Original Article

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Bare-Metal Stent in Dysfunctional Hemodialysis Access: An Assessment of Circuit Patency according to Access Type and Stent Location

혈액투석 접근로 기능부전에서의 비피복형 스텐트: 접근로 종류와 스텐트 위치에 따른 개통률 평가

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Purpose To evaluate the circuit patency after nitinol bare-metal stent (BMS) placement according to the type of access and location of the stent in dysfunctional hemodialysis access.

Materials and Methods Between January 2017 and December 2019, 159 patients (mean age, 64.1 ± 13.2 years) underwent nitinol BMS placement for dysfunctional access. The location of stents was as follows: 18 brachiocephalic vein, 51 cephalic arch, 40 upper arm vein, 10 juxta-anastomotic vein, 7 arteriovenous (AV) anastomosis, and 33 graft-vein (GV) anastomosis. Circuit patency was evaluated by the Kaplan-Meier method, and cox regression model.

Results A total of 159 stents were successfully deployed in 103 AV fistula (AVF) and 56 AV graft (AVG). AVG showed lower primary and secondary patency at 12-months compared with AVF (primary patency; 25.0% vs. 44.7%; $p = 0.005$, secondary patency; 76.8% vs. 92.2%; $p = 0.014$). Cox regression model demonstrated poorer primary patency at 12 months after stenting in the cephalic arch and GV anastomosis compared with the other sites.

Conclusion AVF showed better primary and secondary circuit patency at 12 months following the

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placement of BMS compared with AVG. Stents in the cephalic arch and GV anastomosis were associated with poorer primary patency at 12 months compared to those in other locations.

Index terms Stent; Angioplasty; Arteriovenous Fistula; Vascular Patency; Renal Dialysis

INTRODUCTION

Percutaneous transluminal angioplasty (PTA) is a viable alternative to surgery in that it is efficient, associated with lower peri-operative mortality, and required shorter recovery periods (1). However, long-term results of PTA are plagued with recurrent stenoses that lead to poor patency and the need for repeated interventions. Primary patency rate at 12 months following PTA ranges between 26%–58% (2, 3). Bare-metal stents (BMS) were introduced in the 1980s to salvage accesses with short-lived patency after angioplasty, especially in stenotic lesions associated with elastic recoil and those that are refractory to balloon dilation. Early studies comparing BMS and PTA reported that stent placement had no apparent superiority over PTA alone (4-6). However, stainless steel stents were among those that were used in these patient groups. Following the development of self-expandable nitinol BMS, improved patency rates were reported for BMS compared to PTA (7-9). Despite these results, in-stent restenosis resulting from neointimal hyperplasia remains problematic (10). The aim of this study was to assess circuit patency after nitinol BMS placement according to the access type and stent location within the circuit.

MATERIALS AND METHODS

PATIENTS AND LESION CHARACTERISTICS

This retrospective study was reviewed and approved by the Institutional Review Board, and written informed consent was waived due to the retrospective observational nature of this study (IRB No. AJIRB-MED-MDB-21-388). Patient information was retrospectively collected via an electronic medical database and picture archiving and communication systems. A total of 265 consecutive patients with vascular access dysfunction underwent successful nitinol BMS insertion between January 2017 and December 2019 (Fig. 1). One-hundred six patients were excluded from review according to the following exclusion criteria: history of previous stent insertion (n = 47), stents in multiple locations (n = 5), stent-graft insertion (n = 3), stents either in unclassifiable locations such as perforating veins and collateral veins or in rare locations where the number of cases was limited (n = 12), and patients lost to follow up (n = 39). As a result, a final number of 159 patients (95 males, 64 females; mean age, 64.1 years) were included in this study. One-hundred three patients had native arteriovenous fistulas (AVFs) and 56 had arteriovenous grafts (AVGs). The location of stents was as follows; brachiocephalic vein (n = 18), cephalic arch (n = 51), upper arm vein (n = 40), juxta-anastomotic vein (n = 10), AV anastomosis (n = 7), and GV anastomosis (n = 33).

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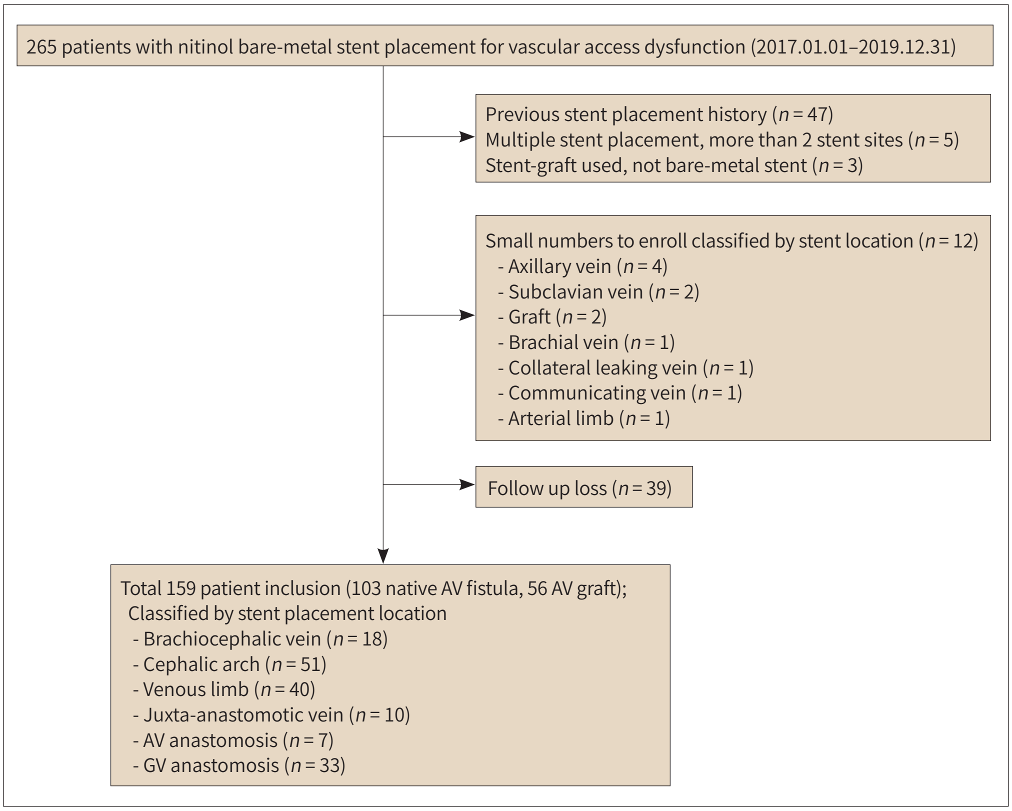
Fig. 1. Patient inclusion and exclusion criteria.



AV = arteriovenous, GV = graft-vein

BALLOON ANGIOPLASTY AND STENT PLACEMENT PROCEDURE

All procedures were performed on an outpatient basis. AVF or AVG were cannulated with an 18-gauge needle after local anesthesia, and a 6–8 Fr sheath (Terumo, Tokyo, Japan or Cook, Bloomington, IN, USA) was introduced into the outflow vein of the arm over a 0.035-inch guidewire (Terumo, Tokyo, Japan). Venography was performed to assess the circuit for stenosis or occlusion. Once the lesion was identified, angioplasty was performed using a balloon catheter with balloon diameters ranging from 5 mm to 16 mm. The diameter of the balloon was 0%–10% larger in relation to the diameter of the adjacent vessel segment. A self-expanding nitinol BMS was deployed in the dilated lesion when any of the following indications were met: 1) elastic recoil resulting in residual stenosis of more than 30% after angioplasty, 2) early restenosis developing within 1 month after treatment, 3) flow-limiting dissection, or 4) vessel rupture. The diameter of stents was equal to or larger than the diameter (up to 30%) of the angioplasty balloon, ranging from 5 to 20 mm. One of the following stents was used: S.M.A.R.T. Stent (Cordis Corp, Fremont, CA, USA), Absolute Pro stent (Abbott Vascular, Santa Clara, CA, USA), and Zilver Flex stent (Cook). Patients received Aspirin 100 mg (Astrix cap, Boryung Pharmaceutical Co., Seoul, Korea) and Clopidogrel 75 mg (Plavix tab, Handok, Seoul, Korea) once a day for 3 months following treatment.

FOLLOW-UP

Follow-up data were collected from our institution's electronic medical database and picture archiving and communication systems. All patients included in this study underwent at least one year of follow-up in the outpatient clinic. Those with signs of access dysfunction on physical examination or ultrasound assessment, and those with a history of failed hemodialysis underwent diagnostic venography.

DEFINITIONS

Circuit patency was defined according to 'reporting standards for percutaneous interventions' published in the Society of Interventional Radiology (11). Postintervention primary patency is the interval after stent deployment until access dysfunction or repeated intervention. Postintervention secondary patency is the interval after stent deployment until the access is surgically de-clotted, altered, or abandoned, resulting from the inability to treat the original lesion, surgeon's choice, kidney transplant status, or the loss of follow-up.

Major and minor complications were categorized according to 'reporting standards for clinical evaluation of new peripheral arterial revascularization devices' published in the Society of Interventional Radiology (11).

STATISTICS

Survival analysis was performed using the Kaplan-Meier method, log-rank test, and Cox regression model. Postintervention primary and secondary patency rates were evaluated by the Kaplan-Meier method. Log-rank test was performed to compare patency rates between AVF and AVG groups. Cox regression model was used to determine the risk factors if there were any predictors of loss of primary or secondary patency after stent placement. The following variables were analyzed: patient age, sex, hypertension, diabetes mellitus, type of access (AVF or AVG), preceding thrombectomy, and reason for stent insertion. Kaplan-Meier method was used to compare circuit patency among subgroups divided according to different stent locations. Cox regression analysis was further performed to independently compare each location with a reference location that was designated for the comparison of circuit patency. A p value of less than 0.05 was regarded as significant. Data were analyzed using SPSS software version 25.0 (Statistical Package for the Social Sciences; IBM Corp., Armonk, NY, USA).

RESULTS

Stents were successfully deployed in all patients. Baseline demographics of 159 patients are summarized in Table 1. Type of access was as follows: radiocephalic AVF (n = 52, 32.7%), brachiocephalic AVF (n = 51, 32.1%), brachiocubital loop AVG (n = 32, 20.1%), brachiocephalic AVG (n = 2, 1.3%), brachial-axillary AVG (n = 13, 8.2%), Axillary-axillary loop AVG (n = 3, 1.9%), radiocubital AVG (n = 5, 3.1%), and radioaxillary jump graft (n = 1, 0.6%). Clinical presentation of dysfunctional access was as follows: absent flow (n = 95, 59.7%), venous hypertension (n = 28, 17.6%), insufficient flow (n = 26, 16.4%), swelling (n = 8, 5.0%), and maturation failure (n = 2, 1.3%).

Location of stent placement is presented in Table 2. Number of deployed stents per loca-

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Table 1. Baseline Characteristics of 159 Patients

Characteristics	*n* (%)
Demographics	
Sex	
Male	95 (59.7)
Female	64 (40.3)
Age, years	
Mean ± SD	64.1 ± 13.2
Medical history	
Hypertension	150 (94.3)
Diabetes mellitus	97 (61.0)
Hemodialysis access type	
Native AV fistula	
Radiocephalic AVF	52 (32.7)
Brachiocephalic AVF	51 (32.1)
AV graft	
Brachiocubital loop AVG	32 (20.1)
Brachiocephalic AVG	2 (1.3)
Brachial-axillary AVG	13 (8.2)
Axillary-axillary loop AVG	3 (1.9)
Radiocubital AVG	5 (3.1)
Radioaxillary jump graft	1 (0.6)
Clinical presentation	
Absent flow	95 (59.7)
Venous hypertension	28 (17.6)
Insufficient flow	26 (16.4)
Swelling	8 (5.0)
Maturation failure	2 (1.3)

AV = arteriovenous, AVF = arteriovenous fistula, AVG = arteriovenous graft, SD = standard deviation

tion was as follows: 18 in brachiocephalic vein (11.3%), 51 in cephalic arch (32.1%), 40 in upper arm vein (25.2%), 10 in juxta-anastomotic vein (6.3%), 7 arteriovenous anastomosis (4.4%), and 33 in graft-vein anastomosis (20.8%). Reason for stent placement were elastic recoil (n = 108, 67.9%), short-interval recurrence (n = 35, 22.0%), venous rupture (n = 15, 9.4%), and dissection (n = 1, 0.6%). Eighty patients (50.3%) underwent thrombectomy before stent deployment.

Primary circuit patency according to the type of access is presented in Fig. 2. Primary circuit patency in the whole group (n = 159) at 3, 6, and 12-month after intervention was 78.0%, 56.0%, and 37.7%, respectively. Primary circuit patency for AVF (n = 103) at 3, 6, and 12-month after intervention was 85.4%, 64.1%, and 44.7%, respectively. Primary circuit patency for AVG (n = 56) at 3, 6, and 12-month after intervention was 64.3%, 41.1%, and 25.0%, respectively. Log-rank analysis showed that the primary patency rate for AVF was significantly higher than that for AVG (p = 0.003) (Fig. 2). No significant difference was found between AVF and AVG in terms of gender, age, hypertension, preceding thrombectomy, and reason for stent insertion. Meanwhile, diabetes (hazard ratio [HR], 1.92 [1.25–2.95], p = 0.003) and AVG (HR,

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Table 2. Details of Stent Placement of 159 Patients

Characteristics	*n* (%)
Location of stent	
Brachiocephalic vein	18 (11.3)
Cephalic arch	51 (32.1)
Upper arm vein	40 (25.2)
Juxta-anastomotic vein	10 (6.3)
AV anastomosis	7 (4.4)
GV anastomosis	33 (20.8)
Target lesion of stent placement	
Focal stenosis (> 75%)	59 (37.1)
Multifocal stenosis (> 75%)	21 (13.2)
Luminal obliteration (100%)	51 (32.1)
Thrombosis without stenosis	1 (0.6)
Thrombosis with stenosis (> 75%)	16 (10.1)
Thrombosis with stenosis and aneurysmal dilatation (> 75%)	11 (6.9)
Reason for stent placement	
Elastic recoil	108 (67.9)
Short-interval recurrence	35 (22.0)
Rupture	15 (9.4)
Dissection	1 (0.6)
Preceding thrombectomy	
Yes	80 (50.3)
No	79 (49.7)
Complication during follow up	
Infection	2 (1.3)
Thrombosed aneurysm	2 (1.3)
Procedure-related bleeding	1 (0.6)

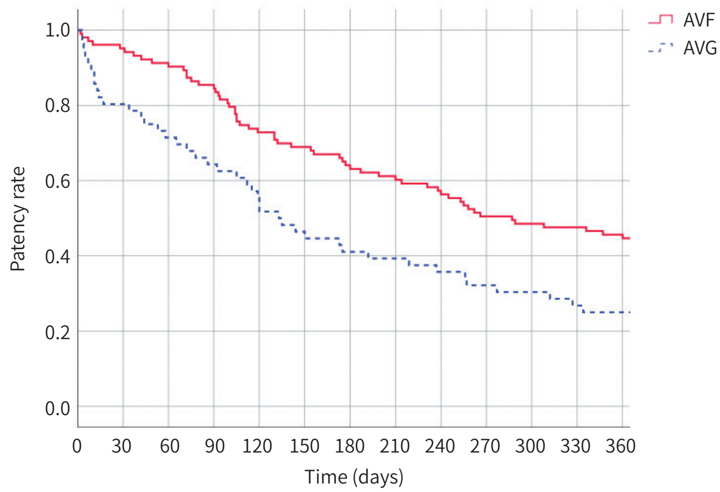
AV = arteriovenous, GV = graft-vein

1.78 [1.19-2.66], $p = 0.005$) were associated with poorer primary circuit patency (Table 3).

Secondary circuit patency according to the type of access is shown in Fig. 3. Secondary circuit patency of whole group ($n = 159$) at 3, 6, and 12-month after intervention was 93.1%, 91.8%, and 86.8%, respectively. Secondary circuit patency for AVF ($n = 103$) at 3, 6, and 12-month after intervention was 98.1%, 97.1% and 92.2%, respectively. Secondary circuit patency for AVG ($n = 56$) at 3, 6, and 12-month after intervention was 83.9%, 82.1% and 76.8%, respectively. Log-rank analysis showed that the secondary patency rate was significantly higher than that for AVG ($p = 0.004$) (Fig. 3). No significant difference was found between the two in terms of gender, diabetes, hypertension, preceding thrombectomy, and reason for stent insertion. Meanwhile, older age (HR, 1.04 [1.01–1.08], $p = 0.040$) and AVG (HR, 3.04 [1.25–7.36], $p = 0.014$) were associated with poorer secondary circuit patency (Table 4).

Primary circuit patency at 12-month in the whole group ($n = 159$) according to stent location was as follows (Fig. 4); brachiocephalic vein 50.0%, cephalic arch 29.4%, upper arm vein 40.0%, juxta-anastomotic vein 80.0%, AV anastomosis 71.4%, and GV anastomosis 21.2%. Pri-

Fig. 2. Postintervention primary patency of AVF and AVG.



	Number of Patients	Primary Patency Rate (%)		
		90 Days	180 Days	365 Days
AVF	103	85.4	64.0	44.7
AVG	56	64.3	41.1	25.0
Total (AVF + AVG)	159	78.0	56.0	37.7

p = 0.003 by log-rank test.

AVF = arteriovenous fistula, AVG = arteriovenous graft

Table 3. Factors Affecting Primary Patency by Univariate and Multivariate Cox Regressions

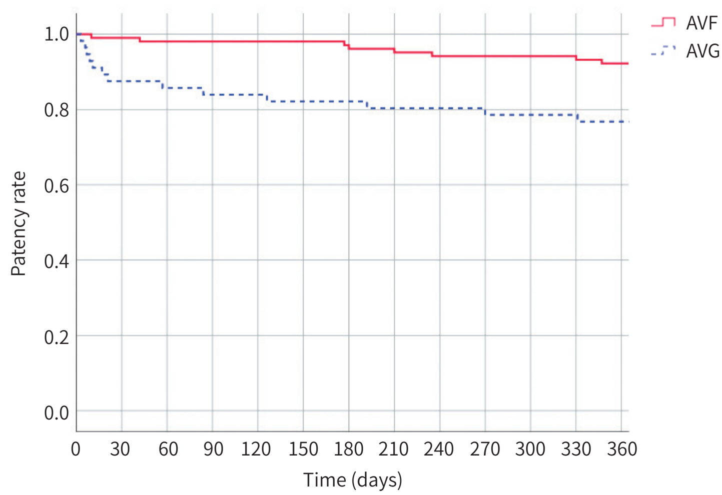
Variable	Univariate Analysis		Multivariate Analysis	
	HR (95% CI)	*p*-Value	HR (95% CI)	*p*-Value
Sex	1.23 (0.81–1.88)	0.266		
Age	1.01 (0.99–1.03)	0.122		
DM	2.03 (1.30–3.16)	0.002	1.92 (1.25–2.95)	0.003
HTN	0.46 (0.21–1.01)	0.121		
Access type (AVF or AVG)	1.78 (1.14–2.78)	0.018	1.78 (1.19–2.66)	0.005
Preceding thrombectomy	0.88 (0.57–1.37)	0.575		

AVF = arteriovenous fistula, AVG = arteriovenous graft, CI = confidence interval, DM = diabetes mellitus, HR = hazard ratio, HTN = hypertension

mary patency according to stent location in the AVF group (n = 103) was as follows (Fig. 5): brachiocephalic vein 43.8%, cephalic arch 31.1%, upper arm vein 48.0%, juxta-anastomotic vein 80.0%, AV anastomosis 71.4%, and GV anastomosis 21.2%. For the AVG group (n = 56), results were as follows (Fig. 6): brachiocephalic vein 100.0%, cephalic arch 16.7%, upper arm vein 26.7%, and GV anastomosis 21.2%

Cephalic arch and GV anastomosis, which demonstrated the lowest circuit patency rates among stent locations, were individually designated as reference locations for cox regression analysis. Stent in the GV anastomosis demonstrated significantly poorer primary circuit patency compared to that in other locations ($p < 0.05$) (Table 5) except the cephalic arch. Mean-

Fig. 3. Postintervention secondary patency of AVF and AVG.



	Number of Patients	Secondary Patency Rate (%)		
		90 Days	180 Days	365 Days
AVF	103	98.1	97.1	92.2
AVG	56	83.9	82.1	76.8
Total (AVF + AVG)	159	93.1	91.8	86.8

$p = 0.004$ by log rank test.

AVF = arteriovenous fistula, AVG = arteriovenous graft

Table 4. Factors Affecting Secondary Patency by Univariate and Multivariate Cox Regressions

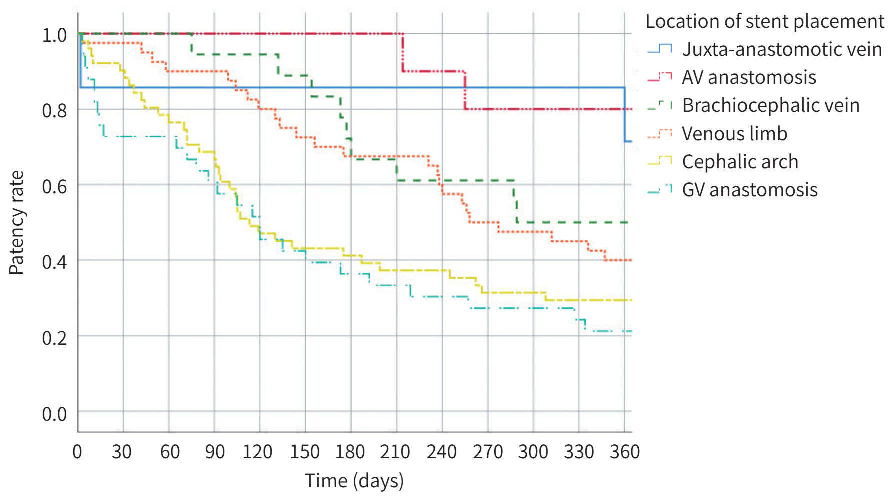
Variable	Univariate Analysis		Multivariate Analysis	
	HR (95% CI)	*p*-Value	HR (95% CI)	*p*-Value
Sex	0.95 (0.39–2.29)	0.904		
Age	1.04 (1.00–1.08)	0.042	1.04 (1.01–1.08)	0.040
DM	1.52 (0.58–3.97)	0.397		
HTN	0.31 (0.07–1.43)	0.133		
Access type (AVF or AVG)	2.68 (1.00–7.15)	0.050	3.04 (1.25–7.36)	0.014
Preceding thrombectomy	1.54 (0.53–4.43)	0.425		

AVF = arteriovenous fistula, AVG = arteriovenous graft, CI = confidence interval, DM = diabetes mellitus, HR = hazard ratio, HTN = hypertension

while, a stent in the cephalic arch was associated with significantly poorer primary circuit patency compared to that in the brachiocephalic vein and juxta-anastomotic vein ($p < 0.05$) (Table 6). The difference in primary circuit patency between stent in the cephalic arch and that in the outflow vein ($p = 0.058$) or AV anastomosis ($p = 0.053$) was insignificant. No significant difference was seen in terms of secondary circuit patency according to stent location.

Five complications (3.1%) were reported: two cases of thrombosis in aneurysmal fistula, one case of fistula infection in the cannulation segment which was treated by antibiotic therapy, one case of graft infection resulting in surgical removal of graft, and one case of postprocedural bleeding requiring a surgical operation. Taken together, there were four major complica-

Fig. 4. Postintervention primary patency according to stent location in all patients.



	Number of Patients	Primary Patency Rate (%)		
		90 Days	180 Days	365 Days
Brachiocephalic vein	18	94.4	72.2	50.0
Cephalic arch	51	68.6	41.2	29.4
Upper arm vein	40	90.0	67.5	40.0
Juxta-anastomotic vein	10	100.0	100.0	80.0
AV anastomosis	7	85.7	85.7	71.4
GV anastomosis	33	60.6	36.4	21.2

p = 0.001 by log rank test.

AV = arteriovenous, GV = graft-vein

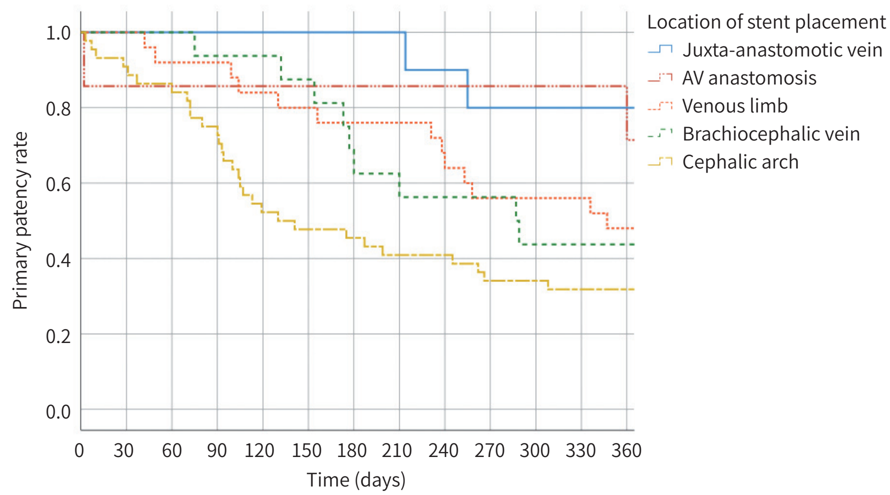
tions (2.5%) and one minor complication (0.6%) after the procedure. None of the complications were attributed to the BMS itself.

DISCUSSION

While the stent-graft has gained popularity over its bare-metal counterpart due to its superior patency, BMS still retains its role in overcoming technical issues related to unsuccessful angioplasty including elastic recoil, short-interval recurrence, and venous rupture (12). In contrast to accumulating data on stent-grafts and drug technology such as drug-coated balloons, data on nitinol BMS is limited to studies that are dated. Studies comparing nitinol BMS to standard PTA in dysfunctional vascular access have reported 12-month primary patency rates ranging from 41% to 49% for BMS, which proved to be superior to PTA (7-9). In the current study, the 12-month primary patency rate was 37.7%, which was comparable to the results from previous studies. With limited data in terms of circuit patency among different types of accesses and location of stent placement, we compared circuit patency after BMS placement between AVF and AVG groups and that between different stent locations.

AVG showed lower primary and secondary circuit patency rates compared with AVF in our

Fig. 5. Postintervention primary patency according to stent location in AV fistula.



	Number of Patients	Primary Patency Rate (%)		
		90 Days	180 Days	365 Days
Brachiocephalic vein	16	93.8	68.8	43.8
Cephalic arch	45	75.6	44.4	31.1
Upper arm vein	25	92.0	76.0	48.0
Juxta-anastomotic vein	10	100.0	100.0	80.0
AV anastomosis	7	85.7	85.7	71.4

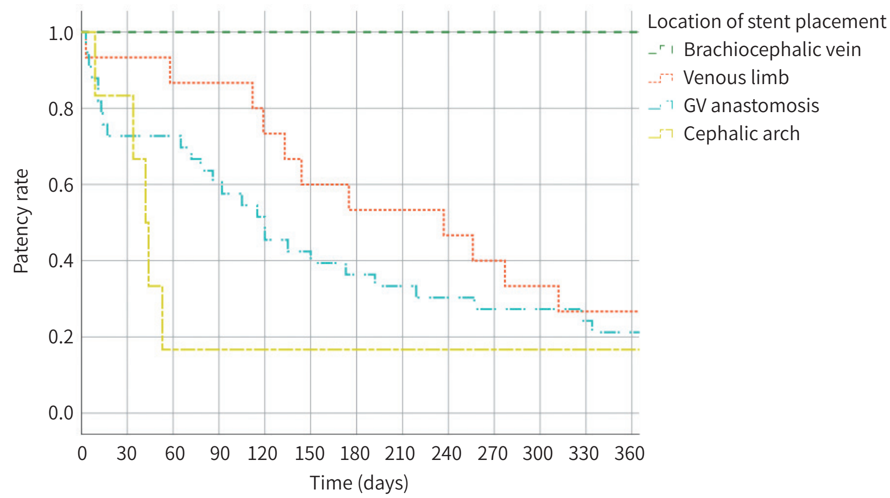
AV = arteriovenous

study. This result is consistent with previous studies that reported superior patency for AVF after endovascular treatment in comparison to AVG (13-15). Further to these findings, diabetes was observed to be associated with poor primary patency after BMS insertion, while older age was associated with poor secondary patency after stent deployment. Prosthetic graft, history of diabetes, and older age have previously been associated with poor patency (15-17).

There were four different indications for BMS insertion including elastic recoil, short-interval recurrence, flow-limiting dissection, and vessel rupture. No statistical difference was observed with regard to circuit patency among different indications. Furthermore, preceding thrombectomy for thrombosed access was not related to circuit patency which contrasts with the results of previous studies that have reported poorer postintervention patency in thrombosed access compared to non-thrombosed access (18, 19). Although the reason for this disagreement is unclear, the fact that we perform a hybrid technique that involves venotomy with manual extraction of thrombus for thrombosed accesses may have resulted in a better outcome as compared to completely endovascular techniques. Details and outcomes of this technique have been previously described (20).

Circuit patency according to stent location was analyzed revealing stent placement in the cephalic arch and GV anastomosis was associated with poorer patency compared to other stent locations. Subgroup analysis of primary circuit patency in AVF and AVG groups revealed the lowest patency rate for BMS placed in the cephalic arch and GV anastomosis, respectively.

Fig. 6. Postintervention primary patency according to the location of the stent placement in arteriovenous graft.



	Number of Patients	Primary Patency Rate (%)		
		90 Days	180 Days	365 Days
Brachiocephalic vein	2	100.0	100.0	100.0
Cephalic arch	6	16.7	16.7	16.7
Upper arm vein	15	86.7	53.3	26.7
GV anastomosis	33	60.6	36.4	21.2

p = 0.106 by log rank test.

GV = graft-vein

Table 5. Cox Proportional-Hazards Model of Primary Patency according to Stent Location in All Patients

Location of Stent	Number of Patients	HR	95% CI	*p*-Value
GV anastomosis	33	1.000*		
Cephalic arch	51	0.818	0.494–1.355	0.434
Upper arm vein	40	0.495	0.284–0.864	0.013
Brachiocephalic vein	18	0.379	0.177–0.809	0.012
AV anastomosis	7	0.200	0.047–0.843	0.028
Juxta-anastomotic vein	10	0.127	0.030–0.538	0.005

*GV anastomosis as a reference value.
AV = arteriovenous, CI = confidence interval, GV = graft-vein, HR = hazard ratio

The cephalic arch and GV anastomosis have frequently been associated with recurrent stenosis in patients undergoing angioplasty for dysfunctional access. The cephalic arch is located within the deltopectoral groove where it is exposed to extrinsic compression by the clavipectoral fascia (21). This, along with the presence of valves and shear stress resulting from shoulder movement (22), is thought to promote neointimal hyperplasia. Meanwhile, GV anastomosis is s common site of stenosis in AVG patients. Shear stress occurs at the junction of the prosthetic device and native vessel, resulting in endothelial injury and consequent intimal hyperplasia (23). While BMS may prevent immediate or short-interval recoil after PTA, it is inevi-

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Table 6. Cox Proportional-Hazards Model of Primary Patency according to Stent Location in All Patients

Location of Stent	Number of Patients	HR	95% CI	*p*-Value
Cephalic arch	51	1.000*		
GV anastomosis	33	1.223	0.738–2.026	0.434
Upper arm vein	40	0.606	0.361–1.016	0.058
Brachiocephalic vein	18	0.463	0.223–0.963	0.039
AV anastomosis	7	0.244	0.059–1.016	0.053
Juxta-anastomotic vein	10	0.156	0.037–0.648	0.011

*Cephalic arch as a reference value.
AV = arteriovenous, CI = confidence interval, GV = graft-vein, HR = hazard ratio

tably exposed to the same mechanical factors in these anatomical locations which potentially promotes intimal hyperplasia in the stented segment. Stent-grafts have demonstrated better patency rates and therefore should be considered when available (24-26).

Cox regression analysis was performed to test for statistical significance in primary circuit patency among various stent locations. Cephalic arch and GV anastomosis, which demonstrated poorer patency in relation to other locations on Kaplan-Meier estimation of primary circuit patency, were independently designated as reference locations for comparison with other individual locations. When the primary circuit patency rate of GV anastomosis was individually compared to those of other stent locations, the patency rate was significantly lower for GV anastomosis compared to all other locations except the cephalic arch. In comparison to the primary circuit patency rate of the cephalic arch to that of other locations, a significant difference was observed in the brachiocephalic vein and juxta-anastomosis. Due to the rare event of BMS insertion in the AV anastomosis, only seven patients were in this study had stents placed in this location. Borderline *p*-value may have resulted from the insufficient number of cases. As for the comparison of primary circuit patency between the cephalic arch and upper arm vein, the difference in patency was not statistically significant at 12 months. However, the primary circuit patency rate was observed to be significantly lower in the cephalic arch compared to the upper arm vein at 6 months ($p = 0.008$).

The complication rate was 3.1%, none of which were related to the stent itself. This result is comparable to that reported previously (1, 27).

There are some limitations related to the retrospective and non-randomized nature of this study. First, the outcome of endovascular treatment using nitinol BMS was not compared to that of PTA alone or of stent-graft. Second, there is a possibility of selection bias resulting from a large number of patients being lost to follow-up. Third, owing to the small number of patients available for subgroup analysis, the effect of stent location on circuit patency may have been overestimated. A large-scale study is required to validate such an outcome.

In conclusion, AVF showed better primary and secondary circuit patency rates at 12 months following placement of BMS compared with AVG. Stents in the cephalic arch and GV anastomosis were associated with poorer primary patency at 12 months compared to those in other locations. Since cephalic arch and GV anastomosis can worsen primary patency, other treatment options using drug-coated balloon or stent-graft instead of using nitinol BMS may be considered through additional comparative or randomized control studies in the future.

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Author Contributions

Conceptualization, L.K., W.J.H., K.Y., K.J.; data curation, L.K., W.J.H., K.Y., K.J.; formal analysis, L.K., W.J.H., K.Y., K.J.; investigation, all authors; methodology, all authors; project administration, all authors; resources, all authors; supervision, W.J.H., K.J.; validation, L.K., W.J.H., K.J.; visualization, L.K., W.J.H., K.J.; writing—original draft, L.K., W.J.H., K.J.; and writing—review & editing, L.K., W.J.H., K.J.

Conflicts of Interest

The authors have no potential conflicts of interest to disclose.

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혈액투석 접근로 기능부전에서의 비피복형 스텐트: 접근로 종류와 스텐트 위치에 따른 개통률 평가

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목적 기능장애 혈액투석 접근로에서 나이티놀 비피복형 스텐트 설치 후 접근로 유형과 스텐트의 위치에 따른 개통성을 평가하고자 한다.

대상과 방법 2017년 1월과 2019년 12월 사이에 159명의 환자(평균 연령, 64.1 ± 13.2세)가 혈액투석 접근로 기능장애를 치료를 위해 나이티놀 스텐트를 설치하였다. 스텐트의 위치는 다음과 같다; 18개 팔머리 정맥, 51개 노쪽피부정맥궁, 40개 위팔 정맥, 10개 문합부위 인접 정맥, 7개 동정맥 문합부 및 33개 인조혈관-정맥 문합부. 12개월 개통률은 카플란-마이어 방법과 콕스 회귀 모델로 평가하였다.

결과 총 159개의 스텐트가 103개의 자가동정맥루와 56개의 인조혈관접근로에 성공적으로 설치되었다. 인조혈관접근로는 자가동정맥루에 비해 12개월 일차 및 이차 개통률이 더 낮았다 (일차 개통률; 25.0%대 44.7%; $p = 0.005$, 이차 개통률; 76.8%대 92.2%; $p = 0.014$). 스텐트 설치 후 노쪽피부정맥궁 및 인조혈관-정맥 문합부에서 다른 부위에 비해 12개월 일차 개통성이 불량하였다.

결론 나이티놀 비피복형 스텐트 설치 후 자가동정맥루는 인조혈관접근로와 비교하여 더 좋은 12개월 일차 및 이차 개통률을 보인다. 노쪽피부정맥궁 및 인조혈관-정맥 문합부의 스텐트는 다른 위치의 스텐트에 비해 더 낮은 12개월 일차 개통률을 보인다.

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