extremity skin and soft tissue defects caused by various reasons are very common, with an extremely high incidence of surgical disease. Among the several clinical treatment and repair methods for limb trauma with different degrees of injury, flap repair is 1 of the most important approaches.^[1,2]

With the rapid development of microsurgery technology, the concealment and aesthetics of the donor site should be under intensive focus to minimize the impact of iatrogenic scars on the appearance of the flap donor site while repairing the wound.^[3] For example, arbitrary local skin flaps have defects, such as poor postoperative function, appearance recovery, and insufficient coverage of larger wounds with respect to wound repair, due to the limitation of the length-to-width ratio; therefore, it is not the best treatment option.^[3,4] The donor site of the superficial circumflex iliac artery perforator flap is located in the groin, 1 of the hidden parts of the human body. Typically, the donor site can be closed and sutured without the need for secondary operations, such as skin grafting. Short skirts or shorts can be worn for iatrogenic scars. This advantage makes the superficial circumflex iliac artery perforator flap 1 of the best choices for wound repair.^[4,5]

Since Daniel et al employed microsurgical techniques in 1973 and successfully repaired the ankle wound with the first free inguinal flap anastomosis with blood vessels, a large

number of flaps anastomotic with blood vessels have been used in clinical practice. Retrograde flaps anastomosed with distal vessels and venous reflux have also been reported successively,^[6,7] and most of these flaps were anastomosed to 2 accompanying veins, while Kou et al^[8] showed free flaps anastomosed to a single vein. In clinical practice, we observed that the incidence of nosocomial incision infection after skin flap repair of the limb wound was high, which could have an adverse impact on the prognosis of patients. Also, valve blood supply is closely related.^[9] The advantage of using the retrograde blood supply perforator flap compared with traditional repair methods is that the blood vessels are thin at the distal end, which can resolve the issue of incompatibility of the caliber of the skin flaps. Consequently, the flap repair has a high success rate, which can shorten the operating time by about 1 to 1.5 hours and save the physical strength of the operator and the operation cost to the patient.^[10]

2. Materials and methods

A total of 25 patients with soft tissue defects of the limbs treated from January 2019 to December 2021 were selected and repaired with free inguinal flaps anastomotic with retrograde blood supply. This study was approved by the institutional ethical review board of First Affiliated Hospital of Bengbu Medical

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All data generated or analyzed during this study are included in this published article [and its supplementary information files].

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College. The present cohort comprised 25 patients, including 19 men and 6 women, aged 22 to 58 (median, 34) years. Among them, 14 patients had open limb injuries due to traffic accidents, 2 with heavy objects, and 9 patients had machine-caused injuries. Moreover, 7 cases had hand injuries, 6 cases were in the calf, 4 in the foot, and 8 in the forearm. The cut area of the flap was 7.0 cm × 3.5 cm to 27.5 cm × 8.5 cm. The data are summarized in Tables 1 and 2.

2.1. Surgical technique

2.1.1. Flap design and incision. The flap is designed along the line that connects the pulse of the femoral artery and the anterior superior iliac spine about 2.0 cm below the inguinal ligament. For the outside design, the backside should not exceed the posterior axillary line. The incision is made in the groin area, the superficial circumflex iliac vein is dissected in the superficial layer of the superficial fascia and proximally, and then the superficial branch of the superficial circumflex iliac artery in the deep layer near the vein is searched according to the preoperative Doppler position. The inguinal lymph node is always located in the superficial layer of the superficial circumflex iliac artery, which can be used as an anatomical landmark. The deep branch of the superficial circumflex iliac artery is found while dissecting the superficial branch of the superficial circumflex iliac artery from the deep fascia to the proximal end. At this time, the free deep branch can be dissected proximally and distally. If no deep branch is found, the distal end of the anterior superior iliac spine is incised to find the perforator of the deep branch of the deep circumflex iliac artery under the deep fascia, and the deep branch is dissected retrogradely along the perforator. The lateral femoral cutaneous nerve and the deep branch of the superficial circumflex iliac artery run in a vertical direction in the deep layer of the deep fascia, which can be used as an anatomical landmark to locate the deep branch. After dissecting the deep and superficial branches of the superficial circumflex iliac artery to the source artery, whether the origin of the superficial iliac arteries is co-trunked and the correlation between the deep branch and the lateral femoral cutaneous nerve, was recorded. Then, the periphery was incised, and the skin flap was freed at the superficial layer of the deep fascia, following which only the

vascular pedicle was connected to the body. After confirming an adequate good blood supply to the skin flap, the skin was cut and ligated at the beginning of the superficial circumflex iliac vessel.

2.1.2. Flap anastomosis. The flap was fixed in the recipient area by suture, and the anastomosis point was determined according to the length of the pedicle. The flap was relaxed to a certain extent, the vascular pedicle cut off in the recipient area, and the cut end should be trimmed appropriately, followed by anastomosis of the accompanying vein. Subsequently, the arteries were operated under a microscope, and the anastomosis was kept unobstructed without blood leakage. After the blood supply was restored, 4 to 6 stitches were sutured to anastomose the epineurium. A drainage tube was prepared, and the wound was immobilized with a plaster cast after the wound was sutured. The donor site was sutured directly intradermally (Figs. 1 and 2).

3. Results

In this group of 25 patients, all flap repairs survived. One case had a skin flap infection, but all wounds healed after symptomatic treatment. One case had a venous embolism, but the flap survived after reanastomosis. The patients were followed up for 6 to 18 months after the operation. At the last follow-up, the 2-points discrimination of the flap was 8 to 10 mm, the shallow pain sensation and touch recovered adequately, the appearance, texture, and softness of the flap were satisfactory. The operation was repeated, the function of the donor area was unobstructed, and the patient was satisfied with the treatment outcomes.

4. Discussion

The free inguinal flap predicated on the superficial circumflex iliac artery was successfully applied for the first time in 1972 by McGregor and Jackson.^[11] However, due to the technical difficulties of the free flap transplantation, a new flap donor site was required. Currently, this flap is rarely used clinically as a free graft. In recent years, due to the concept of “super microscopy,” the flap has the advantages of less damage to the donor site and convenient incision and has been widely used in clinical practice. The superficial circumflex iliac artery perforator flap can be used to repair limbs, head, neck, other wounds, and sarcoma in the other parts of the trunk after surgery and also to reconstruct the tongue, breast, penis, and other organs.^[12–15] The superficial external oblique aponeurotic branch, the lymph node branch, the deep branch of the sartorius muscle branch, and the iliac branch can be used to cut multi-tissue chimeric skin flaps, segmented skin flaps, and lymphatic skin flaps.^[14] Based on the advantages of multifunction, multipurpose, and hidden supply and demand, this flap is superior to the anterolateral thigh flap commonly used in clinical practice.

Several studies have focused on the venous return mechanism of retrograde blood supply flaps; however, the exact reverse flow mechanism has not been confirmed. The role of the superficial venous trunk on the retrograde flap is also debated clinically.^[16,17] Nonetheless, 2 theories have been proposed for the venous return of retrograde blood supply flaps: the labyrinth return and the valve failure return. Most domestic scholars believe that the “maze” return is the main way of the venous return of the retrograde blood supply flaps. When the flap arterial bleeds, the venous return increases, the veins expand and even become distended, the venous valve is insufficient, the pressure at the proximal end of the vein is > the distal end, and venous blood reflux occurs (there are fewer venous valves in the wrist and ankle, and the blood is more likely to reflux). The flow of venous blood completes the anterograde return through the fixed and

Table 1

Summarized data.

Number of patients	Male 19	Female 6
Median age (y)	34 (22–58)	
Etiology	Traffic accident	Heavy rolling Machine damage
	14	2 9
Flap dimension (cm)	7.0 × 3.5–27.5 × 8.5	
Two point discrimination (mm)	8–10	
Mean flap thickness (mm)	11 ± 3 (8–15)	
BMI	24.7 ± 4.3 (18–31)	
Follow up (month)	12 ± 5 (6–18)	

Table 2

Etiology and locations of defects.

Location of defects	Traffic accident	Heavy rolling	Machine damage	Total
Forearm	5	1	2	8
Hand	3		4	7
Foot	1	1	2	4
Shank	5		1	6
Total	14	2	9	25

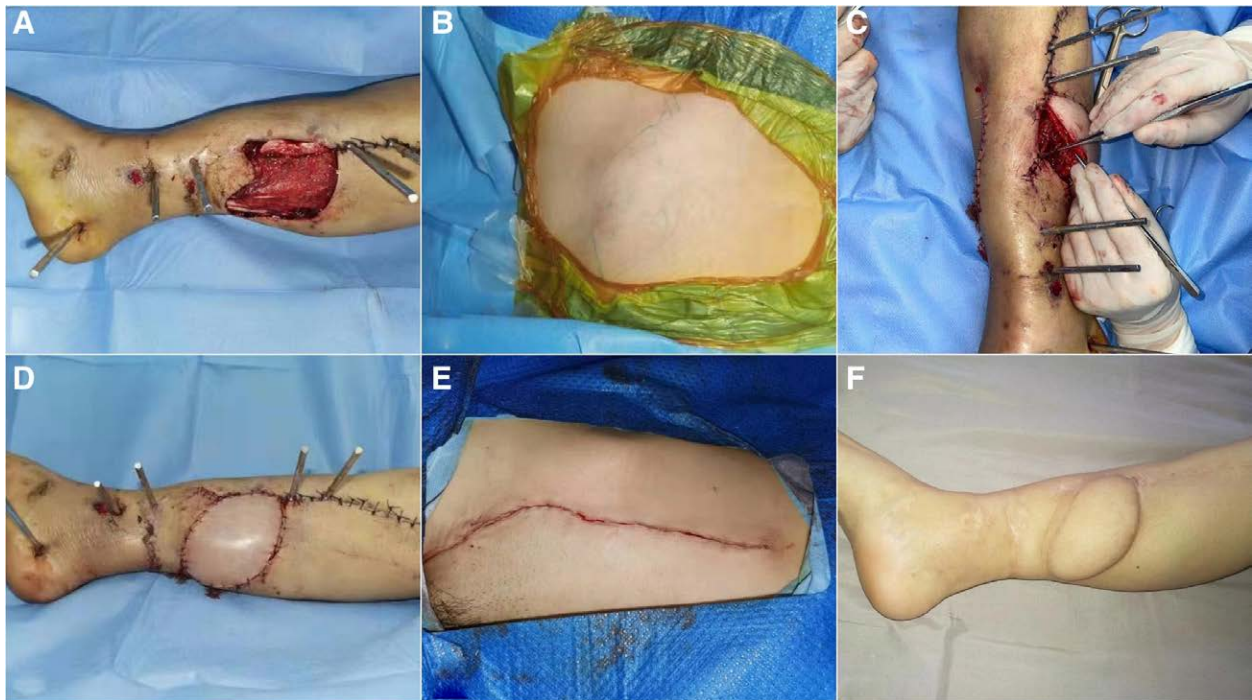


Figure 1. A patient with lower leg trauma. (A) Preoperative condition. (B) Flap design. (C) The artery and accompanying vein were anastomosed with the affected part during operation. (D) Postoperative condition. (E) Postoperative supply area. (F) Six months after surgery.

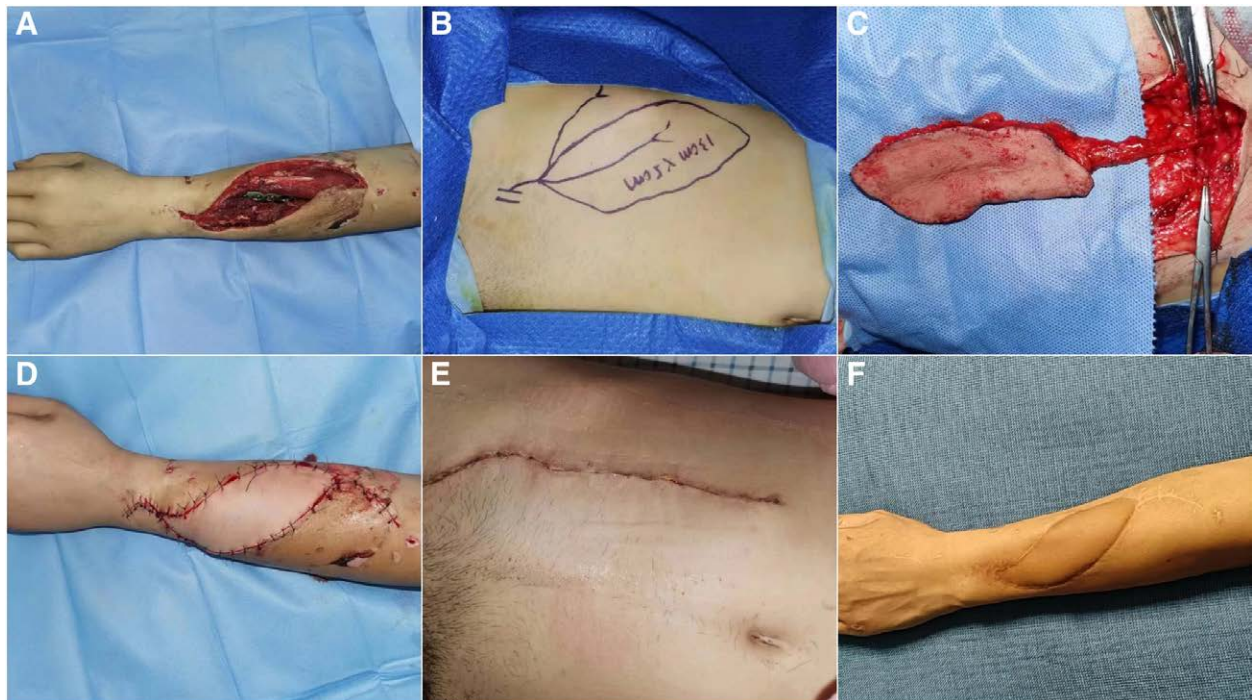


Figure 2. A patient with forearm trauma. (A) Preoperative condition. (B) Flap design. (C) The artery and accompanying vein were anastomosed with the affected part during operation. (D) Postoperative condition. (E) Postoperative supply area. (F) Six months after surgery.

abundant communicating branches between deep-deep veins and deep-superficial veins in the distal pedicle. The retrograde blood supply from anastomotic vessels is used in the free perforator flap to repair the wound. Also, direct communication anastomotic branches between deep-deep veins and deep-superficial veins at the distal end of the venous anastomosis simulate the pattern of blood circulation of the retrograde island flap. Furthermore, the vascular pedicle is straight, not twisted, and

blood flow is smooth, which is safe and reliable.^[18-20] Therefore, retrograde blood supply to anastomotic arteriovenous vessels is feasible.

The primary advantages of the free inguinal flap with retrograde arteriovenous anastomosis are as follows: the donor site is concealed and can be sutured directly. Reportedly, the width of the donor site can be directly sutured within 10cm. The wounds with a width < 10cm were directly sutured at 1

stage; the incision was convenient and the skin was soft; the perforators were constant and the damage to the patient was small; the operation time was short and the cost was reduced; the maximum area of the middle flap was 27.5 cm × 8.5 cm. The disadvantages of this flap were that it had no nerve for coaptation, the vascular diameter was small and the vascular pedicle was short. When only 1 superficial circumflex iliac artery is anastomosed, an anastomotic thrombus can be performed easily when the accompanying vein of the branch is small.

The main points of prevention and treatment of complications are as follows: Dehiscence of the donor site wound is a common postoperative complication, mainly due to excessive wound suture tension, accumulation of blood in the wound, and infection. Some studies proposed that the application of negative pressure technology can prevent postoperative wound rupture and promote healing.^[21,22] Nonetheless, our experience is as follows: Complete hemostasis is required during the operation; If the tension of the wound suture is large, the hip and knee should be flexed after the operation and gradually straightened after 1 week, while large movements should be avoided for 2 weeks; If the wound cannot be sutured directly, absorbable sutures are not recommended.

In summary, the application of retrograde arteriovenous anastomosis with free inguinal flaps to repair complex soft tissue defects in limbs can reduce trauma, avoid complications such as bridge flaps, simplify the surgical procedures, and improve the quality of vascular anastomosis. However, the mechanism of the retrograde blood supply of anastomotic vessels in the free perforator flap is not yet clarified and needs further investigation.

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