Treatment of intragraft stenosis in hemodialysis grafts with Supera stents : A retrospective study

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PURPOSE

The National Kidney Foundation's Kidney Disease Outcomes Quality Initiative (KDOQI) recommends arteriovenous fistula (AVF) as the first access for hemodialysis (HD) but arteriovenous grafts (AVGs) are still an appropriate option for vascular access in certain HD patients. Hemodynamically significant stenosis at the venous anastomosis is the most common cause of prosthetic AVG dysfunction in patients with HD, followed by arterial anastomosis and venous outflow stenosis. The rate of intragraft stenoses varies from 6% to 20%. Unlike stenotic lesions occurring at other sites, stenoses within the AV graft is correlated with repeat needle puncture, causing fibroplastic ingrowth via needle puncture tracts and graft structure distortion.The primary patency rates of intragraft stenoses after conventional balloon angioplasty from 56% to 75% at 6months and 18% to 33% at 1year. For recurrent lesions, there are only few studies analyzing the outcomes of deploying a stent on intragraft stenoses. Supera stent is made of nitinol wires woven around a central lumen. This interwoven design is resistant to kink formation, especially during the compression. Therefore, it can maintain the integrity of graft lumen and allow for repeat needle puncture. The current study aimed to report our experience of using an interwoven nitinol stent for salvaging failing synthetic AVGs in patients with recurrent intragraft stenoses

MATERIALS and METHODS

Procedural database review was performed to identify all patients with intragraft stenoses treated with interwoven nitinol stents from May 2018 to May 2020. In total, 20 patients (18 women and 2 men; mean age: 79.9 (range: 38–89) years) who had failing AVGs due to recurrent intragraft lesion within 3months were treated with the Supera stent (Abbott Vascular, Santa Clara, CA, USA). Data including patient demographics, hemodialysis parameters, and procedural details were collected. The indication for intragraft stenosis treatment was significant stenosis (>50%) on ultrasonography or angiography, which meets the treatment criteria established by the KDOQI. Meanwhile, those with concurrent treatment for other lesions, particularly venous anastomosis, were excluded. All procedures were performed by a single endovascular surgeon in a hybrid operating room while the patient was under local or general anesthesia. All intragraft stenoses were initially treated with balloon angioplasty using a 6-, 7-, or 8-mm diameter high-pressure noncompliant balloon. If intragraft stenosis was the main culprit lesion for reintervention, stenting was performed. Considering the mechanism underlying intragraft lesion correlated with injury caused by needle cannulation, different stenosis statuses were found over both puncture sites for all patients. For this reason, all patients required a long stent (12 or 15cm in length) to cover the whole AVG area, including both arterial and venous puncture sites. The stent diameter was selected to match the graft diameter dilated by the angioplasty balloon. The 6.5-mm Supera stent was preferred if a 6- or 7-mm balloon was used for dilatation. All stent deployments were conducted via the retrograde access, starting 2 or 3cm away from the arterial anastomosis and extending toward the venous anastomosis (Figure 1). If a covered stent was over the venous anastomosis, the Supera stent was extended into it. If there was no covered stent over the venous anastomosis, the stent was deployed 1–2 cm close to venous anastomosis without extending over it.

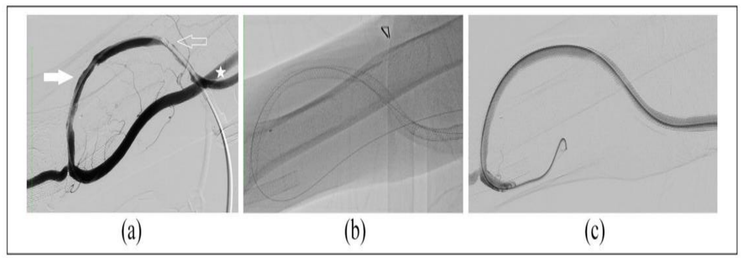

Figure 1. Angioplasty of intragraft stenosis and deployment of the Supera stent within the graft. (a) Digital subtraction angiography (DSA) after the use of two 6-Fr sheaths for catheter-directed thrombectomy showing severe stenosis over the arterial (white arrow) and venous (open arrow) cannulation sites. The asterisk denotes the covered stent placed over the venous anastomosis site. (b) Fluoroscopic image of the 6.5-mm × 12-cm Supera stent deployed within the AVG, covering both the cannulation sites and extending into the covered stent. (c) Final DSA showing complete expansion and patency of the stent within the whole graft.

RESULTS

In total, 21 Supera stents were deployed in 20 patients (Tables 1 and 2). Seventeen (85%) patients were women. The median length of time between the creation of an AVG and the placement of the Supera stent was 19.7 (interquartile range (IQR): 6–36)months. Approximately 95% of these AVGs had recurrent venous anastomosis dysfunction treated with covered stent before. All intragraft stenoses were initially treated with a balloon. Recurrent stenoses within 3months were observed during follow-up. Six (30%) patients presented with acute thrombosis. Seventeen (75%) patients exhibited stenosis over the venous puncture site. Five patients had stenoses over both puncture sites. There was only a patient who had a larger length of AV loop graft over forearm received stenting first over the venous site but developed significant stenosis over the arterial side after 5months. Another 4cm Supera stent was placed over the arterial side (Figure 2). In 95% of patients, 6.5-m supera was used for stenting. Only one 7.5-mm Supera stent was used in one patient due to severe recoil and success dilatation with an 8-mm angioplasty balloon. The median stent length was 12 (range: 4–15) cm. The technical success rate was 100%, without any procedural complications. In the retrograde access for stent deployment, direct manual compression was performed on patients with forearm AVGs.

Table 1. *Baseline characteristics of the 20 study patients and procedure details.

Age, years	70.9 ± 12.8 (38–89)
Female	17 (85)
Age of AVG, months	19.7 ± 8 (6–36)
Previous graft-venous junction stenting with covered stent	19 (95)
Comorbidities	
Diabetes	18 (90)
Hypertension	12 (60)
Ischemic heart disease	16 (80)
Peripheral vascular disease	10 (50)
Stroke	5 (25)
Smoking	3 (15)
Intradialytic hypotension	15 (75)
Indications for intervention	
Thrombosis	6 (30)
Low access flow	5 (25)
Difficult hemostasis over puncture site	10 (50)
Repeat puncture failure	8 (40)
Elevated intradialytic venous pressure	4 (20)

AVG: arteriovenous graft.
*Continuous data are presented as mean ± standard deviation (range); categorical data are given as the number (percentages).

Table 2. *Characteristics of the 20 AV grafts comprising the study population.

Graft location	
Forearm	11 (55)
Upper arm	9 (45)
Graft configuration	
Straight	9 (45)
Loop	11 (55)
Number of intragraft stenoses	
1	15 (75)
2	5 (25)
Location of intragraft stenoses	
Venous side	17 (85)
Arterial side	8 (40)
Number of stent used	
2	21
1	1 (5)
Stent profile	19 (95)
6.5 mm diameter	20 (95)
7.5 mm diameter	1 (5)
Length (cm)	12 ± 3 (4–15)

*Continuous data are presented as mean ± standard deviation (range); categorical data are given as the numbers (percentages).

Access circuit primary patency rates were 95% at 3months, 84% at 6months, and 35% at 12months after stent placement (Figure 3). The median time to loss of primary access patency was 11 (95% CI: 5.5–16)months. The secondary patency was maintained at 100% at 3, 6, and 12months. However, it reduced to 89% at 18months (Figure 3). The target lesion patency rates after Supera stenting were 100% at 3months, 100% at 6months, and 75% at 12months (Figure 3). During follow-up, nine patients required one or more reinterventions for AVG (total: 13 procedures). Only three procedures required intragraft reintervention within the 12-month period. The reintervention rate was 0.15 procedures per year. There were no major complications after Supera placement over the intragraft stenosis.

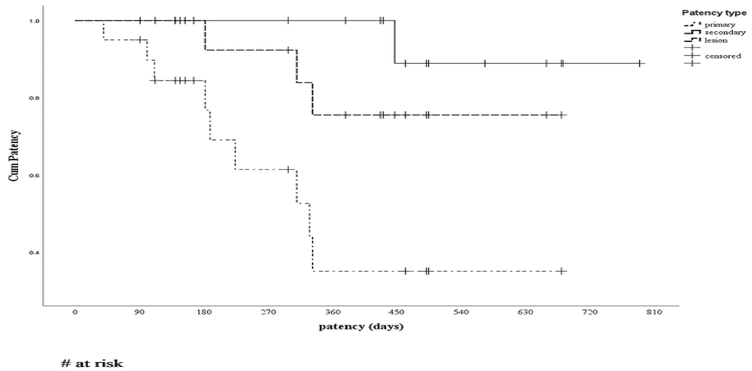

Figure 3. Kaplan–Meier curve of the primary, secondary, and target lesion patency after endovascular intervention for intragraft stenosis.

DISCUSSION

AVGs have a relatively short life span and are at risk of recurrent stenosis. Intragraft stenoses account for 2%–28% of all AVG lesions. Most of the intragraft stenosis occurred at a median age of 19.7months and contributed for late complication of AVGs. Inferior result after balloon angioplasty for intragraft stenosis will result in access failure or abandonment. Some studies showed that plain balloon angioplasty was inferior to treat intragraft stenoses but only stent deployment could prolong lesion patency. The graft permanently loses its strength to sustain needle trauma. Plain balloon angioplasty has an inferior outcome since repeat needle trauma on the same lesion is inevitable due to the lack of new cannulation area in these patients. Reports about the use of stents for the treatment of intragraft stenosis are rare. Stent deployment could improve treatment outcomes in intragraft stenosis. The application of stents is effective for preventing surgical revision, which is complicated by temporary loss of graft function and higher procedural risks. However, none of these stents are designed for needle puncture. Stent distortion, particularly in wall stents, eventually developed after repeat needle puncture. Cannulation of a covered stent will also damage the underlying metal framework that supports the PTFE fabric layer. The Supera stent has six pairs of nitinol wires interwoven to form a helical structure. This interwoven design is resistant to kink formation. It has been postulated that this stent can provide extra supportive force over the intragraft lesion, even when the lesion is going to be punctured after stenting. The interwoven cell design within the stent can accommodate a dialysis needle, and relative low stent distortion is encountered after repeat puncture at the same lesion, unlike others nitinol bare mental stent or covered stent. Our study first showed the use of the Supera stent in patients with failing AVGs caused by intragraft stenoses. After stenting over intragraft stenoses, Access circuit primary patency rates were 84% at 6months and 35% at 12months. With the Supera stent over the intragraft lesion, the secondary patency rate was up to 89% at 18months. Most reinterventions for the target lesions occurred after 6 months, with a final target lesion patency of 75% at 18 months. None of our patients presented with stent distortion or fracture in the follow-up period and the risk of injury by stent fracture to patient and health care stuff is negligible. The 6.5-mm Supera stent was commonly used because all patients received a 6-mm PTFE graft for AVG creation. The retrograde access is the preferred route for precise deployment.

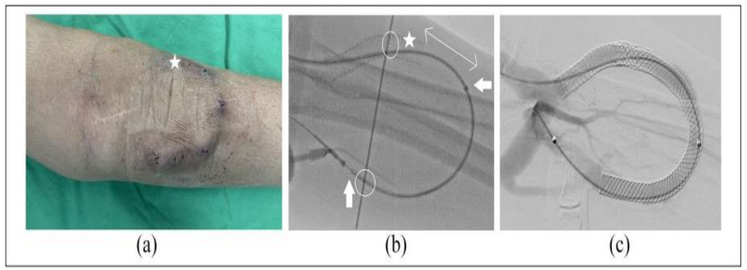

Figure 4. Deployment of the Supera stent within the arteriovenous graft (AVG). (a) A 78-year-old female patient with left-forearm loop AVG who presented with repeat stenosis over the venous puncture site due to repeat needle puncture over the covered stent (asterisk). (b) Fluoroscopic image of the inserted 6.5-mm × 12-cm Supera stent before deployment. The white arrows indicate the actual length of the Supera stent before deployment. The double arrow shows the distance between the Supera stent before deployment and the expected final location of the stent (approximately 4–5 cm). A 0.035-in wire (white circles) was used as a marker to identify both puncture sites for a precise stent deployment guidance. (c) Final digital subtraction angiography showing acceptable stent elongation in the estimated length that can completely cover both puncture sites.

CONCLUSION

Interwoven nitinol stent placement is a promising treatment for failing AVGs caused by intragraft stenoses. Further, access circuit primary, secondary, and target lesion patency rates are acceptable. Since the Supera stent is resistant to compression and fracture, it can be placed over an intragraft lesion to sustain direct cannulation for dialysis and to decrease the risk of stent distortion or fracture. With consideration of the significant improvement in patency with intragraft deployment of the Supera stent, the life span of AVGs can be prolonged in patients on HD with a limited vascular access