Clinical Case Report

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Angioplasty and stenting for the proximal anastomotic stenosis of a brachio-axillary bypass graft using a helical interwoven nitinol stent

A case report

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Abstract

Rationale: Thrombosis due to anastomotic site stenosis is the most common complication in patients with brachio-axillary arteriovenous graft (AVG). Intravascular stent placement may play a special role in the salvage of dialysis grafts that have been previously performed percutaneous angioplasty or surgical procedure on the graft. Herein, we applied a novel stent named Supera which has a high degree of flexibility and resistance to external compression for treating a patient with recurrent venous anastomotic stenosis of brachio-axillary AVG.

Patients concerns and diagnoses: We report a case of the patient with end-stage renal disease who presented with brachio-axillary AVG malfunction.

Interventions: The patient underwent repeated percutaneous angioplasty with thrombectomy for total graft occlusion, and we placed the Supera stent to salvage the graft.

Outcomes: Postprocedural Doppler ultrasonography did not show any restenosis on the 1- and 3-month follow-up periods, and average flow volume in the stent was >1000 mL/min. And he has been on dialysis for 6 months without any problems after stent placement.

Lessons: The Supera stent is a useful treatment option of interventional procedure for recurrent venous anastomotic stenosis of brachio-axillary AVG in the clinical practice.

Abbreviations: AVF = arteriovenous fistula, AVG = arteriovenous graft, BVT = basilic vein transposition, ESRD = end-stage renal disease, PTA = percutaneous angioplasty, US = ultrasonography.

Keywords: angioplasty, arteriovenous graft, Supera stent, thrombosis

1. Introduction

The updated National Kidney Foundation Dialysis Outcomes Quality Initiative and European guidelines recommend brachio-basilic arteriovenous fistula (AVF) or prosthetic graft as an alternative to radio-cephalic or brachio-cephalic AVF when no suitable forearm vessels are available.[1,2] Previous studies have shown that basilic vein transposition (BVT) is more effective than brachio-axillary access grafts; however, recent studies have shown that there is no significant difference because of improvement of polytetrafluoroethylene graft material.[3] Despite the technical development of graft materials, thrombosis due to anastomotic site stenosis is still the most common complication of prosthetic graft use, which remains a challenge.[4] For this reason, intravascular stent placement may play a special role in the salvage of dialysis grafts that have been previously used to perform percutaneous angioplasty or surgical procedure on the graft.[5]

The Supera stent (Abbott Vascular, 3200 Lakeside Drive, Santa Clara, CA) is a new stent comprising 6 pairs of closed-end interwoven nitinol wires and has a high degree of flexibility and resistance to external compression compared with laser-cut nitinol stents.[6] In particular, it maintains the round open lumen in challenging anatomies, such as the popliteal artery.[7]

Herein, we introduce our experience for treating recurrent venous anastomotic stenosis of brachio-axillary arteriovenous graft (AVG) with a helical interwoven nitinol stent.

2. Case report

This was purely an observational case study, and the patient's management and outcome were unaltered. Therefore, no ethical approval was required for this case report. Written informed

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consent was obtained from the patient for publication of this case report and accompanying images.

A 73-year-old man presented with end-stage renal disease (ESRD) and visited our hospital for hemodialysis. He was on medication for diabetic mellitus and hypertension. In the preoperative ultrasonography (US), the diameters of the left and right forearm cephalic veins were 0.8 and 1.1 mm, respectively. Whereas the diameter of the left upper basilic vein was measured as 4 mm, the right upper cephalic vein showed diffuse narrowing. Left upper cephalic and right upper basilic veins were not visible on sonographic evaluation.

He underwent the left brachio-brachial loop graft in the forearm, and hemodialysis was started through the loop graft on the postoperative day 20. However, approximately 2 months later, he visited our hospital again due to AVG malfunction. At the time of admission, fistulography revealed focal severe stenosis at the venous anastomosis site with complete thrombosis in the graft. We performed percutaneous transluminal angioplasty (PTA) with mechanical thrombectomy, and he was discharged with an improved flow of AVG. After that, we performed additional PTA 3 times at intervals of 2 months. We decide to make the new left brachio-axillary straight graft because of AVG malfunction. Twenty days later, he started hemodialysis again through the straight graft.

At 3 months after successful PTA, he went to an intervention clinic due to recurrent AVG malfunction. We performed Doppler US and fistulography again, and they showed focal severe stenosis at the venous anastomosis site with complete occlusion and internal thrombosis in the graft. Because this region is affected by arm motion, we performed abduction anteroposterior (AP), oblique images and adduction AP, oblique images simultaneously. We confirmed that stenosis was more severe in the adduction position than in abduction position (Fig. 1), and these dynamic image acquisitions are routinely used in our institution.

We performed a repeated PTA for stenotic portion on venous anastomosis site using high-pressure balloon (Mustang, Boston Scientific Co, Malborough, MA). Then, we conducted PTA by using gradually upsizing balloon size from 5 to 6 mm and 7 mm, after mechanical thrombectomy in the graft using 7F Desilets-Hoffman sheath (Cook Medical, Bloomington, IN).

After this procedure, the patient visited hospital several times again due to the venous anastomosis site stenosis, and we performed the balloon PTAs in the same way during every visit. The patient underwent 5 balloon PTAs at intervals of approximately 2 months.

For the frequent recurrence of venous anastomotic site stenosis, we decided to place the stent to salvage the graft before creating another access in after having discussion with clinician. This region is a joint especially affected by motion; hence, we planned to use a suitable stent designed for this application. In addition, this stent was specialized for treating lower extremity arteries; we fully informed this feature of the stent and necessity of this treatment to the patient, then we conducted stent placement after having their consent.

First, we took US-guided antegrade and retrograde punctures at the brachio-axillary graft to access the fistula and mechanical thrombectomy by using 7F Desilets-Hoffman sheath. Then, we performed venous anastomotic angioplasty with a 7 mm × 40 mm high-pressure balloon followed by the placement of 6 mm × 40 mm Supera stent. At the beginning of the procedure, 3000 IU heparin was administered in advance through peripheral line for the prevention of potential thrombosis. The stenosis site was completely recanalized without procedure-related complication (Fig. 2). One week after the procedure, there was no evidence of migration or deformity of the stent in the postprocedure X-ray. And follow-up Doppler US examinations were performed at 1 and 3 months after procedure, there was no evidence of restenosis or in-stent thrombosis, and average flow volume in the stent was >1000 mL/min (Fig. 3). And he has been on dialysis for 6 months without any problems after stent placement.

3. Discussion

Patients with ESRD who cannot undergo dialysis using a native AVF due to an unsuitable anatomy or access failure are a challenge to treat.[8,9] The updated Kidney Disease Outcomes Quality Initiative and European guidelines recommend brachio-basilic arteriovenous fistula or prosthetic graft as an alternative to AVF when no forearm vessels are suitable for radio-cephalic or brachio-cephalic AVF.[1,2] Prosthetic grafts have several advantages over BVT, especially in obese patients, which can be made easier and allow early punctures. Davoudi et al[3] reported that there was no statistical difference between the 2 groups in terms of primary patency time and that upper-arm AVG is safe and has a comparable primary patency rate to BVT. This result is consistent with several recently published studies comparing AVG versus BVT in these patients.[10,11] This is because of recent improvement in the material of prosthetic graft.[3,10]

Nevertheless, thrombosis in prosthetic graft is the most common complication, and late thrombosis is mostly due to progressive stenosis over the anastomosis.[4] In the case of a brachio-axillary graft, especially, there are chances for kinking or bending due to upper-arm motion. Surgical treatment, balloon PTA, and stent placement may be available, but conventional surgical revision may be difficult and dangerous in this location, whereas endovascular treatment is easier and more effective. Up to now, many studies reported AVF/AVG endovascular treatment with stent. In early stage, there was no improvement with stent placement compared with angioplasty alone in dialysis grafts with venous outflow stenosis.[12] It might be happened because the early model Gianturco-Rosch Z stent (Cook Medical, Bloomington, IN) and Wallstent (Boston Scientific, Natick, MA) were not functioning properly. However, several current studies with nitinol SMART stent (Cordis Corp, Miami Lakes, FL) suggested that stent placement was more effective compared with angioplasty alone.[13,14] Chan et al[15] reported an increase in access flow and primary patency with nitinol stent, especially in AVG. In recent years, as covered stents are used, the effectiveness of the covered stents is underlined, and many studies on it are proceeded.[16–18] However, these results did not focus on the brachioaxillary graft, and it was not considered at all that stent fracture may occur due to the motion of the axillary anastomosis site, it is not considered at all. However, we focused on this point and tried to apply the Supera stent in the present case.

The Supera stent is made of 6 pairs of closed-end interwoven nitinol wires with helical structure. The helical structures have been shown to enhance radial force, flexibility, and kink resistance and are designed to be suitable for the arterial anatomy. Especially it is useful for femoropopliteal artery. Because femoropopliteal artery gets increased stress from torsion, bending, and radial compression forces by crossing 2 joints (hip and knee) ,[19] Scheiner et al[20] reported 64 (24.5%) stents had complete or partial fractures in femoropopliteal arteries among 261 stents.

Kinking and fracture of the stents tend to occur in area where receive stress repetitively, but this stress is not evenly distributed

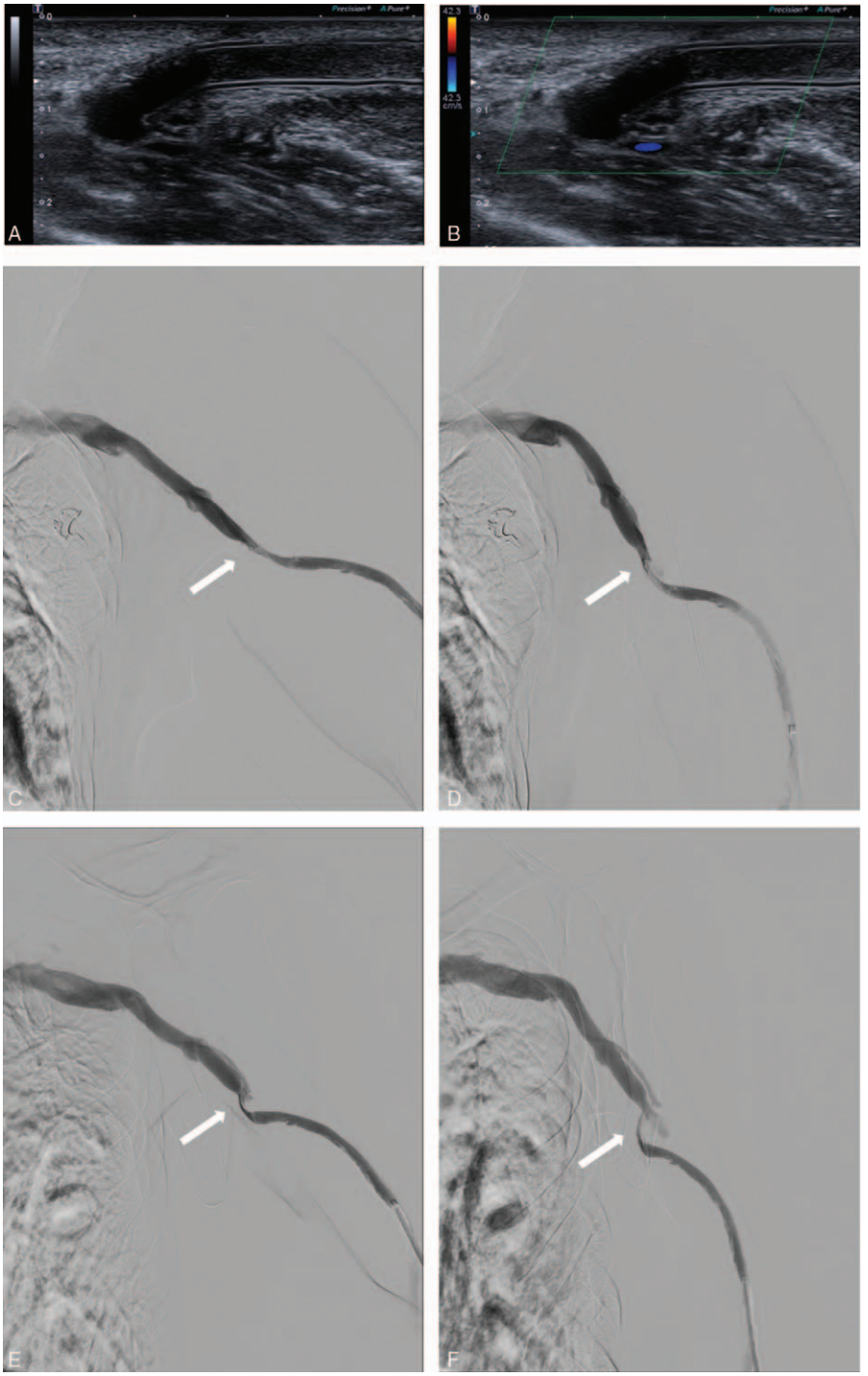

Figure 1. Preprocedural Doppler ultrasonography (US) (A, B) and fistulography (C–F): (A) gray scale image, (B) Doppler US, (C) anteroposterior (AP) view, abduction position (D) AP view, adduction position (E) oblique view, abduction position (F) oblique view, adduction position. (A, B) Ultrasonography shows complete occlusion with internal thrombosis in the graft. (C–F) All images show venous anastomotic stenosis of the left upper brachio-axillary arteriovenous graft (arrows).

through the previous slotted-tube stent. In comparison, the Supera stent disperses effectively radial, axial, and torsional forces, and minimizes stent fracture by partially emulating reticular network of native artery.[21–23]

In the previous studies, clinical outcomes of the Supera stent were demonstrated that have shown good results with a few cases of stent fracture.[23–25] Especially, in popliteal artery, which is known as the no stent zone due to high stent fracture risk from high flexion, the Supera stent did not develop any fractures and showed excellent overall patency.[26,27] We focused on this point in our study because axillary vein can also develop stent fracture or malfunction due to high flexion like popliteal artery. Finally, we placed Supera stent in the axillary vein anastomosis site; consequently, we could have satisfactory clinical outcomes. The

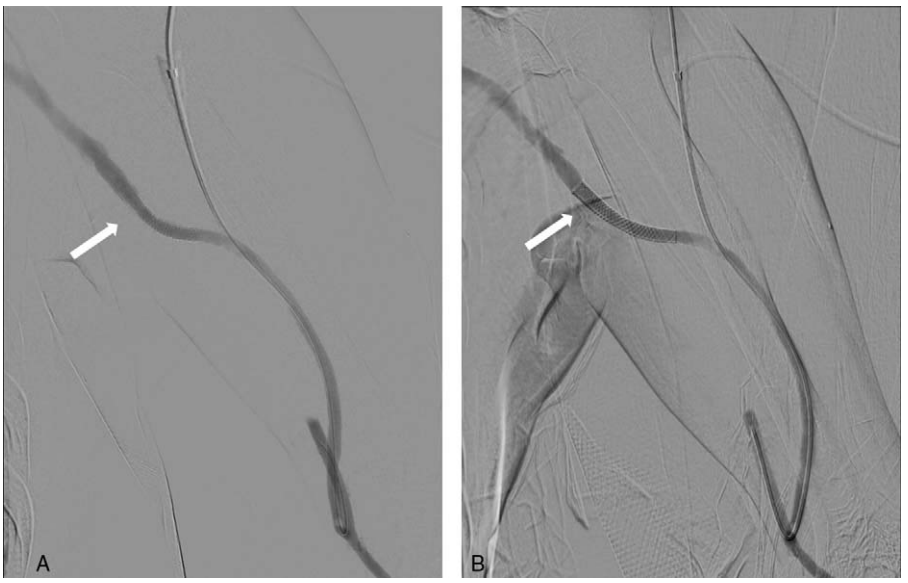

Figure 2. Poststenting fistulography, including anteroposterior view with adduction position (A) and oblique view with adduction position (B) shows complete restoration of luminal diameter at the venous anastomosis site (arrows).

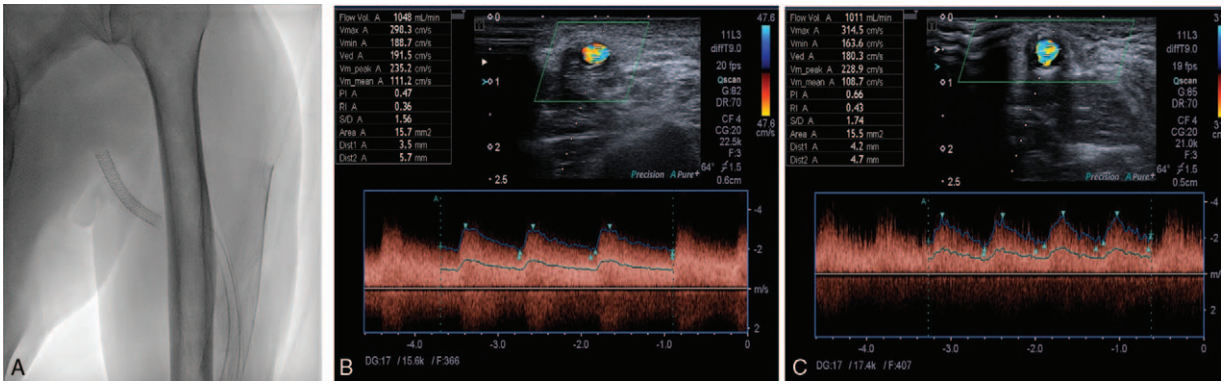

Figure 3. Follow-up plain radiography at 1-week (A) and Doppler US at 1 month (B) and 3 months (C). (A) There is no evidence of stent migration or stent deformity in left upper arm. (B, C) Doppler US images show no visible stenosis and the average flow volume is >1000 mL/min.

patient has received dialysis 3 times in a week with >1000 mL/min flow volumes at Doppler US up to 6 months follow-up. This suggests that the Supera stent can be a sufficient treatment option.

As mentioned ahead, we routinely use dynamic image acquisitions during fistulography in patients with brachio-axillary graft which provide useful information to decide treatment plan. In the present case, we also evaluated AP and oblique views in adduction and abduction positions, and it revealed that stenosis worsened at the adduction position due to high degree of flexion. We also found that the degree of stenosis in the oblique view was greater than AP view because the AP view could not show the stenosis between back and forth. Therefore, we suggest that fistulography should be performed at abduction and adduction position with AP and oblique view to confirm the entire blood vessel, and it can be helpful to lead confident planning and successful management.

Here, we described a case of a brachio-axillary AVG malfunction due to recurrent venous anastomotic stenosis that was treated by Supera stent application. Through this case report, we hope to highlight the clinical usefulness of Supera stent as an interventional treatment option for recurrent venous anastomotic stenosis of brachio-axillary AVG in the clinical practice.

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