

RESEARCH ARTICLE

Clinical analysis of ultrathin anterolateral thigh flap and superficial iliac circumflex artery perforator flap in repairing tissue defects of extremities

Sen Li, Xiuping Xu*

Gansu Provincial Hospital of Traditional Chinese Medicine, Lanzhou, Gansu, China.

Received: March 19, 2024; accepted: May 16, 2024.

Flap repair technology is an advanced means of repairing tissue defects in the extremities, and the flap is transplanted to the injury site through minimally invasive surgery to meet the needs of repairing different injuries. This study retrospectively analyzed the clinical effects of ultrathin anterolateral thigh flap (ALTF) and superficial iliac circumflex artery perforator flap (SCIP) in repairing tissue defects of the extremities and studied the status and limitations of their clinical applications to provide a scientific basis for clinical decision-making and patient treatment. Thirty-four patients who were hospitalized in Gansu Provincial Hospital of Traditional Chinese Medicine and underwent either ALTF or SCIP for repairing soft tissue defects of the skin of the extremities from January 2021 to June 2023 were retrospectively analyzed. The patients were divided into two groups according to the surgical methods with 25 cases in ALTF group and 9 cases in SCIP group. Intraoperative bleeding, complication rate of donor-recipient area at 6 months post operation, blood supply of the flap, and pain were investigated in both groups. The results showed that the average bleeding volume was 166.40 mL and 265.56 mL in ALTF and SCIP groups, respectively. There was a significant difference in intraoperative bleeding volume between the two groups ($P < 0.05$). The 6 months follow-up found that the complication rates of donor and recipient areas were 13.6% and 8.7% in ALTF group and 12.5% and 28.6% in SCIP group. The overall flap blood supply rates were 92% in ALTF group and 88.89% in SCIP group. The pain-free rates were the same in both groups as 86.7%. There were no significant differences of complication incidences in the donor and recipient areas, flap blood supply, and pain between two groups ($P > 0.05$). This study confirmed that flap transplantation has opened new ways and methods for the treatment of patients with complex trauma combined with skin and soft tissue defects, and the flap repair technique is able to preserve the patient's limbs, reduce the disability rate of the patient, and allow the patient to return to the society in a faster and better way. Both ALTF and SCIP demonstrated good repair effects on limb tissue defects, and ALTF transplantation showed less intraoperative bleeding due to more mature technology.

Keywords: anterolateral thigh flap; superficial iliac circumflex artery perforator flap; limb tissue defect; curative effect.

*Corresponding author: Xiuping Xu, Gansu Provincial Hospital of Traditional Chinese Medicine, Lanzhou 730000, Gansu, China. Email: woshixiuping1989@163.com.

Introduction

Limb injury is a common trauma, usually caused by accidents, sports injuries, or other external forces [1]. Limb injury may involve the damage of skin, muscle, bone, blood vessels, and other

tissues, which has a serious impact on the life and work of patients [2], so it is of great significance for the repair and reconstruction of limb injury. Skin flap transplantation is a common surgical repair technique, which is particularly important for patients with limb defects. However, when

selecting a suitable flap, doctors are often faced with many considerations such as postoperative function, cosmetic effect, and functional preservation of living donor flap [3].

Ultrathin anterolateral thigh flap (ALTF) is an advanced technique currently used for the repair of tissue defects in the extremities. This technique maximally preserves the function of the donor area based on traditional flap transplantation, and the ultrathin flap is transplanted to the defective area for repair through minimally invasive surgery, which can meet the needs of injury repair in different limb locations [4]. Traditionally, the anterolateral femoral flap is mainly used for the repair of the face, neck, hands, feet, or organ reconstruction. However, the hands and feet are exposed organs, and their physiological structure is characterized by thin skin and little subcutaneous tissue, especially the dorsum of the hand, which is often less satisfactory to patients with the traditional flap transplantation. To solve this problem, ALTF technique was developed with no need for the second surgical revision and better postoperative hand and foot flatness due to the ultra-thinness and softness of the flap. However, there are many variants of the anterolateral femoral arterial vascular system and the flap's feeder branches, and the dissection of the intramuscular feeder branches is difficult [5, 6]. The superficial iliac circumflex artery perforator flap (SCIP) is a better transplantable flap, but, because of its axial cardiovascular anatomical alignment variations and small caliber, anastomosis difficulty, *etc.*, the clinical application of SCIP was once limited. In recent years, with the continuous improvement of microsurgical technology, inguinal flap has been widely used in limbs and other large range of soft tissue repair because of the advantage of the hidden area on donor's site, which can make the large cutting area [7].

As a clinical application for repairing limb injuries, skin flap transplantation has been widely used in actual surgery. At present, flap transplantation has become increasingly mature, the survival rate of the flap is no longer the main content of

the clinician's pursuit. Instead, based on flap survival and wound healing, how to improve the appearance and function of the recipient area and the appearance of the donor area and minimize the functional damage have become a hot spot and a difficult point [8]. There are advantages and disadvantages of both techniques, which should be recognized accurately, and the correct choice of each technique for trauma repair should be made in clinical work to ensure the maximization of surgical results. Therefore, it is necessary to conduct an in-depth comparative study of their applications to determine the best choice in limb repair. In this study, statistical methods were used to comparatively analyze the intraoperative bleeding, the complication rate of the donor-recipient area, the blood supply of the flap, and the pain in patients with soft-tissue defects of the extremities repaired with ALTF or SCIP grafts.

Materials and methods

Patient information

A retrospective analysis of patients who were hospitalized in Gansu Provincial Hospital of Traditional Chinese Medicine (Lanzhou, Gansu, China) from January 2021 to June 2023 and underwent either ALTF or SCIP for repair of skin soft tissue defects of the extremities was performed. The research procedures were approved by the Ethics Committee of Gansu Provincial Hospital of Traditional Chinese Medicine (Lanzhou, Gansu, China). The patient's inclusion criteria were (1) the patient had a clear history of trauma, the skin and soft tissue defects of the extremities could not be sutured directly, and the important tissue structure was exposed; (2) the patient received skin flap transplantation for repair; (3) there was no injury in the groin and thigh donor area. The exclusion criteria included (1) patients with major chronic diseases or mental illness; (2) patients with clear surgical taboos; (3) patients with incomplete or missing postoperative data. A total of 34 patients who met the criteria were included in this study including 10 cases of car accident injuries, 6 cases

Table 1. Basic information of patients in two groups.

Group	Number	Male/Female	Hand	Forearm	Foot	Shank	Age (years old)
ALTF	25	23/4	8	2	12	3	37.23 ± 12.73
SCIP	9	7/2	2	2	4	1	42.46 ± 14.23

of heavy object injuries, 11 cases of machine strangulation injuries, 3 cases of sharp cuts, 2 cases of thermal compression injuries, and 2 cases of explosion injuries. The patients were divided into the ALTF group and the SCIP group according to the flap grafting method they received with 25 cases in ALTF group and 9 cases in SCIP group. The basic information of the patients was listed in Table 1.

Treatment methods

At the time of the patient's admission, a comprehensive evaluation of the patient was performed including medical history collection, physical examination, laboratory examination, and imaging examination. The routine trauma treatment was performed including using saline for irrigation, infection prevention, and control of the wound. Before performing surgery, patients were thoroughly debrided, local necrotic tissues were clipped, and fracture patients were fixed with fracture reduction brackets. The shape and size of the flap were precisely measured and designed according to the patient's specific situation to ensure that the flap could cover the damaged area and ensure adequate blood supply. In addition, the flap design should also consider the requirements of aesthetics and functional recovery to minimize postoperative deformity and dysfunction. During flap dissection, the doctor delineated the blood vessels, nerves, and tissue structure of the flap accurately and separated the tissues to ensure smooth blood flow and structural integrity of the flap carefully. The wound treatment and suture of the flap also ensured the smoothness and cleanness of the wound surface for the survival and functional reconstruction of the flap. Intraoperative blood flow in the recipient area was closely monitored, and adjustments and treatments were made at any time if necessary.

Postoperative close observation and nursing care, regular dressing changes, checking the blood flow situation were all necessary to ensure the survival of the flap and postoperative healing effect. At the same time, the occurrence of complications such as infection and thrombosis were actively prevented.

Observation indicators

Intraoperative bleeding, complication rate of donor-recipient area at 6 months post operation, blood supply of the flap, and pain were used as the treatment result observation indicators. Intraoperative bleeding was counted in both groups during the procedure. Patients in both groups were followed up for a period of 6 to 24 months after the procedure to record the occurrence of complications in the donor-recipient area, the blood supply of the flap during the 6 months after the procedure, and the pain during the 2 years.

Statistical analysis

SPSS 25.0 (IBM, Armonk, New York, USA) was employed for statistical analysis of this study. The data were expressed as mean ± standard deviation. Student t-test and X^2 were applied to identify the differences of data between the groups with *P* value less than 0.05 as significant difference.

Results

Comparison of intraoperative bleeding volume

Intraoperative bleeding in the two groups showed that the minimum and maximum bleedings in the ALTF group were 60 and 540 mL with the average bleeding of 166.40 ± 105.09 mL, while the minimum and maximum bleedings in the SCIP group were 80 and 580 mL with the

average bleeding of 256.56 ± 160.01 mL. The results showed that the overall bleeding of patients who underwent transplantation using the ALTF was less than that of patients using the SCIP ($P < 0.05$).

Comparison of postoperative complications in the donor recipient area

Postoperative recovery of the recipient area showed that 23 cases of the ALTF group patients' postoperative recipient area flaps survived, 2 cases had complications with 1 of which had venous embolism, and the flap survived through re-anastomosis, and 1 patient had flap infection, but gradually recovered after symptomatic treatment. 7 cases of the SCIP group patients' recipient area flaps survived. 2 cases had flaps with partial skin necrosis, which were covered by implantation after debridement and vacuum sealing drainage (VSD) treatment, and the final wound healed well. 22 cases of the ALTF group patients' postoperative recipient area recovered well, while 3 cases had complications, of which 2 cases had implants after operation. For postoperative skin donor area recovery, 22 cases of the ALTF group recovered well, 3 cases had complications including 2 cases of postoperative skin donor area infection, which improved after treatment, and 1 case of skin grafting on the trauma of the donor area. In the SCIP group, 8 cases recovered well with 1 case of skin donor area infection and recovered well after treatment. There was no significant difference in the complication situation between the two groups ($P > 0.05$).

Comparison of postoperative blood supply of skin flaps

The rehabilitation of the skin flap was followed up for 6 months after operation. The blood supply of the whole flap in the ALTF group was excellent in 14 cases, good in 9 cases, and poor in 2 cases. The excellent and good rate in the ALTF group was 92%. In the SCIP group, the blood supply of the whole flap was excellent in 5 cases, good in 3 cases, poor in 1 case with the excellent and good rate reaching 88.89%. There was no

significant difference between two groups ($P > 0.05$).

Comparison of postoperative pain

The patients were evaluated at 6 months postoperatively for the pain suffered from the surgery. The results showed that there was no obvious pain to the patients in either group after surgery. 7 cases of mild pain and 18 cases of no pain were found in the ALTF group with the rate of no pain as 86.7%, while 3 cases of mild pain and 6 cases of no pain were found in the SCIP group with the rate of no pain as 86.7% too.

Typical cases

(1) Case 1:

A male patient with left hand injury caused by machine strangulation was admitted and emergency debridement, finger amputation, and vacuum sealing drainage (VSD) negative pressure suction were performed to make sure that the granulation tissue of the wound could grow after operation. Debridement and ALTF transplantation were performed for the second time to reconstruct the ulnar side of the hand, thin the flap during the operation, and anastomose the anterolateral thigh cutaneous nerve to reconstruct the sensation (Figure 1). The patient was discharged from the hospital after the operation.

(2) Case 2:

A male patient with left foot injury caused by a car accident was admitted and debridement, toe amputation, and VSD negative pressure suction were performed in the emergency room of local hospital and was transferred to our hospital because of postoperative skin and soft tissue defects. Debridement and ALTF transplantation were performed to cover the wounds in the weight-bearing area. The skin flap was thinned during the operation and the anterolateral thigh cutaneous nerve was anastomosed to reconstruct the sensation of the weight-bearing area (Figure 2).

(3) Case 3:

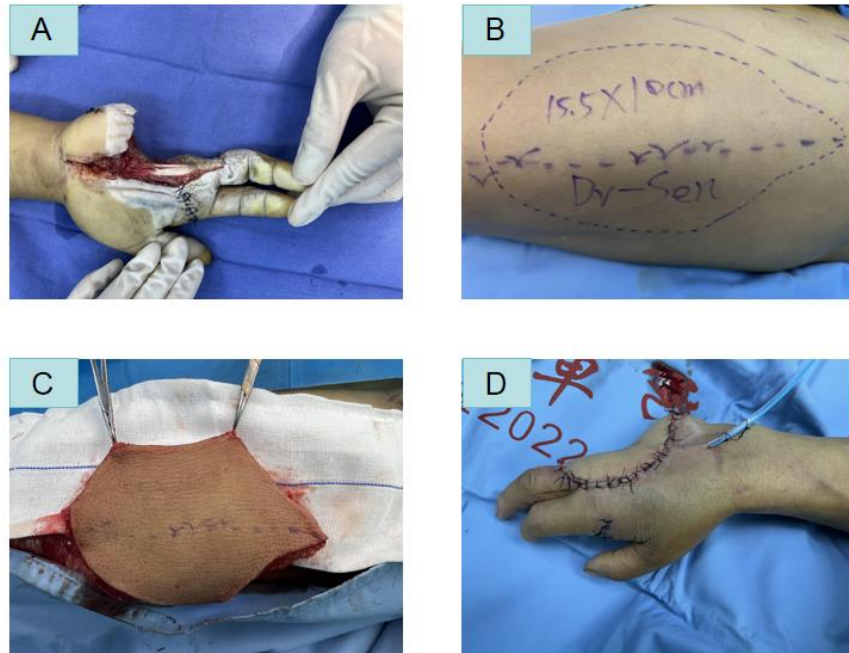


Figure 1. ALTP to repair skin defect of left hand. **A:** wound before skin flap transplantation. **B:** design skin flap. **C:** before skin flap transplantation. **D:** after wound restoration.

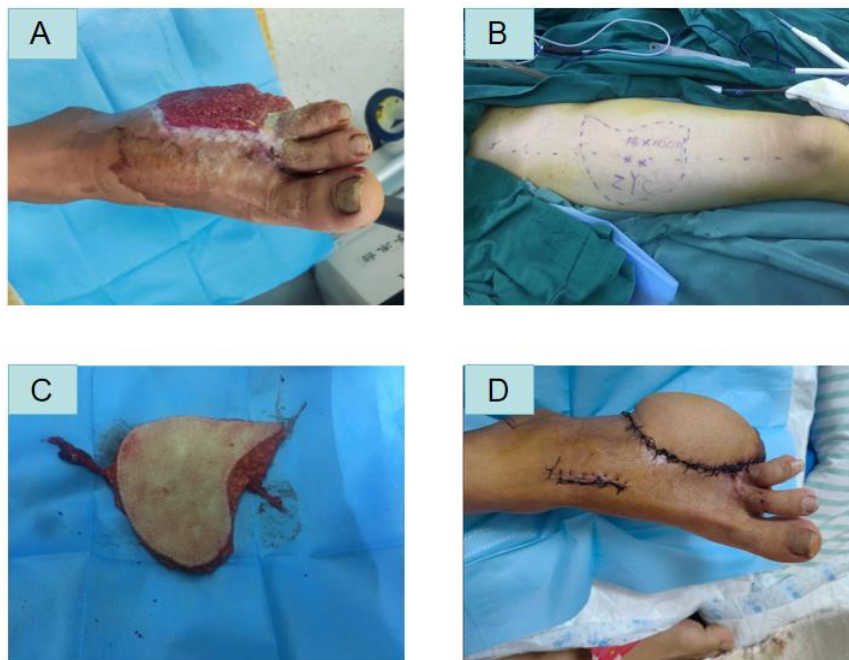


Figure 2. ALTP to repair skin defect of left foot. **A:** the wound before skin flap transplantation. **B:** design the skin flap. **C:** before skin flap transplantation. **D:** after wound restoration.

A male patient with left hand injury caused by explosive injury was admitted and emergency

debridement, fracture fixation, finger amputation, and VSD negative pressure suction

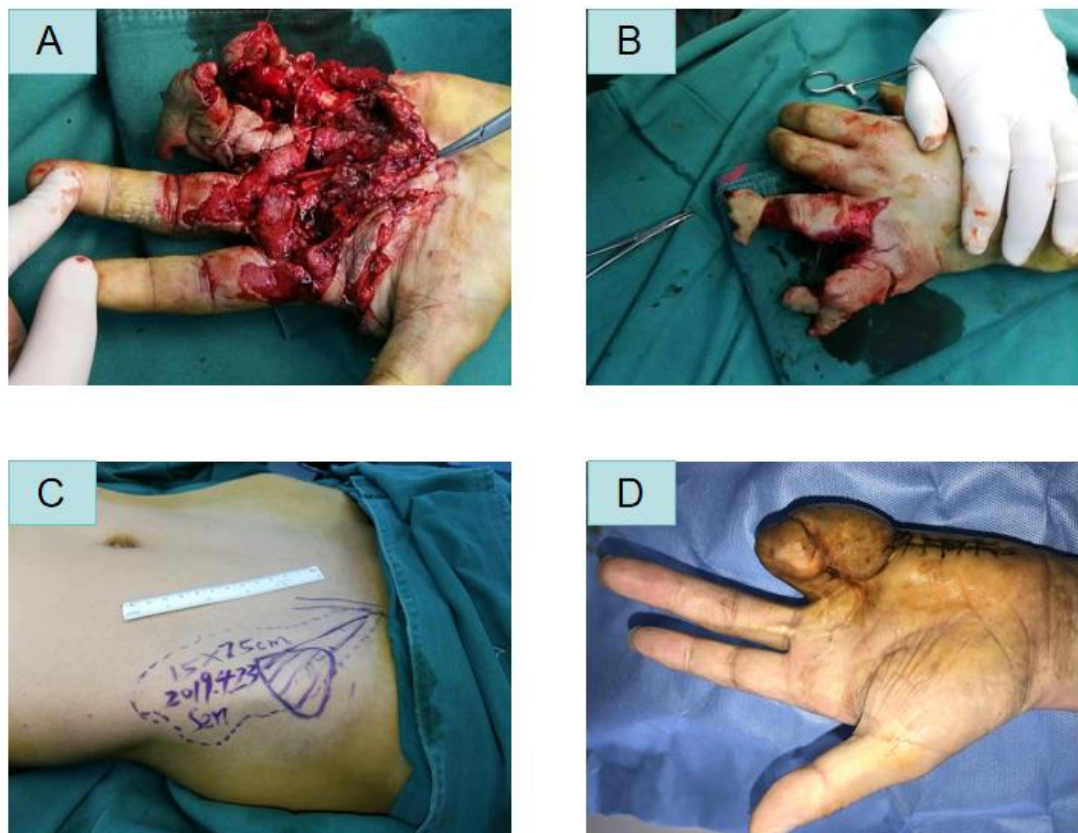


Figure 3. Repair of skin defect of left hand with SCIP. **A and B:** wound before skin flap transplantation. **C:** design of skin flap. **D:** hand status at 3 months after surgery.

were performed. After the operation, the skin and soft tissue were defective, while bone and tendon were exposed. The second operation was performed with debridement and SCIP transplantation to cover the ulnar wound of the left hand, while the donor area of the flap was sutured directly (Figure 3).

Discussion

In the field of medicine, especially in the field of surgery and wound repair, the repair of limb wounds has always been an important clinical demand [9]. Limb wound repair not only needs beautiful effect, but also needs to restore function, reduce the occurrence of complications, and reduce the pain of patients [10]. Therefore, finding an effective repair

method has always been the pursuit and research focus of surgeons. ALTF and SCIP are commonly used flap grafting techniques in repairing wounds and reconstructing tissue defects [11]. The blood supply of ALTF is mainly from the anterior lateral femoral artery and the anterior deep femoral artery with the innervation of the anterior femoral cutaneous nerve. The main points of its design include selecting an appropriate location in the anterior thigh, cutting the flap to avoid the anterior ventral femoral cutaneous nerve and the anterior lateral femoral cutaneous nerve, and orienting the flap parallel to the longitudinal axis of the anterior thigh [12]. The characteristics of SCIP are that its blood supply mainly comes from the perforating branch of the superficial iliac artery with the innervation of the anterior femoral cutaneous nerve. The main points of its design include taking the

material at the midpoint of the line between the anterior superior iliac spine and the sciatic tuberosity, and the orientation of the flap should be parallel to the longitudinal axis of the lateral thigh [13]. In terms of wound repair, ALTF can cover a wide range of wounds, which the donor area is easy to obtain, and the survival area is larger. However, it is thicker and easy to have complications such as edema and distension [14]. SCIP is more suitable for foot and ankle wounds repair because it is thinner and more elastic. However, the surgical operation is more complicated [15]. The ALTF consists of superficial fascia, dermis, and a small amount of subcutaneous fat, which has more subtle vascularization and innervation, and retains better flap flexibility and tactile sensation. Compared with traditional flaps, its thickness is thinner and less invasive to the donor area, which can reduce the complications in the donor area [16]. Currently, the application of ultra-thin technology in clinical practice is increasing, and it is an ideal flap for repairing skin defects of the extremities.

In the retrospective comparison of the two groups of patients in this study, it was found that intraoperative bleeding in the ALTF group was significantly less than that in the SCIP group ($P < 0.05$). The results of follow-up at 6 months revealed that the complication rates of donor area and recipient area in ALTF group were 13.6% and 8.7%, respectively, comparing to that in SCIP group of 12.5% and 28.6%, respectively. The overall flap blood supply excellence rate of ALTF group was 92%, while that of SCIP group was 88.89%. The pain-free rates of ALTF and SCIP groups were the same as 86.7%. There was no significant difference between the flap supply and recipient area complication rates, flap blood supply, and pain between the two groups ($P > 0.05$).

In clinical practice, these two types of flaps have their own indications and need to be selected according to the specific situation. SCIP is suitable for the parts that need thin flap repair, but its surgical difficulty is higher. ALTF is improved

based on the problem that the traditional flap has a large thickness, which is not suitable for the repair of part of the thin-skinned parts. Its thickness is thinner and smaller, and its damage and invasion to the donor area are smaller, which can reduce the complications of the donor area. Therefore, for different clinical situations, it is necessary to choose the appropriate flap transplantation method according to the patient's specific situation and surgical needs to achieve the best repair results.

References

1. Trapero A, Pérez-García A, Andresen-Lorca B, Heredia-Alcalde I. 2022. Anterolateral thigh free flap donor-site morbidity: A retrospective cohort study. *Plast Aesthet Nurs (Phila)*. 42(3):152-155.
2. Park CW, Miles BA. 2011. The expanding role of the anterolateral thigh free flap in head and neck reconstruction. *Curr Opin Otolaryngol Head Neck Surg*. 19(4):263-268.
3. Oliván MV, Busnardo FF, Faria JC, Coltro PS, Grillo VA, Gemperli R. 2015. Chimerical anterolateral thigh flap for plantar reconstruction. *Microsurgery*. 35(7):546-452.
4. Yu P, Selber J, Liu J. 2013. Reciprocal dominance of the anterolateral and anteromedial thigh flap perforator anatomy. *Ann Plast Surg*. 70(6):714-716.
5. Hong JP. 2021. The superficial circumflex iliac artery perforator flap in lower extremity reconstruction. *Clin Plast Surg*. 48(2):225-233.
6. Shi P, Zhang W, Zhao G, Li Z, Zhao S, Zhang T. 2015. Dorsalis pedis flap series-parallel big toe nail composite tissue flap to repair hand skin of degloving injury with thumb defect. *Chinese Journal of Reparative and Reconstructive Surgery*. 29(7):799-803.
7. Ensaf F, Schubert H, Hladik M, Reichl H, Larcher L, Wechselberger G. 2013. Die freie anterolaterale Oberschenkellappenplastik zur Weichteilrekonstruktion an den Extremitäten und im Kopf-Hals-Bereich. *Oper Orthop Traumatol*. 25(2):176-184.
8. Di HP, Mu XL, Shi JJ, Xue JD, Liu L, Guo HN, *et al.* 2021. A prospective randomized controlled study of the effectiveness of artificial dermis combined with split-thickness skin for repairing wounds with bone and tendon exposure in hands and feet. *Zhonghua Shao Shang Za Zhi*. 37(12):1130-1136.
9. Bajus A, Streit L. 2022. Superficial circumflex iliac artery perforator flap on extremity defects - case series. *Acta Chir Plast*. 64(1):39-43.
10. Yoshimatsu H, Karakawa R, Fuse Y, Hayashi A, Yano T. 2022. Superficial circumflex iliac artery perforator flap elevation using preoperative high-resolution ultrasonography for vessel mapping and flap design. *J Reconstr Microsurg*. 38(3):217-220.

11. Li Q, Xiao H, Cen Y. 2018. Application of selectively thinning of free anterolateral thigh flap in repair of heel skin and soft tissue defect. *Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi.* 32(3):350-353.
12. Younis PA, Davis S, Sweedan AO, ElSabbagh AM, Fernandes RP. 2023. Comparative assessment of total versus hemi glossectomy defects reconstructed with anterolateral thigh free flap. *J Oral Maxillofac Surg.* 81(9):1170-1175.
13. Aizawa T, Hirayama T, Tojo S, Kiyosawa T. 2021. A banner flap with adjacent rotation flap for closure of circular skin defects: a schematic comparison with conventional rotation flap technique. *J Plast Surg Hand Surg.* 55(5):278-283.
14. Ellabban MA, Elsayed MA, Zein AB, Ghorab M, Elmasry M, Masadeh S, *et al.* 2022. Virtual planning of the anterolateral thigh free flap for heel reconstruction. *Microsurgery.* 42(5):460-469.
15. Wang L, Liu H, Ma T, Wu X, Zhang L. 2021. Reconstruction of soft tissue defects in the hand with a free anterolateral thigh deep fascia flap. *Orthop Surg.* 13(3):758-767.
16. Son TT, Dung PTV, Thuy TTH, Chien VH, Phuc LH, Huy LA. 2022. One-stage reconstruction of the massive overlying skin and Achilles tendon defects using a free chimeric anterolateral thigh flap with fascia lata. *Microsurgery.* 42(7):659-667.