Brachial Artery–Brachial Vein Fistula for Hemodialysis: One- or Two-Stage Procedure—A Review

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Abstract

Purpose The purpose of the study was to investigate the patency rate of the brachial vein transposition–arteriovenous fistula [BVT–AVF] and to review the available literature regarding the comparison of the one-stage with the two-stage procedure.

Methods A multiple electronic health database search was performed, aiming to identify studies on brachial vein superficialization. Case reports and series with five or less patients were excluded from the study. End points of the study were the patency rates at 12, 24, and 36 months of follow-up. The patency of the one- or two-stage BVT–AVF procedure was investigated.

Results Overall, 380 BVT–AVFs were analyzed. The primary patency rate at 12 months ranged between 24 and 77%. Rate of early fistula malfunction or failure of maturation of the fistula resulting in loss of functionality ranged from 0 to 53%. Forearm edema, hematomas, wound infection, and early thrombosis were among the most common complications. Limited data were available for the comparison of patency rates between the one- and the two-stage procedure because of the absence of sufficient comparative studies. However, series with one-stage procedure presented a lower patency rate at 12 months compared to series with two stages.

Conclusion Patency rates after BVT–AVF, although not excellent, has encouraging results taking into account that patients undergoing these procedures do not have an accessible superficial vein network; failure of maturation and the increased rate of early postoperative complications remain a concern. The BVT–AVF is a valuable option for creating an autologous vascular access in patients lacking adequate superficial veins.

Keywords

- brachial vein
- transposition
- chronic renal failure
- arteriovenous fistula
- one-/two-stage procedure
- grafts

Arteriovenous fistulas (AVFs) consist of the preferable choice for patients needing hemodialysis. They have lower morbidity, mortality rates, and cost compared with grafts or catheters. Brachial vein transposition BVT–AVF is an alternative native option for creating an AVF. Brachial vein superficialization was first reported by Paul G. Koontz and Thomas S. Helling in 1983.¹ The method was conceived for patients with chronic

renal failure (CRF) lacking adequate superficial veins for fistulas, mostly for individuals who have already undergone a large number of access operations. Brachial vein transposition AVF can be performed as one- or two-stage procedure; both methods have advantages and disadvantages.

We collected and reviewed all published data concerning transposition and superficialization of the brachial vein as an

alternative choice for creating an autologous AVF in patients with difficult upper extremity access. The purpose of the study was to investigate the patency rate of the BVT–AVF and to review the available literature regarding the comparison of the one- with the two-stage procedure.

Materials and Methods

A multiple electronic health database search was performed that included Medline, Embase, Ovid, Google, aiming to identify studies on brachial vein superficialization. Case reports and series with five or less patients were excluded from the study. Abstracts in languages other than English were eliminated from the analysis. In cases of duplicated or meta-chronous publications from the same center, the later article was included. End points of the study were the patency rates at 12, 24, and 36 months of follow-up. The patency with the one- or two-stage BVT–AVF procedure was also investigated.

Brief Description of the Technique

One-stage operation: The brachial fascia is excised on its entire length and one of the two brachial veins is carefully dissected cranially and prepared by dividing all tributaries. Having dissected the vein and mobilized on its entire length a brachio-brachial arteriovenous anastomosis is being performed. Generally, the one-stage procedure is performed in patients, whose brachial vein diameter is above 6 mm and has a blood flow > 300 mL/min.² A period of 4 to 6 weeks is needed for the primary BVT–AVF to mature and be ready for hemodialysis.

Two-stage operation: Normally, a period of 4 to 6 weeks after the side-to-side or the side-to-end anastomosis between the brachial vein and the brachial artery is needed in order for the segment of brachial vein to be dilated enough for use. After this, the dissection of the brachial vein with tributaries' division (►Fig. 1) along with the transposition follows (►Fig. 2); an extra period of 4– to 6 weeks is necessary

Fig. 1 After a period of 4 to 6 weeks of the side-to-side or the side-to-end anastomosis between the brachial vein and the brachial artery the dilated brachial vein is dissected and the tributaries are divided.

Fig. 2 The matured brachial vein is superficialized in a pocket created to the subcutaneous tissue.

for the fistula to be mature and useful for hemodialysis. An ultrasound examination may be used for the regular evaluation of the fistulas.

Definition of Patency

Primary patency is defined as exempt from restenosis of the target lesion during follow-up. Primary-assisted patency is defined as patency of the target lesion following reintervention at the target vessel site in case of stenosis. Secondary patency refers to patency of the target vessel after treatment of an occlusion of the index lesion. An access is defined as “functional” when it is able to deliver a flow rate of 350 to 400 mL/min without access recirculation to maintain a treatment time less than 4 hours in accordance with SVS reporting standards.³

Results

Twelve articles were identified and fulfilled the inclusion criteria.^{2,4–14} According to our analysis, results presented a great fluctuation in heterogeneity and patency rates. Overall, 380 BVT–AVF were performed. Not all articles included data for the primary and secondary patency and also the minority of articles determined the functional patency of the AVF. The primary patency rate at 12 months ranged between 24 and 76.8%, whereas the secondary patency rate ranged between 45 and 95.5%. The functional patency at 12 months varied between 40 and 95%. In the two studies with the longer follow-up, the functional patency rate at 36 months was 66 and 82%, respectively. The patency rate at 12, 24, and 36 months are described in ►Table 1.

Available data for the stages of the procedure were not described in all the studies (78 one-stage procedure and 165 staged). Descriptive data for patency after one-stage or staged procedures were included in studies by Jennings et al and Torina et al. However, the study by Torina et al¹⁰ was underpowered to detect differences between the two groups because of the small number of patients treated with staged procedure. In the study by Jennings et al,² 58 BVT–AVFs were completed, 45 of which were done as two-stage procedures and 13 were primary transpositions. With regard to the patency rates, there were no significant differences between primary and staged procedures. Interestingly, the series with the lower patency rates at

Table 1 Cumulative patency

Author/year of publication	No. of AVF	Primary/staged	Functional (%) ^a	Patency rates (%)											
				12 mo						24 mo					
				P	AP	S	F	P	F	S	AP	P	F	S	F
Angle and Chandra ⁴ 2005	20	0/20	100	–	–	–	95	–	–	–	–	–	–	–	–
Elwakeel et al ⁵ 2007	21	0/21	66.6	–	75.9	–	–	–	–	–	55.3	–	–	–	–
Srinivasiah et al ⁶ 2007	20	–	90	60	–	–	–	–	–	–	–	–	–	–	–
Casey et al ⁷ 2008	17	17/0	47	–	–	–	40	–	–	–	–	–	–	–	–
Greenberg et al ⁸ 2008	42	0/42	90.5	42.8	47.6	47.6	47.3	11.9	19.0	19.0	19.0	4.7	21.0	11.9	2.6
Pantea et al ⁹ 2008	47	–	95.75	–	–	–	–	–	–	–	–	–	–	–	66
Torina et al ¹⁰ 2008	13	11/2	–	24	45	45	–	–	–	–	–	–	–	–	–
Jennings et al ² 2009	58	13/45	–	52	84.9	–	92.4	46.2	75.5	92.4	–	–	–	–	–
Lioupis et al ¹¹ 2009	17	0/17	65	35.3	46.3	–	47.5	–	–	–	–	–	–	–	–
Dorobantu et al ¹² 2010	49	0/49	79.6	–	–	82.1	–	–	–	–	–	–	–	–	82
Morale et al ¹³ 2011	48	37/11	–	–	–	–	62	–	–	–	–	–	–	–	–
Urayama ¹⁴ 2012	28	–	–	76.8	–	95.5	–	–	–	–	–	55.8	–	66.3	–

Abbreviations: –, not determined; AP, assisted primary; AVF, arteriovenous fistula; F, functional; P, primary; S, secondary.

^aFailure on maturation or early failure.

Table 2 Perioperative complications in the series of our analysis

Author	No. of AVF	Venous hypertension/forearm edema (%)	Hematoma/lymphorrhea/wound dehiscence (%)	Steal syndrome (%)	Wound infection (%)	Aneurysmatic dilatation (%)	Thrombosis (%)	Stenoses (vein or anastomosis) (%)
Angle and Chandra ⁴	20	5	–	–	–	–	–	–
Elwakeel et al ⁵	21	–	4.7	–	–	9.5	19	–
Srinivasaiah et al ⁶	20	–	–	5	–	–	10	–
Casey et al ⁷	17	5.8	11.7	17.6	11.7	–	–	–
Greenberg et al ⁸	42	2.3	–	2.3	–	–	9.5	–
Pantea et al ⁹	47	25.53	6.38	–	10.63	–	15.9	–
Torina et al ¹⁰	13	–	–	–	–	–	–	–
Jennings et al ²	58	3.5	3.5	1.75	0	0	–	–
Lioupis et al ¹¹	17	17.6	29.4	5.8	5.8	5.8	35.2	59
Dorobantu et al ¹²	49	43.6	–	–	–	–	–	–
Morale et al ¹³	48	–	–	–	–	–	12	–
Urayama ¹⁴	28	–	–	–	3.5	3.5	–	–

Abbreviations: –, not described or not mentioned in the text; AVF, arteriovenous fistula.

12 months were the series by Casey et al and Torina et al, 40 and 45%, respectively. In both studies, patients were treated with a single-stage procedure.

The incidence of early failure or failure of maturation of the fistula resulting in loss of functionality ranged between 0 and 53%. Forearm edema, hematomas, wound infection, and early thrombosis were among the most common complications (–Table 2).

Discussion

In this review article, we focused on a special category of patients who must undergo hemodialysis on a regular basis and have difficult access extremities because of the several previous access operations. We found a great heterogeneity in patency rates between the different studies. This may be the result of different inclusion criteria used in this cohort of patients and also of different follow-up strategies. In our analysis, the primary patency rate at 12 months ranged between 24 and 76.8%, whereas the secondary patency rate ranged between 45 and 95.5%. These data although nonexcellent seem not discouraging, taking in account that patients undergoing these procedures do not have an accessible superficial vein network for fistula creation due to repetitive former operations, vein punctures, or previous fistulas. As a consequence, these patients often have central venous stenosis that may result in venous hypertension, arm edema, and vascular access failure. In fact, venous hypertension and forearm edema were among the most common complications after BVT–AVF in our analysis, ranging between 2.3 and 43.6% and in some limited cases led to ligation of the fistula.^{8,12}

There is a controversy if the AVF should be performed in one- or two-staged procedures. Most studies dealing with this issue focus on the two-stage procedure, as it seems to have fewer complications and better patency rates, when it is compared with the one-stage procedure. In our review, series with the lower patency rates at 12 months were the series by Casey et al and Torina et al, 40 and 24%, respectively.^{7,10} In both studies, patients were treated with a one-stage procedure. A disadvantage of the one-stage procedure is that the smaller of the brachial veins, together with their frequently delicate and irregular structure, diameter, and the fixed anatomy make them susceptible to injury during transposition and this may result in postoperative bleeding, hematomas, stenosis, and thrombosis of the AVF.⁴ The arterialized vein in the second stage has a thickened wall, which makes the dissection easier.⁶ Also, an advantage of the two-stage procedure is that the surgeon in the second stage can check the fistula and examine it or even make an intervention, whenever a problem occurs. On the contrary, the two-stage procedure is time consuming compared with the primary one. This limitation is quite important for candidates in great need of an AVF to undergo hemodialysis.

Complications, such as arm swelling, venous hypertension, wound infection, wound dehiscence, hematomas, thrombosis, and steal syndrome were noticed in a great variety of patients undergoing BVT–AVF. Pantea et al⁹ reported complications that lead to 34% loss of the vascular

access while Torina et al¹⁰ reported an overall 77% complication rate. Dorobantu et al¹² reported that during the 1-month maturation period, the fistula occluded in 9 of 49 patients, while Lioupis et al¹¹ reported anastomotic or venous outflow stenoses in 59%, thrombosis of the fistula in 35%, and failure in maturation after the first stage in 35% of cases. Casey et al⁷ described that only 47% of all fistulas were functional emphasizing the issue of early failure. It becomes evident from our analysis that failure of maturation and the increased rate of postoperative complications remain a concern and which emphasize the loss of not only functionality of the fistula but also a protracted deficit in quality of life.

Another issue for analysis is whether BVT–AVF has better results than AVGs. Regarding the comparison of BVT–AVF with AVGs, literature data are poor and scarce and contradicting information exists. In the study by Torina et al, a comparison between primary BVT–AVF and AVGs was performed.¹⁰ The authors found a statistically significant difference in the secondary patency rate between BVT–AVF procedure and AVGs in favor of the AVGs.¹⁰ On the contrary, the study by Greenberg et al analyzing outcomes of 42 patients with BVT–AVF and 28 with AVGs, concluded that BVT–AVF out-performed the prosthetic access in terms of primary patency and functional patency in patients referred early.⁸ However, both studies were unrandomized and the direct comparison regarding accesses performed in the same target vessels was not feasible. Large controlled trials are needed to confirm the superiority of BVT–AVF over AVGs. Interestingly, some authors have described “conversion” to AVGs in the second stage because of poor maturation of the fistula. Srinivasaiah et al⁶ reported exteriorization of the fistulae by the use of interposition grafts to allow successful use in six patients.

In conclusion, the BVT–AVF is a valuable option for creating an autologous vascular access in patients lacking adequate superficial veins. Failure of maturation and the increased rate of early postoperative complications remain a concern. There is evidence that the two-stage procedure seems to have fewer complications and better patency rates compared with the one-stage procedure but needs to be confirmed in larger trials. Moreover, preoperative ultrasound study with estimation of the central veins’ patency is of paramount importance in every AVF, but of particular importance, when a copious one- or two-stage operation is planned in such, mostly multioperated, patients with CRF.

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