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End-To-End Anastomosis with Vessel Discrepancy: Review of the Literature

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Abstract

Reconstructive Microsurgery is used commonly for the coverage of large defects and for revascularization or reimplantation procedures. The donor and recipient vessels rarely match exactly. Usually, the microsurgeon has to overcome some grade of vessel discrepancy. We performed a literature search and review of the different techniques for end-to-end anastomosis of unequal diameter vessels.

Keywords: Microsurgery; Free flaps; Vessel discrepancy

Introduction

Microsurgical reconstruction is used often nowadays, especially for coverage of large and composite defects. However, it is not uncommon that the microsurgeon encounters vessel size discrepancy intraoperatively. To overcome this hindrance, one can perform end-to-side anastomosis, or end-to-end anastomosis using techniques to diminish the lumen of the larger vessel or enlarge the lumen of the smaller vessel. Considering that end-to-end anastomosis is preferred compared to end-to-side anastomosis due to its relative simplicity, we performed a literature search and review of the different techniques for end to end anastomosis of unequal diameter vessels.

Materials and Methods

The search of the literature was performed using PubMed database with limits: English Language and Human species. The key-words used were: "vessel discrepancy" and "end-to-end anastomosis". Only papers referring to reconstructive microsurgery were reviewed. Moreover, studies discussing the use of grafts were not included. Consequently, the papers were examined and their references checked for any additional techniques in vessel size discrepancy in end-to-end anastomosis. The technique, ratio of vessel size discrepancy, total number of anastomosis, number of artery and vein anastomosis, success rate and cases of reconstruction were documented.

Results

The initial search retrieved 18 papers. Of these, 5 were excluded due to the fact that they referred to end-to-side anastomosis, 2 papers were excluded as they referred to grafts and 5 papers described non-plastic surgery procedures. The references of the remaining 6 papers revealed 8 more papers concerning techniques in end-to-end anastomosis of vessels with size discrepancy. One technique described use in vessel size discrepancy up to 5:1, 2 papers for discrepancy up to 4:1, one technique was utilized for vessel discrepancy up to 3.5:1, 2 methods were used for vessel discrepancy up to 3:1, one technique for discrepancy up to 2.5:1, and one for discrepancy up to 2:1 [1-8]. Two papers referred to minimal differences in vessel size discrepancy and 5 papers provided no information regarding vessel size discrepancy [9-15]. Ten papers referred to arterial or venous anastomosis, 1 to arterial anastomosis, 2 to venous anastomosis and 2 provided no information regarding arterial or venous [1-15]. Cases of reconstruction referred to Breast, Head and Neck, Trunk, Upper limb, Lower limb, Head and Neck, Facial palsy and Testis autotransplantation. The results are summarized in Table 1.

Discussion

Reconstructive microsurgery has expanded throughout the years to include procedures to cover large defects where noble structures are exposed post trauma or extirpation of tumor procedures and function when a reinnervated muscle is transferred. Moreover, it is used in revascularization or reimplantation procedures of amputated body parts. Microvascular anastomosis rarely entails vessels of matching diameters. Usually, there is a discrepancy ranging from small (1:1.5) to major

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Table 1: Different techniques to overcome vessel size discrepancy in end-to-end anastomosis.

Author	Technique	Vessel size discrepancy	No of anastomosis	No of artery anastomosis	No of vein anastomosis	No of thrombosed anastomosis	Cases of reconstruction
H. Ridha [1]	Spatulated end-to end	Up to 5:1	24	22	2	1 vein	Breast Head and Neck
Fossati et al. [5]	Kunlin's technique	Up to 3:1	3	2	1	0	Head and Neck Lower limb Upper limb
Ueda et al. [7]	Distal tapering technique	Up to 2.5:1	2	2	0	0	Upper limb Head and Neck
F. de Lorenzi et al. [8]	Matress anastomosis	Up to 2:1	285	154	131	8	Head and Neck Breast Lower limb Testis auto transplantation
Akan et al. [11]	Open Y technique	No information	10	7	3	0	Head and Neck Breast Upper Limb Lower Limb
Sullivan et al. [4]	Venous coupler	Up to 3.5:1	49	0	49	1 venous congestion that was due to twisting	Breast
Boeckx et al. [6]	Y anastomoses	Up to 3:1	58	1	57	3 vein	Head and Neck Breast Lower limb Testis auto transplantation
Özkan et al. [12]	Open guide suture technique	No information	103	37	56	0	Hand Other
Bakhach et al. [2]	V-plasty	Up to 4:1	14	4	10	0	Upper limb Lower limb
Suri M et al. [13]	Clip to anastomosis	No information	10	0	10	0	Head and Neck
Xiu et al. [14]	Unequal bite anastomosis	No information	No information	No information	No information	No information	No information
Harashina et al. [15]	Fish mouth incision	No information	No information	No information	No information	No information	No information
De la Pena-Salcedo et al. [13]	Sleeve anastomosis	Up to 4:1	34	28	6	0 (1 artery revision and 1 vein revision)	Head and Neck
Ahn et al. [9]	Coupler	Minimal differences	123	24	97	2 vein	Breast Head and Neck Facial Palsy Trunk Upper limb Lower limb
De Bruijin et al. [10]	Coupler	Minimal differences	91	2	85	2 vein thrombosis (one due to vessel size discrepancy and one due to	Head Neck Upper Limb Lower Limb Breast

(1:4 or greater) [2]. A small size discrepancy can be adjusted with the classic interrupted sutures technique and by dilating the smaller diameter vessel lumen [2]. However, greater discrepancies cannot be addressed with these classic maneuvers and several techniques have been described to match the different size vessels.

Vessel discrepancies between 1:1.5 and 1:3.5

F de Lorenzi et al. [7] described the mattress anastomosis for discrepancies up to 2:1 [8]. The posterior wall is repaired first with 3 interrupted stitches and consequently, the anterior wall is repaired taking horizontal mattress bites in the larger vessel wall and vertical mattress bites on the smaller vessel wall. They had 8 thrombosed anastomosis in a total of 285 (2.8%). Ueda et al. described the distal tapering technique for vessel size discrepancies up to 2.5:1 [7]. They excised a wedge shape of the surplus vessel wall so that the size can match the smaller diameter vessel. For vessel size discrepancies up to 3:1 Fossati et al. used the Kunlin's technique [5,16]. They performed a longitudinal incision at the smaller vessel forming a kind of "spatula". Then, the "spatulated" vessel was joined with the vessel of the greater diameter. They reported zero thrombosed anastomosis in a total of 3 (0%). Boeckx et al. described the Y anastomosis for vessel size discrepancies up to 3:1 [6]. They joined two smaller vessels to a larger one. Mostly, they used the technique for veins, joining the two smaller veins of a pedicle to a larger recipient vein. They reported 3 failures (all venous anastomoses) for a total of 58 anastomoses (1.74%). Sullivan et al. described the use of venous coupler for vessel size discrepancy up to 1:3.5 [4]. They used it in 49 venous anastomoses and reported only one venous congestion due to twisting. However, the use of venous coupler in other studies has been reported only for minimal differences [9,10]. The coupler is selected according to the diameter of the smaller vessel; therefore, if there is great vessel size discrepancy the larger vessel lumen may wrinkle inside the coupler and predispose to thrombosis.

Major vessel discrepancies greater than 1:3.5

Bakhach et al. described the V-plasty for lumen discrepancies up to 4:1 [2]. They created a V flap on the wall of the large vessel and a longitudinal incision on the small one. They used a mathematical algorithm to calculate the dimensions of the V flap in order to achieve a smooth transition between the two vessels and a linear axis. They used this method in 14 anastomoses (4 arterial and 10 venous) and reported good results with 0% thrombosis rate. However, we think

that this is a complicated method to address vessel size discrepancy. De la Pena-Salcedo et al. used the sleeve technique in 34 anastomoses (28 arterial and 6 venous) and reported 1 arterial and 1 venous revision but no thrombosis. The lumen ratio was up to 1:4 [3]. Ridha et al. performed the spatulated end-to-end anastomosis for vessel size discrepancies up to 5:1. They incised the end of the smaller diameter vessel longitudinally in order to increase the circumference to match the opposing vessel. They performed the technique in 2 venous anastomoses and 22 arterial anastomoses and reported one venous thrombosis [1]. There are also techniques described for vessel size discrepancies that do not provide information regarding size discrepancy. Harashina et al. described the fish mouth incisions at the smaller diameter vessel. They performed two longitudinal incisions at 180° apart in the smaller vessel. Then, they anastomosed the two vessels using standard interrupted stitches. They did not provide information about the number of anastomosis, thrombosis and discrepancy ratio [15]. Xiu et al. has used the "unequal bite anastomosis". They put the stitches on the larger vessel wall at a point slightly more than twice the thickness of its wall from the stump end and passed through the smaller vessel wall at a point slightly narrower than twice the thickness of its wall from the stump end. When the stitches were tied, the smaller vessel was entubulated into the lumen of the larger one. The information about maximum vessel size discrepancy they used the technique is unclear, however they mention that in discrepancies 1:3, 6 stitches are needed, whilst in discrepancies 1:4, 9 stitches are needed. They did not provide information about the total number of anastomoses and thrombosis ration [14]. Akan et al used the open Y technique. When they came across size discrepancy during a microsurgical operation they found a bifurcation on the smaller vessel, inserted a micro scissors to one of the legs of the bifurcation and brought it out from the other leg, and the vessel wall in between was cut. Thus, they enlarged the diameter of the smaller vessel. They performed this technique in ten anastomoses and mention 0% thrombosis rate [11]. Ozkan et al. used the open guide suture technique. After the first knot they placed a guide suture at 180° and left it untied. Then, they placed the rest of sutures halving the interval spaces each time and leaving the sutures untied. At the end they completed all the knots. They performed this technique in 103 anastomosis and reported a 0% failure rate [12]. Finally, Suri et al. reported using a Ligaclip to diminish the diameter of the larger vessel. After placing the first stitch, they put the second at 180° trying to correct the discrepancy as much as possible. The rest of sutures are placed on the smaller diameter vessel to perform the anastomosis of the smaller vessel to one side of the larger vessel. Then, the clip is placed at the larger vessel in an oblique manner toward the 180° stitch to obliterate the remaining gap. They used the method in severe vessel discrepancies in 10 venous anastomoses and reported 0% thrombosis rate. We have also used it in discrepancies up to 1:4 and found it simple and effective [13]. The conventional technique with 9 interrupted sutures is still the gold standard of microvascular anastomosis [17,18]. However, it is useful for the microsurgeon to have additional methods in his armamentarium to overcome vessel size discrepancy. Among the several techniques described above one can choose the method that works better in their hands.

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