

Using the Saphenous Artery and Great Saphenous Vein Combined with Anterolateral Thigh Flap to Treat Skin Defects after Amputation

Ling Dong Kong, MD^{1,*} Han Xiong Cheng, MD^{1,*} Tao Nie, MD¹ Min Dai, MD¹

¹Department of Orthopedics, The First Affiliated Hospital of Nanchang University, Nanchang, Jiangxi, People's Republic of China

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Address for correspondence Tao Nie, MD, Department of Orthopedics, The First Affiliated Hospital of Nanchang University, Nanchang, Jiangxi 330000, People's Republic of China (e-mail: ncnietao@163.com).

Abstract

Background Aim of this study was to determine the feasibility of using the saphenous artery (SA) and great saphenous vein (GSV) as recipient vessels, combined with anterolateral thigh (ALT) flap, in the treatment of skin defects after lower limb amputation.

Methods From June 2015 to June 2017, 12 patients (average age, 33.5 years; range, 14–56 years; males, 9; female, 3) with large skin defects and symptoms of bone exposure in the proximal lower extremity were included in our study. The patients underwent emergency treatment and multiple debridement combined with vacuum sealing drainage therapy, followed by free flap surgery using the SA and GSV as recipient vessels, and ALT to cover the wound.

Results All 12 patients who underwent free flap surgery survived, but two patients had distal flap necrosis, which, however, was salvaged with conservative measures. All patients were satisfied with the postoperative outcome at the 3 and 6-month follow-up.

Conclusion The SA and GSV can be used as recipient vessels, combined with ALT, to treat skin defects after lower limb amputation.

Keywords

- ▶ saphenous artery
- ▶ great saphenous vein
- ▶ anterolateral thigh flap
- ▶ amputation

With the development in modern and transportation industries, severe lower limb injuries caused by high-energy accidents are becoming more common in clinical practice. Patients who experience such accidents often have severe nerve and blood vessel damage^{1,2} with some necessitating amputation. To preserve the knee joint, many doctors often perform proximal lower limb amputation³ leaving behind a large area of soft tissue defects as well as bone exposure in the lower limb. To cover the remaining wounds, free flap graft is often necessary.^{4–7} However, fewer blood vessels that can be used for anastomosis are left, and inflammatory reaction after trauma can occur. Thus, choosing suitable blood vessels to anastomose with the descending branch of the contralateral circumflex femoral artery is critical to the success of the treatment. The objective of this study was to

determine the feasibility of using the saphenous artery (SA) and great saphenous vein (GSV) as recipient vessels combined with anterolateral thigh (ALT) flap in the treatment to skin defects after lower limb amputation.

Methods

Patient Information

This study included 12 patients (male, 9; female, 3; average age, 33.5 years; range, 14–56 years) who underwent treatment (left leg, 9 cases; right leg, 3 cases) at our institution due to traffic accident injuries from June 2015 to June 2017. Based on the Gustilo's classification, there were 8 Gustilo's IIIB and 4 Gustilo's IIIC type cases, all accompanied by comminuted fracture of the tibia and fibula. All 12 patients underwent emergency debridement, vascular anastomosis, external stenting, and vacuum sealing drainage (VSD) treatment. During the operation of one

* Ling Dong Kong and Han Xiong Cheng are co-first authors.

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patient, we found sever vascular injury accompanied by a long defect; hence, we performed emergency amputation and VSD treatment. Another patient had high fever and vascular crisis on the second day after operation. Emergency surgery was performed, and we noted infection and thus performed amputation. To prevent postoperative infection, all patients underwent free flap graft after multiple debridement and VSD. Free flaps were used to repair wounds 16 to 36 days after injury (►Fig. 1).

Surgical Method

The patients underwent multiple debridement and systemic supportive treatment before surgery to correct anemia, improve hypoalbuminemia, correct electrolyte disturbances, and improve general condition (►Fig. 1A). When the granulation tissue of the wound became red, indicative of controlled infection, and there was no obvious symptom of infection, the wound was repaired with ALT with the patient placed in supine position; continuous epidural or hard-waist combined block anesthesia is used in such cases and the position need not be changed during surgery. First, the size of the soft tissue defect in the lower limb was assessed using the template, and the flap of the same size was determined in the lateral femoral area to ensure that the soft tissue of the defect could be fully covered (►Fig. 1B). Second, knee medial incision was made, entering from the gap between the sartorius and gracilis muscles, pulling the sartorius muscle outward which revealed the SA, saphenous nerve, and GSV. Then the SA, along with the GSV was used as recipient vessel and anastomosed to the descending branch of the circumflex femoral artery and vein, respectively (►Fig. 1C). The lateral femoral cutaneous nerve was anastomosed to the saphenous nerve (►Fig. 1D).

Postoperative treatment

A drainage tube was placed under the flap after operation, and it was removed 2 to 3 days later. Continuous irradiation of the lamp, conventional application of anti-infective, anticoagulant, and antivasospasm drug treatment, and close observation of the flap's temperature, color, and capillary filling reaction was performed (Fig. 1 E, F).

Results

All patients were admitted to the hospital because of trauma. The lower limbs were severely damaged and they had to be amputated. Patients' data are presented in ►Table 1. However, all of the 12 free flaps survived; 10 of them had primary healing, but distal flap necrosis appeared in 2 cases. Fortunately, it was salvaged with conservative measures. After 3 to 6-month follow-up in all cases, the flap was free from bloated appearance and had fine texture. The soft tissue defect was repaired satisfactorily and all skin grafts survived in receiving area. Based on follow-up observations, we found that the patients were satisfied with the treatment. After the prosthesis was installed, the ability to walk was restored and many patients returned to work and activities of daily living.

Discussion

All 12 patients in this study required lower limb amputations due to serious traffic accidents. Considering that the patients are young and have higher functionality and aesthetic requirements, we had to operate relatively far away from the knee to preserve the function of the knee joint as much as



Fig. 1 A 42-year-old man was referred for treatment of a mutilating crush injury on the right lower limb, after three sessions of vacuum-assisted suctioning and debridement, the patient received a $16 \times 30 \text{ cm}^2$ free flap with no complications and recovered in 3 months. (A) After three times of vacuum-assisted suctioning and debridement. (B) Design of the free flap. (C) Reveal the contralateral descending branch of the circumflex femoral artery and flap preparation before transplantation. (D) Reveal the saphenous artery, great saphenous vein, and saphenous nerve. (E) Postoperative appearance. (F) At 3 months after surgery, the flap intact without complications.

Table 1 Patients' information

Case	Sex	Age (y)	Side	Gustilo	Flap size (cm ²)	Complication	Outcome
1	M	42	R	IIIC	30 × 16	N/A	Survival
2	F	27	L	IIIB	32 × 18	Distal necrosis	Survival
3	M	35	L	IIIB	34 × 15	N/A	Survival
4	M	49	R	IIIC	28 × 17	N/A	Survival
5	M	56	L	IIIB	29 × 18	N/A	Survival
6	F	14	L	IIIC	26 × 14	Distal necrosis	Survival
7	M	24	L	IIIB	28 × 17	N/A	Survival
8	M	37	L	IIIB	27 × 16	N/A	Survival
9	M	32	L	IIIB	33 × 15	N/A	Survival
10	F	31	L	IIIC	38 × 19	N/A	Survival
11	M	27	R	IIIB	34 × 14	N/A	Survival
12	M	28	L	IIIB	27 × 18	N/A	Survival

Abbreviations: F, female; L, left; M, Male; N/A, not applicable; R, right.

possible; in other words, the flexion and extension of the knee joint had to be maintained after installing an artificial limb in the future. However, there are contradictions. If we lowered the area of amputation, the risk of infection increases. Moreover, the bone was largely exposed which made it difficult to close the soft tissue wound. This was one of the key aspects to be considered.

The knee has very delicate structure and complex function^{8,9} and the appearance requirements are also high. If we proceeded with the adjacent flap transplantation, the coverage area would not have been enough due to the limited area of the flap and the short pedicle and the contraction of the scar would likely affect the function of the knee joint.^{10,11} Cross-leg flap transplantation has also been reported^{12,13} but this method requires the patient to have a high degree of compliance; the patient must maintain the same posture for a long time and the patients often cannot tolerate this, so we choose free flap for transplantation. In 12 patients in the present study, the SA and GSV were used as the recipient blood vessels, combined with the ALT to repair the skin and soft tissue defects under the knee joint after amputation. This surgical method is particularly suitable in the following situations: (1) anterior tibial artery or posterior tibial artery is injured; (2) long-term pathological changes in the anterior tibial artery or posterior tibial artery have occurred; (3) presence of inflammation scars or ulcers in the anterior tibial artery or the posterior tibial artery; (4) the anterior tibial artery or the posterior tibial artery is not suitable for exploration and anastomosis.^{14,15} In addition, it is not wise to perform anastomosis to the descending branch of the circumflex femoral artery using major blood vessels as the recipient vessels because distal limb blood flow is very poor after trauma. If this is done, it will increase the possibility of distal ischemic necrosis.

The position of the SA is relatively stable with occasional variations.¹⁶ We can easily find it; moreover, we identified and located the artery by preoperative Doppler's imaging.¹⁷ Through clinical observation, we found that the caliber of

the SA and the descending branch of circumflex femoral artery were equivalent, making it easier to anastomose; moreover, the blood flow is relatively stable and can provide sufficient flow for the flap. The return flow of the GSV is also sufficient and the survival rate of the flap is greatly improved.¹⁸ The anastomosis of the saphenous nerve and the ALT nerve can keep the sense of the knee. Another advantage is that the size and thickness of the ALT can meet the soft tissue requirements around the knee joint.

For patients who need surgery, the wound must be aseptic¹⁹; hence, we ensure that the patient has no fever, the C-reactive protein level and erythrocyte sedimentation rate are normal and bacterial culture results are negative. We use Doppler to identify that there is no embolization of the GSV and no venous damage before operation.²⁰ Postoperative anticoagulation therapy and antivasculospasm treatment are conventionally used; furthermore, continuous irradiation of light is also necessary to increase the blood flow of blood vessels. All patients were evaluated preoperatively for physical condition²¹ and surgery was performed by an experienced physician.

However, this surgical method also has limitations. When the skin defect around the knee is large, the skin defect at the donor site may not be able to be sutured. Generally, we perform skin transplantation to cover the wound. However, Tong et al suggested that transplantation with free groin flaps is better.²² Another concern of this design is the prolonged operative time because microsurgery procedures are intensive and require longer operation time. However, if two surgical teams are available, it can shorten the operation time.

Conclusion

The surgical approach of using the SA and GSV as recipient blood vessels combined with contralateral ALT flap to repair large areas of the skin and soft tissue defects in the proximal leg is simple and safe, has a high survival rate, and can meet knee wound coverage requirements.^{19,23} The biggest advantage of

this surgery is the retention of function of the knee. Hence, we highly recommend its clinical application.

Conflict of Interest

None.

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