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ARTICLE

An effective technique for managing vascular diameter discrepancies in microsurgery: tapering with a hemoclip

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ABSTRACT
Microvascular anastomosis is mandatory for free flap surgery, but free flap transfer can be challenging because of vascular diameter discrepancies during microsurgery. Different methods have been described for preventing vascular discrepancies. The aim of this study was to test a simple technique using a hemostatic clip to taper the vessels. In 12 patients who had free tissue transfer with diameter discrepancies between donor and recipient vessels, tapering with a hemostatic clip technique was used. After key sutures were placed on the vessels, a hemostatic clip was placed in an oblique fashion on the vessel with a larger diameter. After the vessel was tapered and the same diameters in the donor and recipient vessels were achieved, anastomosis was completed. This technique was used in head and neck reconstruction and lower extremity reconstruction. The luminal diameters of arteries, and veins of the flap and recipient differed by 1.6- to 3.0-fold and 1.5- to 2.6-fold, respectively. All the flaps survived without complications. Tapering with a hemoclip technique is a rapid procedure that can be considered for managing vascular diameter discrepancies in free tissue transfers.

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KEYWORDS
Anastomosis; artery; vein; flap; reconstructive microsurgery; microvascular

Introduction

Microvascular free tissue transfer is indicated as the surgical procedure of choice for certain tissue defects. Most free flap failures result from technical problems in performing a vascular anastomosis [1]. Vessel size discrepancy is a common issue in microsurgical reconstructions, in which the diameter of the flap vessel is larger than that of the recipient vessel. In head and neck and lower extremity reconstructions, microsurgeons often face vessel diameter mismatches. Various techniques have been described in the literature for vessel diameter discrepancies, but the superiority of any technique has not been shown yet.

The literature describes numerous techniques to overcome vascular diameter discrepancies, such as expanding the vessel with forceps and oblique cuts to the vessel to increase the surface area for small discrepancies. For large diameter discrepancies, end-to-side anastomosis, vascular grafts, variably shaped cuts on vessels and vessel invagination can be used [2,3].

In this study, we managed the problem by using a fast and effective technique. The technique involves tapering the vessel wall with a greater diameter by using a hemostatic clip. The aim of the study was to test the efficacy of the use of a hemostatic clip for tapering the large vessel to minimize vessel discrepancies.

Materials and methods

The study was performed with the approval of the regional ethics committee. From November 2017 to November 2018, the tapering technique with a hemoclip was used in 12 patients who underwent free tissue transfer with vascular discrepancies in anastomosis. The patients underwent head and neck or lower extremity reconstruction. Informed consent was obtained from all the patients. The present study was conducted in keeping with the principles of the Declaration of Helsinki.

Surgical technique

First, arterial anastomoses were performed. The first suture was placed at the side of the smaller artery, and the second suture was placed at 180° from the same artery wall. Subsequently, crossing sutures were placed (Figure 1). The surplus of the flap artery was held with microforceps and pulled up. A small hemoclip (Weck Hemoclip Plus, 3015 Carrington Mill Boulevard Morrisville, NC 27560) was placed obliquely from the anastomotic line toward the vessel wall (Figure 2). To obtain a slowly enlarging cone, we took care not to perforate the vessel wall with the tip of the hemoclip, and thus, the biting tip of the hemoclip was pushed just up to the vessel wall. Thus, turbulence was prevented as much as possible. Both sides of the hemoclip were sutured to prevent anastomotic leakage, and the anastomosis was completed. The same procedure was also applied to the vein (Figures 3 and 4). Blood flow was observed using the milking test (Supplementary Video 1).

Results

Of the 12 patients, the tapering technique with a hemoclip was applied in seven patients simultaneously, for both the vein and artery, and only for vein anastomosis in five patients (Table 1). All

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Figure 1. Surplus of the flap artery with placed sutures, where a hemoclip will be applied.

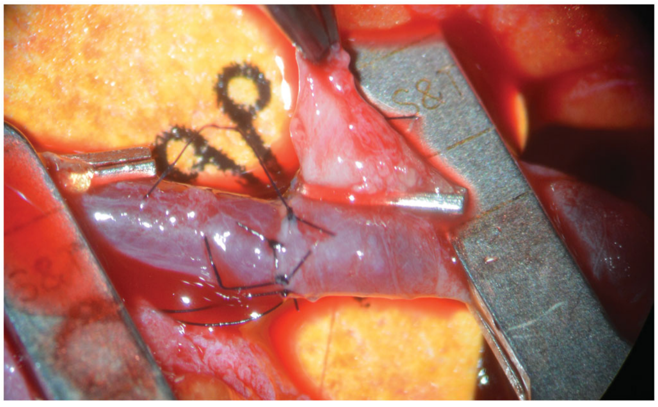

Figure 2. Application of the hemoclip to the artery.

the patients underwent a single-vein anastomosis. Reconstruction of the patients' veins was performed with ten free ALT flaps (Figures 5 and 6) and two free osteocutaneous iliac flaps. Six superficial temporal arteries (STA) and one frontal branch of the STA were used as a recipient artery in the seven patients who underwent head and neck vein reconstruction. The recipient vein was the superficial temporal vein (STV) in four cases and the angular vein (AV) in the other three cases. In the five patients who underwent lower extremity reconstruction, this technique was used only in vein anastomosis. The diameters of the vessels were measured with a micrometer. The luminal diameters of the arteries and veins of the flap and recipient differed by 1.6- to 3-fold and 1.5- to 2.6-fold, respectively. None of the cases required re-exploration. The patients were followed up for a median of 8.4 months. No complications occurred during the follow-up period.

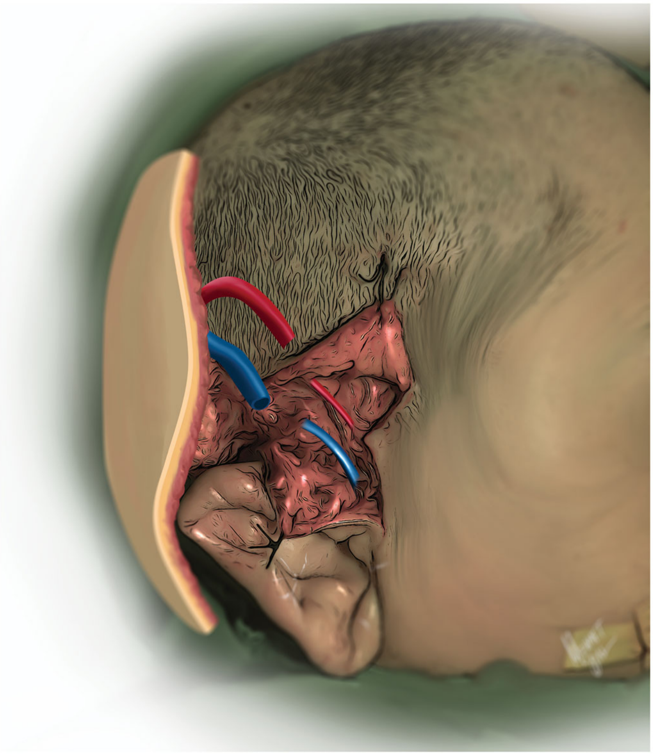

Figure 3. Schematic figure of a patient with a vascular discrepancy during reconstruction with an ALT flap.

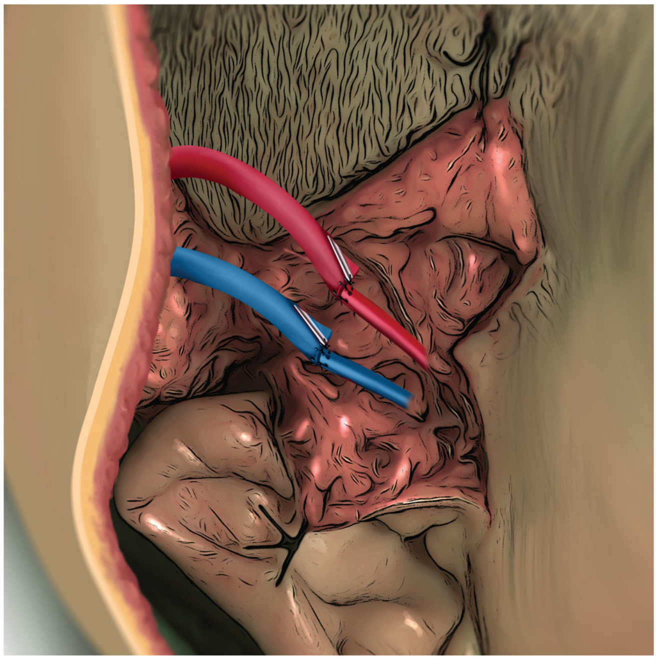

Figure 4. Schematic figure of the hemoclip applied for both the arterial and vascular discrepancies.

Discussion

Anastomosis plays a critical role in the success of microvascular tissue transfers. For a successful anastomosis, the choice of a recipient vessel is important. The correspondence between the diameters of the flap and recipient vessels directly affects the outcome of surgery. In some cases, especially in reconstructive surgery performed in the head and neck region, the choice of a recipient vessel is limited. As observed in reconstructions

Table 1. Characteristics of the patients.

Patient No	Sex	Age	SH	Comorbidites	Etiology	Flap size	Flap vessels diameter	Recipient vessels diameter	Diameter ratio of arteries	Diameter ratio of veins	Follow-up
1	F	50	–	–	Temporoparietal SCC excision	16 × 10-cm ALT flap	DB of LFCA-V A-2.5 mm V-2.7 mm	STA-1.2 mm STV-1.5 mm	2.1	1.8	16 months
2	M	48	+	Coronary disease	Left frontal mucocele excision including anterior and posterior frontal bone	6 × 4×3-cm osteocutaneous iliac flap	DCIA-V A-3 mm V-4 mm	Frontal branch of STA-1 mm AV-1.5 mm	3	2.6	16 months
3	M	40	+	–	Left frontoparietal radiotherapy scar after intracranial tumor excision	9 × 6 cm ALT flap	DB of LFCA-V A-2.5 mm V-2.7 mm	STA-1.5 mm AV-1.5 mm	1.6	1.8	14 months
4	M	35	–	–	Zygomatic bone + infraorbital rim excision due to mucocele infections	6 × 3×2-cm osteocutaneous iliac flap	DCIA-V A-3 mm V-4 mm	STA-1.5 mm STV-1.5 mm	2	2.6	14 months
5	M	51	+	–	Porocarcinoma excision extending from the right frontal to preauricular region	8 × 6-cm ALT flap	DB of LFCA-V A-2.2 mm V-2.6 mm	STA-1.3 mm AV-1.5 mm	1.7	1.7	11 months
6	F	54	–	Diabetes	Frontotemporal SCC excision	9 × 5-cm ALT flap	DB of LFCA-V A-2.6 mm V-2.8 mm	STA-1.4 mm STV-1.5 mm	1.9	1.9	3 months
7	M	55	+	Drug abuse	Frontoparietal defect after parietal bone osteomyelitis	10 × 10-cm ALT flap	DB of LFCA-V A-2.3 mm V-2.5 mm	STA-1.2 mm STV-1.4 mm	1.9	1.7	1 month
8	M	34	–	–	Upper 1/3 cruris defect due to trauma injury	20 × 9-cm ALT flap	DB of LFCV V-2 mm	Posterior tibial vein-3.4 mm	–	1.7	12 months
9	M	36	+	–	Middle 1/3 cruris defect due to trauma injury	22 × 8-cm ALT flap	DB of LFCV V-2 mm	Posterior tibial vein-3 mm	–	1.5	8 months
10	M	42	+	Morbid obese	Middle 1/3 cruris defect due to trauma injury	12 × 7-cm ALT flap	DB of LFCV V-2 mm	Posterior tibial vein-3 mm	–	1.5	4 months
11	M	48	+	–	Upper 1/3 cruris defect due to chemical burn	7 × 6-cm ALT flap	DB of LFCV V-1.9 mm	Posterior tibial vein-2.9 mm	–	1.5	1 month
12	F	27	–	–	Middle 1/3 cruris defect after burn injury	15 × 6-cm ALT flap	DB of LFCV V-1.8 mm	Posterior tibial vein-3 mm	–	1.7	1 month

SH: Smoking habit; SCC: Squamous cell carcinoma; ALT flap: Anterolateral Thigh Flap; DCIA-V: Deep circumflex iliac artery – vein; DB of LFCA: Descending branch of lateral femoral circumflex artery; STA-V: Superficial temporal artery – vein; AV: Angular vein.

Figure 5. Intraoperative view of the patient.

Figure 6. Postoperative view of the patient.

performed in this region, flap vessels are larger, with a substantial discrepancy from recipient vessels.

Numerous techniques have been described in the literature to overcome vascular discrepancies. For small or moderate discrepancies, the small vessel may be expanded with forceps, oblique cuts can be made and vessels can be sutured with unequal bits. For greater diameter differences, end-to-side anastomosis, variably shaped cuts on vessels, invagination techniques and coupler devices, vascular grafts and adhesives can be used [2,3].

End-to-side anastomosis is preferred when surgeons are confronted with the problem of a significant size discrepancy. For conventional end-to-side anastomosis, operative times ranging from 26 to 60 min were reported in the literature [4,5]. End-to-side anastomosis is a time-consuming procedure that clinically prolongs ischemic time. Vein grafts may also be considered when a greater size discrepancy exists [6]. Use of vein grafts was associated with a higher incidence of flap failure in head and neck reconstruction [7]. To avoid flap failure, variably shaped cuts on vessels and various devices have been described in the literature, such as v-shaped cuts, y-shaped anastomosis, coupler devices and angioplasty catheters [8–11]. These techniques were presented as successful in specific cases but have the disadvantages of causing further damage to vessel walls and intima, prolonged surgical times or additional costs.

In 1994, Ueda et al. [1] described a 'distal tapering technique'. They used this technique in cases where the diameter of the flap artery was much larger than that of the recipient artery. They excised the surplus arterial wall in a wedge-shaped fashion and sutured the remaining arterial wall. In this way, a sudden change in luminal diameter was prevented [1]. However, Ueda et al. thought that a thrombus might develop because of a relatively slow venous blood flow, so they used this technique only for arteries. The components of venous thrombogenesis are local vascular stasis, injury to the vascular wall and hypercoagulability [12]. Injury to the vascular wall, which increases the risk of thrombosis, can occur with the technique described by Ueda et al. because of the intimal injury in the wedge-shaped excision areas on the vessel, which in turn slows blood flow. Despite the potential drawbacks of their technique, we were inspired and sought to develop our own approach that we can apply in surgeries involving both arteries and veins. We performed this study to further enhance the technique and determine ways to avoid the risk of thrombosis. With the use of a hemoclip to taper the vein with a greater diameter, we avoided any suturing in the vessel, thus minimizing intimal damage. Furthermore, placing the hemoclip with slight angulation decreased the likelihood of turbulence.

Choi and Suri et al. described a technique similar to our technique [13,14]. In their study, the interpositional vein graft discrepancy between the internal and common carotid artery was tapered with a hemostatic clip in four patients with head and neck malignancies [13]. Vein discrepancies were corrected with a Ligaclips^{TM} (Ethicon, Endo-Surgery, Cincinnati, OH) in the head and neck reconstruction surgery in ten patients [14]. In our study, we used this technique in both arteries and veins with similar success rates as that of the technique described by Choi and Suri et al.

We overcame arterial discrepancies of 1.6–3:1 and venous discrepancies of 1.5–2.6:1. Seven arterial and 12 venous anastomoses were performed. We spent on average an extra 60 s to correct the discrepancies in luminal diameters for each anastomosis. We used our technique for 14 anastomoses and achieved 100% success rate without the need for re-exploration.

One disadvantage to this technique was noted; if it is performed erroneously, then it is irreversible and cannot be repaired. In such cases, the involved vascular site should be excised and re-anastomosed. Therefore, to minimize error, surgery should be accurately planned, and the procedure should be performed with care. In addition, this procedure should not be performed by novice surgeons because if the clip is placed in the wrong place, the damage is irreversible.

In all the cases in this series, superficial temporal vessels, which are known to be reliable but relatively small, were used in head and neck reconstructions. The reliability and size of the flap should be considered in flap selection. Before considering this technique, surgeons should meticulously match the sizes of the donor and recipient vessels, such as choosing the right flap and accurate recipient vessels, dissecting the vessels to match their sizes and making all attempts for an accurate match. If a match is not possible, then this technique should be considered.

In conclusion, the tapering technique with a hemoclip can be considered as an effective procedure that takes relatively less operative time and can be applied in both arteries and veins in selected cases. We think that this technique is an alternative for managing vascular diameter discrepancies in microsurgery.

Disclosure statement

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this article.

Authors contributions

Zulfukar Ulas Bali carried out the conception and design of the study. Acquisition of data, analysis and interpretation of data were done by Zulfukar Ulas Bali, Mustafa Kursat Evrenos and Berrak Karatan. Berrak Karatan drafted the article. Yavuz Kececi carried out the conception of the study, revising it critically for important intellectual content. Levent Yoleri carried out the conception of the study, mentored and done final approval.

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References

[1] Ueda K, Harashina T, Inoue T, et al. Microarterial anastomosis with a distal tapering technique. J Reconstr Microsurg. 1994;10:87–90.

[2] de la Pena-Salcedo JA, Cuesy C, Lopez-Monjardin H. Experimental microvascular sleeve anastomosis in size discrepancy vessels. Microsurgery. 2000;20:173–175.

[3] Lopez-Monjardin H, de la Pena-Salcedo JA. Techniques for management of size discrepancies in microvascular anastomosis. Microsurgery. 2000;20:162–166.

[4] Karamursel S, Kayikcioglu A, Safak T, et al. End-to-side microvascular anastomosis using an external metal ring. Br J Plast Surg. 2000;53:423–426.

[5] Padubidri AN, Browne E, Kononov A. Fibrin glue-assisted end-to-side anastomosis of rat femoral vessels: comparison with conventional suture method. Ann Plast Surg. 1996;37:41–47.

[6] Ryan AD, Goldberg I, O'Brien BM, et al. Anastomosis of vessels of unequal diameter using an interpositional vein graft. Plast Reconstr Surg. 1988;81:414–417.

[7] Miller MJ, Schusterman MA, Reece GP, et al. Interposition vein grafting in head and neck reconstructive microsurgery. J Reconstr Microsurg. 1993;9:245–251.

[8] Akan M, Cakir B, Akoz T. "Open y" technique in vessel diameter discrepancy. Microsurgery. 2006;26:506–514.

[9] Yuksel E, Safak T, Ozcan G, et al. Perioperative dilation for vessel-size discrepancy using a percutaneous transluminal angioplasty catheter. J Reconstr Microsurg. 1999;15:31–35.

[10] Sullivan SK, Dellacroce F, Allen R. Management of significant venous discrepancy with microvascular venous coupler. J Reconstr Microsurg. 2003;19:377–380.

[11] Bakhach J, Dibo S, Zgheib ER, et al. The V-Plasty: a novel microsurgical technique for anastomosis of vessels with marked size discrepancy. J Reconstr Microsurg. 2016;32:128–136.

[12] Thomas DP, Merton RE, Wood RD, et al. The relationship between vessel wall injury and venous thrombosis: an experimental study. Br J Haematol. 1985;59:449–457.

[13] Choi EC, Lim YC, Lee SY, et al. Titanium hemostatic clip tailoring method to overcome vessel caliber discrepancy in interposition saphenous vein graft for carotid artery resection. Acta Otolaryngol. 2005;125:638–641.

[14] Suri MP, Ahmad QG, Yadav PS. Managing venous discrepancy: simple method. J Reconstr Microsurg. 2009;25:497–499.