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Microvascular Anastomotic Coupler Assessment in Head and Neck Reconstruction

John W. Frederick, MD¹, Larissa Sweeny, MD¹, William R. Carroll, MD¹, and Eben L. Rosenthal, MD¹

¹Department of Surgery, Division of Otolaryngology–Head and Neck Surgery, University of Alabama at Birmingham, Birmingham, Alabama

Abstract

Objective.—To assess the advantages of using mechanical anastomotic systems in head and neck free tissue transfer.

Study design.—Case series with chart review.

Setting.—A university-based tertiary care center.

Subjects and Methods.—A retrospective review of mechanical venous coupler devices in head and neck reconstruction performed between October 2004 and December 2006. A total of 261 venous anastomoses were performed in 234 consecutive patients. Five types of flaps were performed: radial forearm (66%), anterior lateral thigh (12%), fibula (9%), rectus abdominis (8%), and latissimus dorsi (2%). Demographic data were collected, and the outcomes measured were flap survival and microvascular complications.

Results.—The size of the venous anastomosis ranged from 1.5 to 4.0 mm, with most being 3.0 mm (56%) followed by 3.5 mm (23%). The most common recipient vein used was an unidentified venous branch off the internal jugular vein (76%) followed by the external jugular vein (17%). Microvascular complications occurred in <5% (n = 11) of patients, with >50% of those being arterial insufficiency (n = 7). Total failures occurred in 3% (n = 7) of patients: 1.5% (n = 4) acute failures (<5 days) and 1.5% (n = 3) late failures. Of the acute failures, causes included venous congestion (n = 1) and arterial insufficiencies (n = 3). The venous coupler used in the failures was 3.0 mm in diameter. Free flap failures resulting from arterial insufficiency involved coupling to the external jugular vein, while the remaining free flap failures (n = 4) used the internal jugular vein.

Conclusion.—With an early venous failure rate of 0.38%, mechanical anastomosis is an adequate alternative to hand-sewn techniques.

Keywords

reconstruction; head and neck; microvascular; outcomes; mechanical anastomosis

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Corresponding Author: John W. Frederick, Division of Otolaryngology, BDB Suite 563, 1808 7th Avenue South Birmingham, AL 35294-0012, USA. jwfred@uab.edu.

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Author Contributions

John W. Frederick, collection, analysis, interpretation, writing; **Larissa Sweeny**, analysis, writing; **William R. Carroll**, approval, interpretation; **Eben L. Rosenthal**, analysis, interpretation, writing, approval.

Disclosures

Competing interests: None.

Microvascular free tissue transfer has largely become the gold standard for repair of complex head and neck defects.^{1,2} The survival of the free tissue relies on patent anastomosis of venous and arterial donor to recipient vessels. Advances in microvascular techniques have allowed for improvements in flap survival and overall favorable outcomes.³ While the incidence of free tissue transfer failure is low, typically between 3% and 5%,^{4,5} reasons for failure are most often technical. This reflects that microvascular anastomosis remains one of the most technically challenging and crucial portions of free tissue transfer procedures.

Historically, anastomosis has been achieved by hand-sewn techniques using 8-0 to 10-0 nylon suture. While this method has been the gold standard for more than 40 years, hand-sewn anastomosis is not only time-consuming and technically challenging but also potentially introduces many problems for the anastomosis: exposing suture material into the lumen of the vessel or poor vessel edge eversion, for example.⁶ Mechanical anastomotic coupler devices (MACDs) have proven to be a valuable alternative to the traditional hand-sewn techniques. Although the use of MACDs in microvascular anastomosis was first demonstrated in 1962 by Nakayama et al,⁷ it has remained underused in head and neck reconstruction. In this retrospective review, we analyzed the use of venous mechanical anastomotic coupler devices (vMACDs) for free tissue transfers to the head and neck.

Materials and Methods

Patient Selection

Following institutional review board approval by the University of Alabama at Birmingham, a prospectively database was compiled of all patients presenting to the otolaryngology clinic for microvascular free flap reconstruction of the head and neck. For this study, all patients who presented between October 2004 and December 2006 for a microvascular free flap reconstruction using a vMACD were included (n = 234). The number of microvascular anastomoses (n = 261) and venous coupler size used were included. The flap donor site, recipient vessels, and anastomotic technique were determined by patient comorbidities (diabetes mellitus, cardiac disease, immunosuppression) and surgeon preference. Demographic data and outcomes (flap survival and microvascular complications) were analyzed. Microvascular complications were found to be due to either venous congestion (evident through decreased venous Doppler signal, pin-prick examination, and changes in flap color/consistency) or arterial insufficiency (evident through decreased arterial Doppler). Free flap complications were classified as either partial failure, late total failure (>5 days), or acute total failure (<5 days).

Statistical Analysis

Descriptive variables were summarized by mean ($\pm$ SD) for continuous variables and n (%) for categorical variables. A 1-way analysis of variance was used to analyze relationships between categorical factors and continuous responses. A Student *t* test was used to compare differences in means between groups. A contingency analysis was used to analyze relationships between categorical factors and responses. A *P* value of <.05 was considered statistically significant. Statistical analysis was performed using JMP 10 software (SAS, Cary, NC).

Results

Patient Characteristics

The mean age of the patients was 62 years (range, 25-93 years), with most patients being male (69%, $n = 162$). The vast majority of patients were Caucasian (85%, $n = 199$), with the remaining being black (14%, $n = 32$) or Hispanic (1%, $n = 3$). A total of 234 patients underwent 261 microvascular anastomoses. Indications for reconstruction included primary lesion (59%, $n = 139$), recurrent lesion (29%, $n = 68$), secondary reconstruction (8%, $n = 18$), and osteoradionecrosis (3%, $n = 8$). The locations of the defects were as follows: oral cavity (40%, $n = 95$), hypopharynx/larynx (19%, $n = 44$), cutaneous (17%, $n = 39$), oropharynx (14%, $n = 32$), midface (8%, $n = 20$), and skull base (2%, $n = 4$).

Microvascular Reconstruction

The donor free flap most commonly used was the radial forearm (66%, $n = 154$), followed by anterior lateral thigh (12%, $n = 27$), fibular (9%, $n = 22$), rectus abdominis (8%, $n = 20$), osteocutaneous radial forearm (3%, $n = 7$), and latissimus dorsi (2%, $n = 5$). The internal jugular vein was the most common recipient vein used (76%, $n = 198$), followed by the external jugular (17%, $n = 44$). The size of the coupler used for the venous anastomosis ranged from 1.5 to 4.0 mm, with most being 3.0 mm (53%, $n = 140$), followed by 3.5 mm (23%, $n = 59$; Table 1). The facial artery was the most common recipient artery used for the arterial anastomosis (58%, $n = 135$), followed by an unidentified arterial branch off the external carotid artery (22%, $n = 52$), lingual artery (13%, $n = 56$), and superior thyroid artery (6%, $n = 15$).

Multiple couplers were used in 11% ($n = 26$) of patients. While it is our institution's preference to perform a single venous anastomosis, multiple couplers were used in cases with venous branching or suboptimal pedicle geometry to ensure adequate outflow in the case of thrombosis. The only variable found to affect the requirement for multiple couplers was surgical indication ($P = .03$). Microvascular anastomosis for secondary reconstruction required multiple couplers more frequently (17%, $n = 3/18$) than did osteoradionecrosis (12.5%, $n = 1/8$), primary lesion (12.5%, $n = 17/139$), or recurrent lesion (6%, $n = 4/68$). Further, a requirement for multiple couplers was not affected by the recipient vein used ($P = .23$), location of the defect ($P = .78$), or free flap used ($P = .41$).

Complications

Microvascular complications were rare (<5%, $n = 11$) and included venous congestion ($n = 3$), vessel wall rupture ($n = 1$), and arterial insufficiency ($n = 7$). Free flap vascular compromise was less than 5% ($n = 10$) and was classified as partial flap loss ($n = 3$) and total flap loss ($n = 7$). Other complications associated with the operation included hematoma ($n = 12$), free flap dehiscence ($n = 10$), fistula formation ($n = 11$), infection requiring intravenous antibiotics ($n = 10$), chylous leak ($n = 1$), and 1 perioperative death due to cardiovascular arrest.

Most of our venous anastomoses were to an unidentified branch off the internal jugular vein. While this is traditionally thought to be protective against venous congestion, the selection of recipient vein did not affect the occurrence of a microvascular complication ($P = .57$), free flap total or partial loss ($P = .41$), or other operative complications ($P = .63$). Microvascular complications were not affected by defect location, free flap used, coupler size, multiple anastomoses used, or surgical indication ($P > .05$).

Discussion

Microvascular anastomosis is a technically challenging aspect of free flap reconstruction. While traditional hand-sewn techniques have been the gold standard, there are many flaws with this technique. First, back-wall introduction of the suture into the lumen of the vessel potentiates thrombosis and anastomotic stenosis. Second, the inadequate eversion of vessel edges exposes thrombotic material within the lumen. Finally, poor suture placement can result in anastomotic leak. By using the mechanical anastomotic devices, anastomosis and flap transfer are simplified. This provides an overall decrease in flap anastomosis time, a decrease in flap ischemia time, and a decrease in microvascular complications.^{8,9}

Coupler size ranged from 1.5 to 4.0 mm, the most common being 3.0 mm (56%). The diameter of the coupler was not correlated with failure rates. Similar results were found by Zhang et al⁶ using couplers ranging from 1.5 to 4.0 mm, again indicating that the size of the coupler does not affect tissue transfer outcomes.⁶ Success with various sizes of venous couplers is not limited to head and neck reconstruction, as Jandali et al¹⁰ described the venous coupler in breast surgery. With 1000 anastomoses, and with size ranging from 1.5 to 4.0 mm, there was only a 0.6% incidence of venous thrombosis.¹⁰ This shows the versatility of the vMACDs and supports the use of mechanical coupling in small-diameter vessels and in situations with poor vessel caliber match.^{1,9} By using vMACDs, anastomotic complications can be potentially avoided, and tissue transfers relying on smaller-caliber vessels can be transferred without increased risk of free flap loss.

Most of our patients received 1 venous anastomosis. Many institutions prefer using the coupler device for multiple venous anastomoses for each free flap transfer, regardless of the circumstance.^{6,11,12} Published data comparing dual to single anastomosis in head and neck reconstruction show a failure rate of 4% (range, 0%-10%) compared with 7% (range, 3%-12.5%), respectively.^{5,13,14} In our experience, however, similar to data published by Futran and Stack,¹³ we were able to achieve acceptable outcomes with 1 venous anastomosis in most of our cases. Multiple anastomoses were performed on only a case-by-case basis, namely, for secondary reconstructions. We suggest performing multiple venous anastomoses with the coupler device only in cases of complex pedicle geometry to theoretically supply additional venous drainage in the event of a thrombus.

In our series, there were a total of 3 confirmed venous congestions, only 1 of which resulted in a total flap loss. When compared with published data concerning hand-sewn venous congestion, vMACDs are proven to be a reliable form of venous anastomosis with no increased risk of congestion.¹⁵ An unidentified branch off the internal jugular vein was most commonly used for venous anastomosis for a variety of reasons. Availability of acceptable vessels after the ablative resection is varied, limiting reconstruction options. In these cases, the internal jugular vein provides a consistent and reliable vessel for anastomosis. Also, the increased volume of flow in the internal jugular vein is considered protective against venous congestion. Other frequent recipient veins include the facial, lingual, and external jugular vein and can be used with acceptable outcomes.⁶

There are obvious limitations to mechanical coupling devices. To achieve an adequate anastomosis, the vessels must be pliable and allow eversion on the ring and pin couplers. Perhaps the most common reason for surgeons to reject the coupler is unwillingness to lose familiarity with hand-sewn anastomosis since the most difficult cases are associated with those in which the coupler cannot be used. This includes vessels that are thickened from repeated venipuncture, in an irradiated neck, or with lack of vessel pliability. For this reason, there must still be an emphasis placed on teaching and proficiency with traditional suture techniques.

Many institutions are beginning to use the coupler device for arterial anastomosis. While its effectiveness is still debated, there have recently been large series displaying promising results with its use in select arteries.^{6,16} Again, this is still controversial, with many of the earlier studies showing poor flap outcomes with arterial coupling.¹⁷ There was no use of arterial coupling in this case series.

Mechanical failures (the physical breaking of the anastomotic ring formed by the device) are extremely rare, with our series producing a 0% occurrence. This is similar to other published data, supporting a less than 1% incidence of mechanical failure.¹⁸ However, it has been reported that occasionally, the coupler device is not able to generate enough force to adequately fuse the anastomosis. This can be remedied by placing a hemostat on either side of the anastomotic ring and applying pressure for a short period of time to ensure appropriate closure.

Mechanical venous anastomosis in head and neck reconstruction is a reliable form of microsurgical reconstruction. With the average anastomosis time ranging from 5 to 15 minutes, mechanical anastomosis clearly decreases flap ischemia time and overall operative time.^{8,19,20} Also, by removing the potential of foreign body exposure to the lumen of the anastomosis, namely, the suture used in hand-sewn techniques, there is an obvious advantage to vMACDs. Our experience has shown the reliability of vMACDs in head and neck reconstruction, even in small-diameter vessel reconstruction. It is clear that mechanical venous anastomosis is a reliable and technically sound method of end-to-end anastomosis in head and neck reconstruction.

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References

1. Nakatsuka T, Harii K, Asato H, et al. Analytic review of 2372 free flap transfers for head and neck reconstruction following cancer resection. *J Reconstr Microsurg*. 2003; 19:363–368. [PubMed: 14515225]
2. Rinaldo A, Shaha AR, Wei WI, et al. Microvascular free flaps: a major advance in head and neck reconstruction. *Acta Otolaryngol*. 2002; 122:779–784. [PubMed: 12484656]
3. Kakarala K, Emerick KS, Lin DT, et al. Free flap reconstruction in 1999 and 2009: changing case characteristics and outcomes. *Laryngoscope*. 2012; 122:2160–2163. [PubMed: 22674647]
4. Pohlenz P, Klatt J, Schon G, et al. Microvascular free flaps in head and neck surgery: complications and outcome of 1000 flaps. *Int J Oral Maxillofac Surg*. 2012; 41:739–743. [PubMed: 22424757]
5. Genden EM, Rinaldo A, Suarez C, et al. Complications of free flap transfers for head and neck reconstruction following cancer resection. *Oral Oncol*. 2004; 40:979–984. [PubMed: 15509488]
6. Zhang T, Lubek J, Salama A, et al. Venous anastomoses using microvascular coupler in free flap head and neck reconstruction. *J Oral Maxillofac Surg*. 2012; 70:992–996. [PubMed: 21741742]
7. Nakayama K, Tamiya T, Yamamoto K, et al. A simple new apparatus for small vessel anastomosis (free autograft of the sigmoid included). *Surgery*. 1962; 52:918–931. [PubMed: 13937508]
8. Yap LH, Constantinides J, Butler CE. Venous thrombosis in coupled versus sutured microvascular anastomoses. *Ann Plast Surg*. 2006; 57:666–669. [PubMed: 17122555]
9. DeLacure MD, Kuriakose MA, Spies AL. Clinical experience in end-to-side venous anastomoses with a microvascular anastomotic coupling device in head and neck reconstruction. *Arch Otolaryngol Head Neck Surg*. 1999; 125:869–872. [PubMed: 10448733]

10. Jandali S, Wu LC, Vega SJ, Kovach SJ, Serletti JM. 1000 consecutive venous anastomoses using the microvascular anastomotic coupler in breast reconstruction. *Plast Reconstr Surg.* 2010; 125:792–798. [PubMed: 20195107]
11. Alan Turner MJ, Smith WP. Double venous anastomosis for the radial artery forearm flap. Improving success and minimising morbidity. *J Craniomaxillofac Surg.* 2009; 37:253–257. [PubMed: 19144528]
12. Chernichenko N, Ross DA, Shin J, Chow JY, Sasaki CT, Ariyan S. Arterial coupling for microvascular free tissue transfer. *Otolaryngol Head Neck Surg.* 2008; 138:614–618. [PubMed: 18439467]
13. Futran ND, Stack BC Jr. Single versus dual venous drainage of the radial forearm free flap. *Am J Otolaryngol.* 1996; 17:112–117. [PubMed: 8820186]
14. Ichinose A, Terashi H, Nakahara M, et al. Do multiple venous anastomoses reduce risk of thrombosis in free-flap transfer? Efficacy of dual anastomoses of separate venous systems. *Ann Plast Surg.* 2004; 52:61–63. [PubMed: 14676701]
15. Ropke E, Berghaus A, Bloching M. The ring-pin anastomosis technique. Long-term clinical experiences with the mechanical ring-pin system for microvascular anastomoses in reconstructive head and neck surgery [in German]. *HNO.* 2004; 52:121–124. [PubMed: 14968313]
16. Ross DA, Chow JY, Shin J, et al. Arterial coupling for microvascular free tissue transfer in head and neck reconstruction. *Arch Otolaryngol.* 2005; 131:891–895.
17. DeLacure MD, Wong RS, Markowitz BL, et al. Clinical experience with a microvascular anastomotic device in head and neck reconstruction. *Am J Surg.* 1995; 170:521–523. [PubMed: 7485747]
18. Ahn CY, Shaw WW, Berns S, et al. Clinical experience with the 3M microvascular coupling anastomotic device in 100 free-tissue transfers. *Plast Reconstr Surg.* 1994; 93:1481–1484. [PubMed: 8208815]
19. DeLacure MD, Wong RS, Markowitz BL, et al. Clinical experience with a microvascular anastomotic device in head and neck reconstruction. *Am J Surg.* 1995; 170:521–523. [PubMed: 7485747]
20. Ostrup LT, Berggren A. The UNILINK instrument system for fast and safe microvascular anastomosis. *Ann Plast Surg.* 1986; 17:521–525. [PubMed: 3827122]

Table 1Characteristics of microvascular free flap reconstructions.^a

	% (n)
Total	100 (234)
Venous coupler size, mm	
1.5	1 (3)
2.0	3(8)
2.5	11 (30)
3.0	53 (140)
3.5	23 (59)
4.0	8(21)
Recipient vein ^b	
Anterior jugular	1.5(4)
External jugular	17 (44)
Internal jugular	76 (198)
Facial	5(13)
Temporal	0.7 (2)
Recipient artery	
Facial	58 (135)
Lingual	13 (56)
Stump off external carotid	22 (52)
Superior thyroid	6(15)
Inferior thyroid	1 (3)
Temporal	1 (2)
Transverse cervical	1 (2)
Occipital	3 (7)
Ascending pharyngeal	1 (2)
Other	0.4(1)

^aReconstruction of 1 patient required 2 free tissue transfers.^bSome revascularizations required more than 1 anastomosis (n = 26).