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Safety of a Single Venous Anastomosis in Anterolateral Thigh Free Flap for Extremity Reconstruction

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Purpose: The main cause of flap loss in microsurgical tissue transfer is venous insufficiency. Whether or not multiple venous anastomoses prevents vascular thrombosis and reduces the risk of flap failure remains controversial. Some researchers are in favor of performing dual venous anastomoses, but the counterargument holds that performing a single venous anastomosis does provide advantages.

Materials and Methods: We carried out a retrospective analysis of 15 cases of anterolateral thigh free flap for extremity reconstruction performed between January 2011 and December 2013. The patients were categorized into two groups: group A that received a single venous anastomosis and group B that received dual venous anastomoses. The time of the anastomosis, size of the flap, complications of the flap, and survival rate of each group were analyzed.

Results: The total microsurgical time in the single venous anastomosis group ranged from 28 to 43 minutes (mean 35.9 minutes). The total time in the dual anastomoses group ranged from 50 to 64 minutes (mean 55.7 minutes). No statistically significant difference was found between the two groups with regards to postoperative complications and flap failure.

Conclusion: Our study suggests that the use of a single venous anastomosis in the venous drainage of anterolateral thigh free flaps is a safe and feasible option for extremity reconstruction and provides shorter operative time and easy flap dissection.

Key Words: Free tissue flaps, Surgical anastomosis, Reconstructive surgical procedures, Extremities

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INTRODUCTION

The anterolateral thigh free flap was first described by Song et al.[1] in 1984 and has been performed in the reconstruction of many parts of the body in recent years. Advantages of this flap include donor harvesting with a two-team approach, long length and large caliber of the pedicle, volume variability, minimal donor site morbidity, and the ability to incorporate various tissue components, such as skin, subcutaneous fat, deep fascia, and muscle, in varying proportions as needed.[2,3] However, in common with other flaps, the most severe complication is flap necrosis, and venous insufficiency is one of the main reasons for the necrosis.[4,5] Therefore, some researchers are in favor of performing dual venous anastomoses that could provide a back-up venous drainage in case the primary venous anastomosis shuts down.[6-9] However, the counterargument is that performing a dual venous anastomoses unnecessarily adds to operative time and cost.[10-12]

These previous studies focused on the radial forearm free flap, rectus abdominis free flap, latissimus dorsi flap, and fibula

osteocutaneous free flap.[6-12] Moreover, the study by Chen et al.[6] on anterolateral thigh flap is limited to the reconstruction of the head and neck and recommends performing dual venous anastomoses to increase the flap's vascular stability; however, in this study, no difference in overall flap survival was observed. There was also no comparative study between single and dual venous anastomoses for extremity reconstruction using the anterolateral thigh flap. Therefore, we analyzed 15 cases of anterolateral thigh free flaps for extremity reconstruction to assess the need for a single venous anastomosis.

MATERIALS AND METHODS

Patients

A retrospective study was undertaken for 15 patients who underwent anterolateral free flap for extremity reconstruction by a single surgeon during January 2011 to December 2013. Patients with compromised vascular diseases and risk factors such as hypertension, diabetes mellitus, and smoking were excluded. Of these, 9 flaps had a single venous anastomosis and 6 flaps had dual venous anastomoses. Patients were divided into two groups (A and B) according to the number of veins used for anastomosis (single or dual).

All the causes of the wounds were traumatic soft tissue defects or amputations. The recipient anatomic locations included the forearm, thigh, popliteal area, lower leg, ankle, and foot (Table 1). The recorded data were composed of patient demographics, diagnosis, size of defect, recipient vessel, type of anastomosis, time of anastomosis, and complications.

Surgical technique

Debridement and wound irrigation was performed, and the recipient vessels were dissected. The cutaneous perforator of the donor site was detected using a hand-held Doppler device. The shape of the flap was designed according to the recipient site. The flap was raised in a suprafascial plane, except for the periphery of the pedicle in a subfascial plane. Primary closure was performed in the entire donor site, except for two cases covered by skin graft. The decision to perform a single anastomosis was made prior to starting the first anastomosis. In case of a single anastomosis, one of the vena comitantes was ligated by using a clip, and another vein was used to perform the anastomosis (Fig. 1). All arterial and venous anastomoses were performed in an end-to-end fashion with the hand-sewn method (Fig. 2).

Postoperative management

The flaps were monitored every 2 hours for the first 2 days and then every 4 hours for 1 week. Capillary refill, pin-prick testing, and a hand-held Doppler ultrasonic probe were

Table 1. Summary of the patient characteristics

Case No.	Age (yr)	Sex	Location	Diagnosis	Flap size (cm)	Recipient vessels	Anastomosis
1	62	Male	Left big toe	Soft tissue defect	8×4.5	Medial plantar	Single
2	55	Male	Right lower leg	Soft tissue defect	7×6	Posterior tibial	Single
3	38	Male	Left thigh	Amputation	11×6	Feroral circumflex	Single
4	38	Female	Right ankle	Soft tissue defect	11×6.5	Anterior tibial	Single
5	43	Male	Left popliteal area	Soft tissue defect	15×6	Superficial femoral	Single
6	43	Male	Right forearm	Soft tissue defect	15×6.5	Radial	Single
7	22	Male	Right lower leg	Soft tissue defect	16×8	Anterior tibial	Single
8	28	Male	Left lower leg	Soft tissue defect	19×8.5	Anterior tibial	Single
9	55	Male	Right lower leg	Soft tissue defect	20×12.5	Anterior tibial	Single
10	37	Male	Left lower leg	Soft tissue defect	9×7	Posterior tibial	Dual
11	69	Male	Right thigh	Soft tissue defect	11×8	Feroral circumflex	Dual
12	59	Female	Right lower leg	Soft tissue defect	12×6	Posterior tibial	Dual
13	21	Male	Right lower leg	Soft tissue defect	15×6	Anterior tibial	Dual
14	24	Male	Left ankle	Soft tissue defect	15.5×8	Dorsalis pedis	Dual
15	53	Male	Left foot	Amputation	21×10	Posterior tibial	Dual

used as monitoring methods. All patients were administered prophylactic antibiotics and prostaglandin E1 (Eglandin®; Mitsubishi Tanabe Pharma Korea Co., Ltd., Seoul, Korea) intravenously for 1 week.

Data collection and statistical analysis

The time of the microsurgical anastomosis, size of the flap, complications of the flap, and survival rate of each group were retrospectively reviewed. All analyses were two-tailed with a p-value <0.05 indicating a statistically significant difference. PASW Statistics ver. 18.0 software (IBM Co., Armonk, NY, USA) was used for the statistical calculations.

RESULTS

The patient demographics are shown in Table 1. The most common location of the surgery in both groups was the lower leg. All flaps were fasciocutaneous anterolateral thigh free flaps without any other procedures. All donor sites were closed by primary repair, except in two cases that required a split-thickness skin graft, and there were no complications of the donor site.

In all cases, the flaps survived without flap failures. However, of the 9 flaps in which a single vein was used, only one flap demonstrated partial necrosis (1.5×2.0 cm) postoperatively, which healed by secondary intention. There was no statistically significant difference in the overall flap survival (Table 2).

The total microsurgical time (1 artery, 1 vein) in the single venous anastomosis group, which began with the placement of the first stitch and ended when the last stitch was cut, ranged from 28 to 43 minutes (mean 35.9 minutes). The total microsurgical time (1 artery, 2 veins) in the dual anastomoses group ranged from 50 to 64 minutes (mean 55.7 minutes) (Table 2).

The smallest flap measured 36.0 cm^2 and the largest measured 250.0 cm^2. In single venous anastomosis, the average flap size was 104.72±67.45 cm^2 (range, 36.0 to 250.0 cm^2). In dual venous anastomosis, the average flap size was 106.54±53.86 cm^2 (range, 63.0 to 210.0 cm^2). There was no statistically significant difference between the two groups in flap size (Table 3).

DISCUSSION

The anterolateral thigh flap has been reported by in 1985, Song et al.[1] in 1984, Koshima et al.[13,14] in 1989 and 1993, and Zhou et al.[15] in 1991. The anterolateral thigh flap is suitable for the coverage of defects that require a relatively large flap, especially for defects in the extremities because it has reliable anatomy, a long pedicle, and the flexibility to reconstruct tissue defects with a chimeric flap as it is composed of various tissues.[16] There is some donor site morbidity, such as lateral thigh paresthesia, musculoskeletal dysfunction, scarring, and pain, but relatively minor.[17] In our study, there were no donor

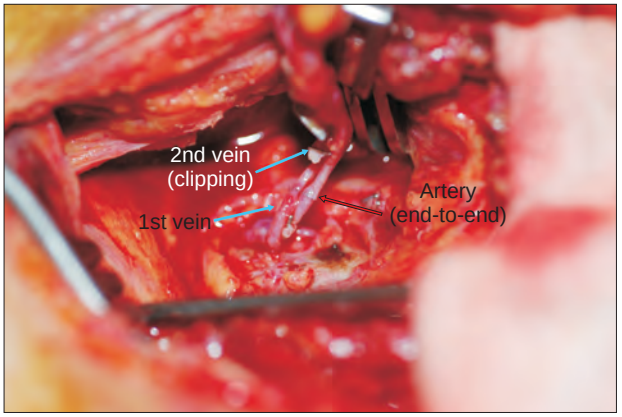

Fig. 1. Surgical procedure for the single venous anastomosis. Secondary vein was ligated by using a clip.

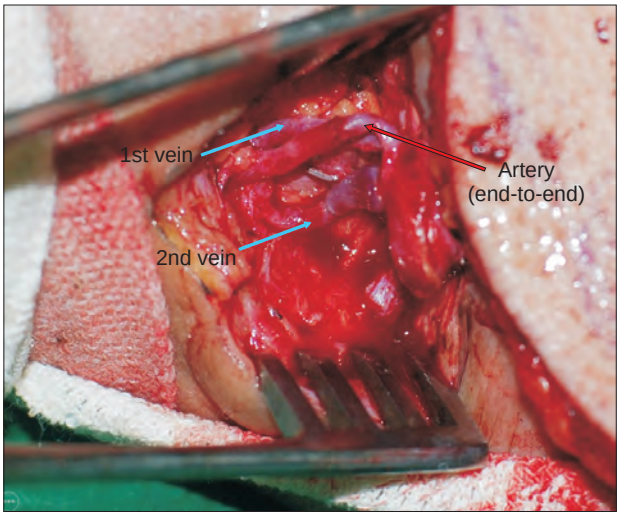

Fig. 2. Surgical procedure for the dual venous anastomoses. All venous anastomoses were performed in an end-to-end fashion.

Table 2. Postoperative complications and time of microsurgical anastomosis

Variable	Single anastomosis (n=9)	Dual anastomosis (n=6)	p-value
Flap failure	0	0	
Complications			
Venous congestion	0	0	
Partial necrosis	1	0	
Hematoma, seroma, infection	0	0	
Mean of total microsurgical time (min)	35.9	55.7	<0.001

Table 3. Length, width, dimension of the flap

Variable	Single anastomosis (n=9)	Dual anastomosis (n=6)	Mean (n=15)	p-value
Length (cm)	13.56±4.58	13.92±4.25	13.25±4.08	0.880
Width (cm)	7.17±2.32	7.42±1.50	6.89±1.39	0.820
Dimension (cm^2)	104.72±67.45	106.54±53.86	95.13±46.85	0.957

Values are presented as mean±standard deviation.

site complications.

Despite the fact that microvascular surgery is widely practiced, it has lengthened operative time and arguably increased morbidity. Efforts to reduce operative time involves a two-team approach and limiting the number of anastomoses, because microvascular anastomoses represents significant time expenditure in most cases.[11] Additional anastomoses also increase the general anesthesia duration in patients that are at a high risk for perioperative complications. However, technical controversy for single or dual venous anastomoses remains. It is important to prevent venous thrombosis in order to achieve better survival rate. Therefore, some authors recommend performing dual venous anastomoses for the stability and tolerance of the drainage in case the primary venous anastomosis shuts down.[6-9] Ross et al.[7] and Ichinose et al.[8,9] suggested that dual venous anastomoses should be performed in head and neck free flap reconstruction. Chen et al.[6] recommended, in a study of 315 anterolateral thigh flaps, that performing dual venous anastomoses in head and neck reconstruction using an anterolateral thigh flap increases the flap's vascular stability and its tolerance to postoperative vascular disturbance. However, there was no difference in overall flap survival in this study. The reconstruction site of the head and neck after cancer resection was also different from the anatomical site in our study. Although these previous studies showed that the incidence of complications such as venous congestion or thrombosis was lower in the dual anastomoses group, the flap survival rate was not statistically different between single and dual anastomoses.

On the other hand, Han et al.[10] showed in a study of 201 free fibula osteocutaneous flaps that there was no significant difference in the success rate between the single and dual anastomoses groups. Futran and Stack[11] demonstrated in a study of 43 radial forearm free flaps that the pattern of venous anastomoses has no bearing on flap survival. However, these previous studies focused on the free fibula osteocutaneous flap and radial forearm free flap for the reconstruction of the head and neck. In addition, Hanasono et al.[12] reported that dual anastomoses would reduce the blood flow velocity and that this stasis could be a causative factor for the development of venous thrombosis. Limitations of this study included all flap success without any flap complications and lack of a standard value in case venous thrombosis occurs.

It has been theorized that dual venous drainage of the free flap provides protection against venous insufficiency.[18] Furthermore, the superficial venous system can reduce venous congestion by providing a drainage route for the skin paddle.[19] However, we suggest that dual venous anastomoses in anterolateral thigh flap would be an unnecessary procedure because the venous system of the anterolateral thigh free flap differs from the double venous drainage system of the radial forearm free flap and deep inferior epigastric artery perforator flap.[20] Anterior lateral thigh free flap usually involves vena comitantes of the deep vein system in dual vein anastomosis; however, free flaps, such as the radial forearm and deep inferior epigastric artery perforator flaps were mostly anastomosized to the superficial system (the cephalic vein/the superficial inferior epigastric vein) and the deep system (the paired venae comitantes) in dual vein anastomoses. Dual venous anastomosis would be more effective in these kinds of flaps that use double venous drainage system (Fig. 3).[20] If dual vein anastomosis could be also performed by using both superficial (subcutaneous) and deep vein (venae comitantes) systems in case of anterolateral thigh free flap, it would be helpful for venous drainage of flaps.

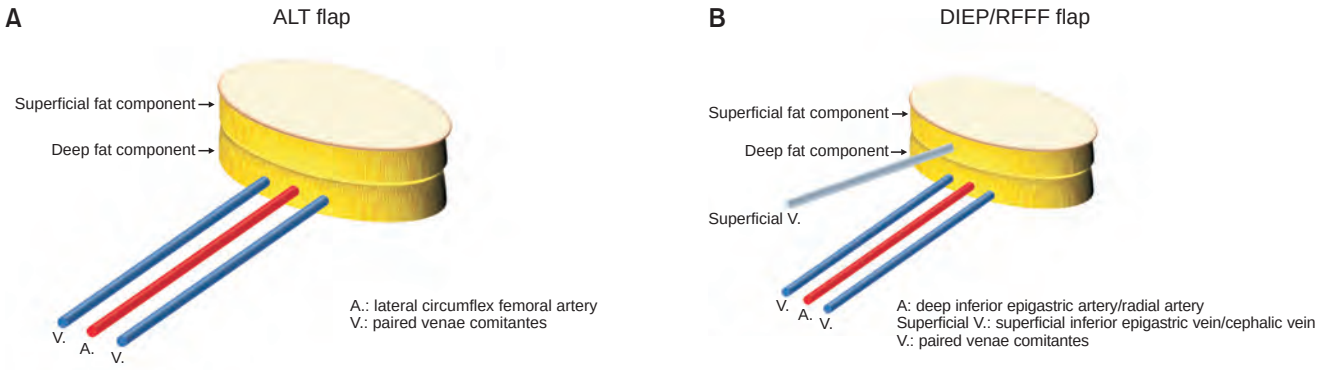

Fig. 3. Difference of venous system between anterolateral thigh flap (ALT) and deep inferior epigastric perforator flap (DIEP)/radial forearm free flap (RFFF). (A) Presentation of the vascular anatomy of the ALT flap with venous flow usually drained by only deep venous system, paired venae comitantes. (B) The most of DIEP/RFFF flap drained by both superficial and deep venous systems. If dual vein anastomosis was performed by using each of superficial and deep venous systems, it would be effective for dual venous drainage.

In this study, we tried to compare the success rates of single venous anastomosis with dual venous anastomoses of anterolateral thigh flaps in extremity reconstruction. We found that there was no significant difference in the survival rate between the single and dual anastomoses groups that received anterolateral thigh free flaps. Also, additional operative time and microsurgical suture materials could also be saved by using a single venous anastomosis. We assume that venous drainage through single venous anastomosis in the free flap with only the deep vein system, paired with venae comitantes, provides adequate safety for flap survival. In addition, the single venous anastomosis shortens operative time and costs. Therefore, our study suggests that the use of a single venous anastomosis in the venous drainage of anterolateral thigh free flaps is a safe and feasible option for extremity reconstruction and provides shorter operative time and easy flap dissection. However, the limitations of our study includes a small number of cases (n=15) and limited flap size (range, 36.0 to 250.0 cm^2), and further study is needed for more objective results.

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