HAYDARPAŞA NUMUNE MEDICAL JOURNAL

DOI: 10.14744/hnhj.2019.26214
Haydarpasa Numune Med J 2021;61(4):382–386

hnhtipdergisi.com

ORIGINAL ARTICLE

The Practical Value of Microvascular Anastomosis Techniques

Ayşe İrem İskenderoğlu,[1] Ali Haydar İskenderoğlu,[2] İbrahim Ethem Ökçesiz,[3] Nimet Emel Lüleci[4]

[1]Department of Plastic Surgery, University of Health Sciences, Hamidiye Faculty of Medicine, Haydarpaşa Numune Health Application and Research Center, Istanbul, Turkey
[2]Department of Plastic Surgery, Eren Hospital, Istanbul, Turkey
[3]Department of Microsurgery, Delta Hospital, Istanbul, Turkey
[4]Department of Internal Medicine, Marmara University Faculty od Medicine, Gastroenterology Institute, Istanbul, Turkey

Abstract

Introduction: In surgical applications requiring vascular anastomosis, the success of the operation depends on the anastomosis stay open. In this case, the surgical technique that can be applied is of great importance. The fact that too many surgical techniques have been described in microvascular anastomoses shows that the search continues in this area. Our aim in this study was to examine the effectiveness of existing methods.

Methods: In this study, known methods of microvascular anastomosis were reviewed in chronological order.

Results: In our study, microvascular suture techniques used in end-to-end and end-to-side anastomoses since 1978 were examined and compared with conventional suture technique combined with interrupted eversion suture. Although the important point is that the surgeon knows which technique and applies that technique well, conventional suture combined with interrupted eversion suture was superior to other available techniques in our practice.

Discussion and Conclusion: Many microvascular suture techniques have been described and applied for microsurgical anastomoses, including both end-to-end and end-to-side anastomoses. Research has shown that regardless of the method, techniques which work in order and can provide anastomoses with good long-term results, are successful.

Keywords: Eversion suture; microvascular anastomosis; microvascular suture.

In surgical applications requiring vascular anastomosis, the success of the operation depends on the anastomosis stay open. In this case, the surgical technique that can be applied is of great importance. In particular, microvascular anastomosis techniques have a much more special sensitivity in this sense. It constitutes a very important step in very critical operations, from revascularization and replantations to free tissue transplants and organ transplants. The fact that too many surgical techniques have been described in microvascular anastomoses shows that the search continues in this area. Because problems such as spasm, thrombus, microembolism, reperfusion injury can easily develop. Therefore, the method to be applied must first be safe, simple and easily applicable, and must not cause intimal lesion. Finally, it should be easy to learn and easy to teach.

Materials and Methods

In this study, known methods for microvascular anastomoses were reviewed in chronological order. The advan-

Correspondence (İletişim): Ayşe İrem İskenderoğlu, M.D. Saglik Bilimleri Universitesi Hamidiye Tip Fakultesi, Haydarpasa Numune Saglik Uygulama ve Arastirma Merkezi, Plastik Cerrahi Klinigi, Istanbul, Turkey
Phone (Telefon): +90 530 876 09 34 **E-mail (E-posta):** iremmert@gmail.com
Submitted Date (Başvuru Tarihi): 26.02.2019 **Accepted Date (Kabul Tarihi):** 23.10.2019

tages and disadvantages of 24 techniques and articles published between 1978 and 2018 for end-to-end and end-to-side anastomoses were reviewed.

Results

Moscana et al.[1] reported the continuous suture use in microvascular anastomosis in 1978, Little et al.[2] reported microvascular anastomosis with continuous suture in 1978, and Colen et al.[3] reported the relationship between the number of sutures and the strength of the anastomosis in 1979. Harashina et al.[4] in 1980 provided diameter match by widening the narrow vessel mouth in the shape of a fish mouth, in the case of diameter mismatch in microvascular anastomoses. Harris et al.[5] applied autogenic graft around the anastomosis in the posterior wall technique with four sutures in 1981. Firsching et al.[6] suggested the combination of continuous and interrupted sutures in end-to-end microvascular anastomoses in 1984. Hung et al.[7] experimentally observed the wrapping of arterial sheath and fat tissue in microvascular anastomoses in 1988, and used only 4 sutures. Robbins et al.[8] applied the vessel sleeve technique in microvascular anastomoses in 1991. Schlechter et al.[9] compared different microvascular techniques in 1994. In 1994 and 1996, Ökçesiz combined interrupted eversion sutures and conventional sutures in microvascular anastomoses.He also applied this method with continuous sutures (However, applying it as individual sutures allows better adaptation of the vessel ends at the anastomosis site and prevents stenosis). It has been successfully applied in end-to-end anastomoses, as well as in end-to-end anastomoses[10,11].

In this technique, the first suture is usually the eversion suture and placed close to the posterior wall (on the right side if the right hand is used). The second eversion suture is placed in the middle of the anterior wall, thus avoiding the danger of inversion of the intima in this space. That is, the subendothelial tissue cannot be exposed into the lumen and now the part between these two sutures is sutured very securely with conventional sutures. The third eversion suture is placed on the other side of the posterior wall. Two gaps are formed in this suture, where inversion of the intima is prevented, and these gaps are sutured seperately with conventional sutures. In this way, it is ensured that the gaps between the eversion sutures are sutured very securely with conventional sutures. The number of sutures varies according to vessel width, it is important to apply the least possible number of sutures. This is necessary for minimal vessel trauma and adaptation.

Interrupted eversion sutures are placed in a number of 1-2 if the vessel diameter is less than 1 mm, of 3 if the vessel diameter is 1 mm, and of 3-4 if the vessel diameter is more than 1 mm. The width of the "u" suture used here should not be wider than the thickness of the artery wall so that there is no narrowing at the anastomosis site. In case of diameter mismatch, the narrow mouth is cut vertically from the anterior wall after the first eversion suture is placed. The second eversion suture is placed at the bottom of this incision. The third eversion suture is placed on the other side of the posterior wall. Gaps are sutured with conventional sutures (Fig. 1).

The conventional suture application combined with the interrupted eversion suture, as stated by Ökçesiz, was made to make the conventional suture technique, which is actually the fastest and easiest microvascular anastomosis technique, safe, and was applied using the least possible number of eversion sutures according to the vessel width. The eversion suture mentioned is a horizontal mattress suture for eversion (i.e. "U" suture).

Bowen et al. in 1996[12] performed sleeve anastomosis with only 2 sutures and used fibrin glue together. Together with all auxiliary agents and methods, they achieved high success, as a common feature in the studies.

Tellioglu et al. in 1997[13] modified the end-to-side anastomosis by adding 2 lateral incisions in their experimental study.

Yildirim et al. in 1998[14] performed z-plasty in end-to-end microvascular anastomoses. They claimed that by this way, they increased the lumen diameter and prevented vasospasm by disrupting the circular musculature. However, in this technique, the anastomosis time was prolonged and more sutures were required, and the intimal lesion increased.

Turan et al. in 2001[15] used 2 classical interrupted and 2 horizontal mattress sutures that everted vessels with fish mouth incision in end-to-end anastomoses. In this way, they reduced the anastomosis time by half. They also reported that less foreign body reaction developed in the vessel lumen because they used less sutures. The possi-

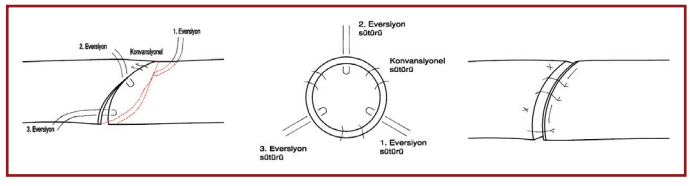

Figure 1. Conventional suture technique combined with interrupted eversion suture (schematic illustration).

ble disadvantages of this method are the longer pedicle requirement, narrowing of the vessel lumen, diameter change and prolonged bleeding time and hemodynamic turbulence. It is also unclear whether the horizontal mattress suture is intended for inversion or eversion.

Tetik et al.[16] used continuous horizontal mattress suture for microvascular anastomoses in their experimental study in 2005. Şimşek et al.[17] performed microvascular anastomosis with a continuous horizontal mattress suture in the rat carotid artery in their experimental study in 2006. Orak et al.[18] reported a new microvascular anastomosis method in 2006. They applied 3 incisions at 120 degrees intervals to the vessel ends and made 3 eversions with a total of 3 horizontal mattress sutures. Although this technique has the same disadvantages and advantages as the technique of Turan et al., they stated that it is difficult to make 3 equally spaced incisions on the vessel wall. They also stated that it causes higher intimal and medial damage compared to the classical technique. Şen et al.[19] reported in 2006 that they achieved a simple and safe application with the 'diamond' technique in end-to-side microvascular anastomoses. Aygün et al.[20] suggested the use of vascular vertical mattress sutures in 2008. Inversion of the intima cannot be reliably prevented with this method. Akan et al.[21] defined the technique they named 'open Y' in 2009 as a method that can be used for diameter mismatch in end-to-end anastomoses. In this technique, the bifurcation region of the pedicle is incised horizontally. Diameter mismatch is overcome by obtaining a single large lumen.

Alghoul et al.[22] reviewed anastomoses performed with different suture techniques, from interrupted single sutures to complex spiral sutures in microvascular anastomoses. Odobescu et al.[23] described the application of horizontal mattress suture in vessels with diameter mismatch in 2015. In 2018, Ooi et al.[24] reported the application of geometric three-dimensional end-to-side microvascular anastomosis (Table 1).

Discussion

Except for the conventional suture application combined with interrupted eversion suture[10,11] all of the later methods outlined in the article are different modifications of this idea. As a result, in techniques other than the interrupted eversion method, vessel length would be wasted in critical areas. As a result, it may be necessary to use a vein graft. In addition, these additional modified methods can never be applied in vessels with a diameter of 0.5 mm and less. In addition, incisions made on the vessel cause additional intimal lesions within the vessel. These additional intimal lesions also cause thrombus. Another disadvantage of these methods is that the anastomosis site which is expanded by the use of flaps or z-plasty, etc., causes thrombus with turbulence caused by disrupting the fluid dynamics. All of the modified methods described are very time consuming techniques.

When evaluating microvascular anastomosis techniques, it was always examined whether the anastomosis site remained open. In other words, thrombus formation and spasm development were seen as the main problems. Although great care is taken with anticoagulant, antiplatelet drugs and antispasmodic measures for this problem, despite the open anastomosis provided with this precision both during and after the operation, the lack of circulation in the periphery is generally attributed to reperfusion injury, and the possibility of early rejection in organ transplants can often be considered. This results in premature tissue or organ loss. However, in both microvascular anastomoses and wider vascular anastomoses, there is an issue that is easily overlooked and not emphasized even by the most experienced hands, which is the exposure of subendothelial tissue into the lumen. The basic philosophy of the eversion suture is to provide eversion of this subendothelial tissue and to prevent any exposition of this tissue into the lumen.[25] In this way, platelets are prevented from being activated by striking the subendothelial tissue. Therefore, the "platelet-endothelium interaction" of activated platelets in the periphery is also prevented. This i salso the situation in the leukocyte-endothelium interaction in reperfusion injury. And unfortunately, it is an important overlooked cause of the "no flow" phenomenon in clinical practice.[10,12]

Conclusion

Many microvascular suture techniques have been described and applied for microsurgical anastomoses, both end-to-end and end-to-side anastomoses. Research has shown that whatever method is used, techniques that are in working order and can provide anastomoses with good long-term results are successful. All techniques have their advantages and disadvantages when the studies were examined. The important thing is that although the surgeon knows which technique and applies that technique well, conventional suture combined with interrupted eversion suture is superior to other available techniques in our prac-

Table 1. Summary table of reviewed microsurgical technique studies

Researcher	Date	Study
Moscana et al.	1978	The use of continuous sutures in microsurgery has been described.
Little et al.	1978	Microvascular anastomosis with continuous suture has been described.
Colen et al.	1979	The relationship between the number of sutures and the strength of the anastomosis has been investigated.
Harashina et al.	1980	In microvascular anastomosis, they eliminated the diameter mismatch between the 2 vessels by making a fish-mouth incision on the vessel wall.
Harris et al.	1981	Posterior wall technique with 4 sutures: After suturing, an autogenous cuff was applied around the anastomosis line. They reported that they obtained working anastomoses in a shorter time.
Firsching et al.	1984	They applied a combination of continuous and interrupted sutures.
Hung et al.	1988	They applied both artery cuff and fat wrap around the microvascular anastomosis and used only 4 sutures.
Robbins et al.	1991	Sleeve technique for microvascular anastomosis: They used only a few sutures, wrapping a vascular cuff around the anastomosis.
Schlechter et al.	1994	Microvascular suture techniques have been compared.
Ökçesiz et al.	1994-1996	Combination of intermittent eversion suture and conventional suture: The least possible number of eversion sutures were applied and conventional sutures in between, according to the vessel width.
Bowen et al.	1996	They applied sleeve anastomosis using only 2 sutures and used fibrin glue together.
Tellioğlu et al.	1997	They modified the end-to-side anastomosis by adding 2 lateral incisions.
Yıldırım et al.	1998	They applied the z-plasty technique in end-to-end microvascular anastomoses. In this way, they suggested that they increase the lumen diameter and prevent vasospasm by disrupting the circular muscle structure.
Turan et al.	2001	In end-to-end anastomosis, fish-mouth incision and eversion were applied; they used 2 classically interrupted and 2 horizontal mattress sutures.
Tetik et al.	2005	They experimentally used continuous horizontal mattress sutures in microvascular anastomoses.
Şimşek et al.	2006	They performed microvascular anastomosis in the rat carotid artery with a continuous horizontal mattress suture.
Orak et al.	2006	They applied eversion with a total of 3 horizontal mattress sutures by making 3 incisions at 120-degree intervals on the vessel ends that would be anastomosed.
Şen et al.	2006	The 'diamond' technique in end-to-side microvascular anastomosis: They performed an arteriotomy in the recipient vessel and made a perpendicular incision of the same length to the vessel wall in the pedicle vessel, adapting both vessels to each other with interrupted sutures.
Aygün et al.	2008	Vertical mattress suture technique: They suggested that it reduces intimal damage and foreign body reaction by everting the vessel wall like the horizontal mattress suture technique.
Akan et al.	2009	Open-Y technique in end-to-end anastomosis: They eliminated the diameter mismatch between the vessels by horizontally incising the bifurcation region of the pedicle and obtaining a single large lumen.
Alghoul et al.	2011	Comparison of microvascular suture techniques: 6 basic microvascular suture techniques have been mentioned [Continous suture, interrupted (conventional) suture, locked continuous suture, continuous horizontal mattress suture, horizontal mattress suture with interrupted eversion and sleeve anastomosis suture]
Odobescu et al.	2015	For vessels with diameter mismatch, horizontal mattress sutures have been used to pass longer than vessels with larger diameters.
Ooi et al.	2018	Geometric three-dimensional end-to-side microvascular anastomosis: They elevated a triangular flap in the recipient vessel and made an incision in the equidistant pedicle. Elevated flap and recipient vessel were adapted to pedicle vessel with interrupted sutures.

tice. As a matter of fact, in the years after the presentation of this method, a significant increase was observed in the number of surgeons dealing with microvascular surgery at national microsurgery meetings. In addition, it can be investigated from the literature that the success in small vessel organ transplantations has increased and the early complications have decreased after this date.

Peer-review: Externally peer-reviewed.

Authorship Contributions: Concept: A.I.I., I.E.O., A.H.I.; Design: A.I.I., I.E.O.; Data Collection or Processing: A.I.I., A.H.I., I.E.O.; Analysis or Interpretation: A.I.I., I.E.O.

Conflict of Interest: None declared.

Financial Disclosure: The authors declared that this study received no financial support.

References

1. Moscona AR, Owen ER. Continuous anastomotic technique in microsurgery. Isr J Med Sci 1978;14:979–83.
2. Little JR, Salerno TA. Continuous suturing for microvascular anastomosis. J Neurosurg. 1978;48:1042–5. [CrossRef]
3. Colen LB, Gonzales FP, Buncke HJ. The relationship between the number of sutures and the strength of microvascular anastomoses. Plast Reconstr Surg 1979;64:325–9. [CrossRef]
4. Harashina T, Irigaray A. Expansion of smaller vessel diameter by fish mouth incision in microvascular anastomosis with marked discrepancy. Plast Reconstr Surg. 1980;65:502–3. [CrossRef]
5. Harris GD, Finseth F, Buncke HJ. The vascular anastomotic autogeneos cuff. Br J Plast Surg 1981;34:50–2. [CrossRef]
6. Firsching R, Terhaag PD, Müller W, Frowein RA. Continuous and interrupted suture technique in microsurgical end-to-end anastomosis. Microsurgery 1984;5:80–4. [CrossRef]
7. Hung LK, Au KK, Ho YF. Comparative study of artery cuff and fat wrap in microvascular anstomosis in the rat. Br J Plast Surg 1988;41:278–83. [CrossRef]
8. Robbins TH. Microvascular anastomosis: vascular cuff technique. Plast Reconst Surg 1991;87:567–8. [CrossRef]
9. Schlechter B, Guyuron B. A comparison of different suture techniques for microvascular anastomosis. Ann Plast Surg 1994;33:28-31. [CrossRef]
10. Ökçesiz İE. Mikrovasküler anastomozlarda aralıklı eversiyon sütürü kullanımı. VII. Periferik damar cerrahisi kongresi özet kitabı. 15-18 Mayıs 1994;86.
11. Ökçesiz İE. Mikrovasküler anastomozlarda aralıklı eversiyon sütürü kullanımı.1996 Ulusal cerrahi kongresi program ve özet kitabı. 15-19 Mayıs 1996;68.
12. Bowen C, Leach D, Crosby N, et al. Microvascular anastomoses: a comparative study of fibrinogen adhesive and interrupted suture techniques. Plast Reconst Surg 1996;97:792–800. [CrossRef]
13. Tellioğlu T. End on side microvasculer anastomosis: an experimental study. Ann Plast Surg 1997;39:137–40. [CrossRef]
14. Yıldırım M, Güzel Z, Yücel A, Aygit AC. Z-plasty and microvasculer anastomosis. J Reconstr Microsurg 1998;14:117–20. [CrossRef]
15. Turan T, Özçelik D, Kuran İ, Sadikoğlu B, Baş L, San T, et al. Eversion with four sutures: an easy, fast and reliable technique for microvascular anastomosis. Plast Reconst Surg 2001;107:463–70. [CrossRef]
16. Tetik C, Ünal MB, Kocaoğlu B, Erol B. Use of continuous horizontal mattress suture techniques in microsurgery: an experimental study in rats. J Hand Surg 2005;30:587–95. [CrossRef]
17. Simsek T, Eroğlu L, Engin MS, Kaplan S, Yıldız L. End-to-end microvascular anastomosis in the rat carotid artery using continuous horizontal mattress sutures. J Reconstr Microsurg 2006;22:631–40. [CrossRef]
18. Orak İ, Güneren E, Yıldız L. A new technique for microvascular anastomosis: eversion with 3 horizontal matress sutures. Ann Plast Surg 2006;57:80–3. [CrossRef]
19. Şen C, Ağır H, İşcen D. Simple and reliable procedure for end-to-side microvascular anastomosis: the diamond technique. Microsurgery 2006;26:160–4. [CrossRef]
20. Aygün H, Yıldırım ÖS. Vertical mattress suture technique: an alternative vascular anastomosis. J Reconstr Microsurg 2008;24:397–404. [CrossRef]
21. Akan M, Çakır B, Gideroğlu K, Aköz T, Kavurmacıoğlu L. End-to-side anastomosis with open-y technique on small vessels to increase patency and facilitate anastomosis. J Craniofac Surg 2009;20:2226–9. [CrossRef]
22. Alghoul MS, Gordon CR, Yetman R, Buncke GM, Siemionow M, Afifi AM, et al. From simple interrupted to complex spiral: a systematic review of various suture techniques for microvascular anastomoses. Microsurgery 2011;31:72–80. [CrossRef]
23. Odobescu A, Moubayed SP, Daniels E, Danino MA. Horizontal mattress technique for anastomosis of size mismatched vessels. Plast Surg 2015;23:100–2. [CrossRef]
24. Ooi ASH, Butz DR, Fisher SM, Collier ZJ, Gottlieb LJ. Geometric three-dimensional end-to-side microvascular anastomosis: a simple and reproducible technique. J Reconstr Microsurg 2018;34:258–63. [CrossRef]
25. Ökçesiz İ, İskenderoğlu AH, Kuran B. Elde ampüte başparmağın ayak parmağından hazırlanan 'wrap around free flep' ile rekonstrüksiyonu. Haydarpaşa Numune Med J 1993;33:223–6.