Use of a fluoropolymer-based paclitaxel-eluting stent for arteriovenous graft outflow vein stenosis in hemodialysis patients

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ABSTRACT

We implanted a fluoropolymer-based paclitaxel-eluting stent (FP-PES) in four hemodialysis patients with refractory outflow venous stenosis of their arteriovenous graft. The mean observation period after FP-PES implantation was 11.5 ± 4.7 months (range, 7.0-18.0 months). After FP-PES implantation, the patients were evaluated by ultrasound every 3 months. No of the patients experienced neointimal hyperplasia in the stents during the observation period, and no reintervention was performed. FP-PESs could be an attractive alternative to percutaneous transluminal angioplasty for patients with refractory outflow venous stenosis of arteriovenous hemodialysis grafts. (J Vasc Surg Cases and Innovative Techniques 2021;7:326-31.)

Keywords: Arteriovenous shunt; Drug-eluting stents; Hemodialysis; Paclitaxel; Stenosis

Worldwide, the number of patients with chronic kidney disease requiring renal replacement therapy has been dramatically increasing.[1] The creation and maintenance of vascular access (VA) is mandatory to conduct hemodialysis as the main method of renal replacement therapy. An arteriovenous fistula (AVF) is generally recommended owing to the low risk of infection and durable patency.[2] An arteriovenous graft (AVG) is a second-line option when an AVF cannot be created. Several studies have revealed that the 1-year primary patency rate after AVG placement is lower than that for AVFs.[3,4] Although percutaneous transluminal angioplasty (PTA) is the treatment of choice for failed AVGs, the 1-year secondary patency after standard PTA has been far from satisfactory.[5]

We report our first experience with the use of a fluoropolymer-based paclitaxel-eluting stent (FP-PES) for the treatment of outflow vein stenosis of AVGs.

At our institution, patients with AVGs undergo routine ultrasound examinations every 3 months. The indication for treatment is determined comprehensively by a flow volume <500 mL/min or clinical symptoms such as elevated venous pressure or recirculation. Formerly, plain balloon angioplasty was routinely conducted, with bare metal stents implanted for AVG outflow vein stenosis only at early retreatment failure. After FP-PES became available, it was used for the early retreatment cases. In the present case series, the flow volume, measured by ultrasound, and the clinical symptoms determined the decision to treat, and serial ultrasound scans were performed 3 months after drug-eluting stent (DES) implantation. In all cases, statins were not used, and only patient 3 was taking an antiplatelet before and after DES implantation. We did not add dual antiplatelet therapy owing to the bleeding effect with repeated dialysis sessions. In Japan, drug-coated balloons and stent-grafts were not available during the study period.

CASE REPORT

Patient 1. An 86-year-old women with hypertension had required hemodialysis for 4 years. A 4.0- to 6.0-mm tapered expanded polytetrafluoroethylene loop graft (inflow, proximal radial artery; outflow, basilic vein) had been implanted in her left forearm for VA at the initiation of dialysis. After 3 years, axillary vein stenosis with left arm swelling developed. PTA was performed; however, restenosis occurred 3 months later. After unsuccessful balloon angioplasty, an 8.0- × 60-mm bare metal stent was placed. After 6 months, a new stenosis between the graft outflow and the bare metal stent had developed (Fig1, *a* and *b*). Because of concerns regarding short-term restenosis with plain balloon angioplasty or a bare metal stent, we decided to use a 7.0-mm × 120-mm FP-PES (Eluvia; Boston Scientific, Marlborough, Mass), which had become available at our institution (Fig 1, *c*). After implantation, the graft was still patent at 18 months (Fig 1, *d* and *e*).

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Author conflict of interest: none.

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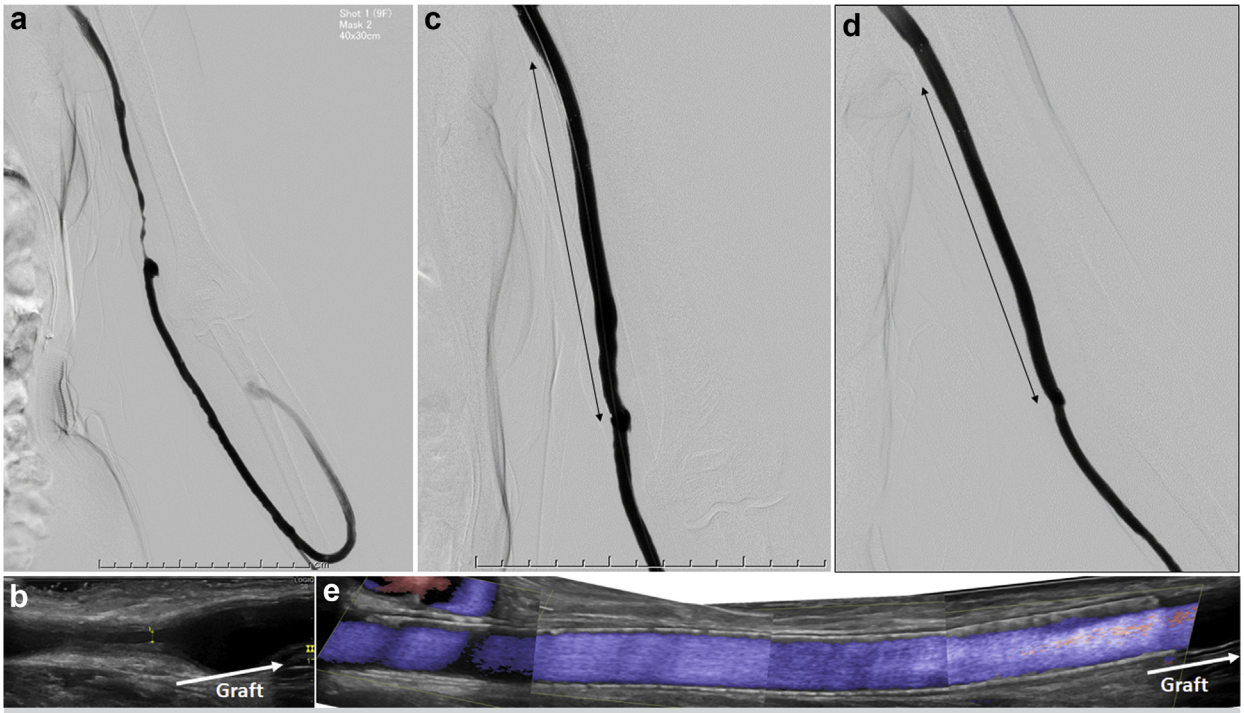

Fig 1. Angiograms and ultrasound images before and after 7.0-mm × 120-mm fluoropolymer-based paclitaxel-eluting stent (FP-PES) implantation for patient 1. Initial angiogram **(a)** and ultrasound scan **(b)** revealed in-stent restenosis and a new lesion between the graft outflow and bare metal stent. **c,** Angiogram after implantation of the FP-PES (*double arrow*) showing improvement of the stenosis. **d,** Angiogram 7 months after implantation of the FP-PES (*double arrow*) showing no restenosis. **e,** Ultrasound image 10 months after implantation of the FP-PES showing no restenosis.

Patient 2. A 63-year-old man with hypertension, hyperlipidemia, and abdominal aortic aneurysm had required regular hemodialysis for 2 years. He had had a 5.0-mm polyurethane (PU) loop graft (inflow, proximal radial artery; outflow, basilic vein) implanted in his right forearm at the initiation of dialysis. After 12 months, outflow vein stenosis had developed and was treated with PTA. A second PTA for the same area was required 11 months later; however, the patency period was only 3 months (Fig 2, *a* and *b*). At that time, the recoil was strong during attempted balloon angioplasty. Therefore, a 6.0-mm × 40-mm FP-PES (Eluvia; Boston Scientific) was implanted at the restenosis (Fig 2, *c*). After implantation, the graft was still patent at 11 months (Fig 2, *d*).

Patient 3. A 66-year-old man with hypertension had required regular hemodialysis for 17 years. He had had a 5.0-mm PU loop graft (inflow, brachial artery; outflow, cephalic vein) implanted in his right forearm after 7 years of dialysis. At 4.5 years after PU loop graft implantation, PTA was performed for outflow vein stenosis. Since then, PTA for outflow vein restenosis (Fig 3, *a* and *b*) was performed every 3 or 4 months. A 7.0-mm × 80-mm FP-PES (Eluvia; Boston Scientific) was implanted at the restenosis (Fig 3, *c*). After implantation, the graft was still patent at 10 months (Fig 3, *d*).

Patient 4. A 64-year-old woman with hypertension had required regular hemodialysis for 7 years. She had had a 5.0-mm PU loop graft (inflow, proximal radial artery; outflow, basilic vein) implanted in her right forearm after 5 years of hemodialysis. At 13 months after graft implantation, outflow vein stenosis had developed, and PTA was performed. Restenosis had occurred at the same area at 3, 6, and 9 months. After the last restenosis (Fig 4, *a* and *b*), a 6.0-mm × 120-mm FP-PES (Eluvia; Boston Scientific) was implanted at the restenosis (Fig 4, *c*). However, 3 months later, the graft–venous puncture site became infected. A portion of the infected graft was removed and partially replaced with a PU graft. The outflow venous anastomosis remained patent, and the DES was not infected. At 7 months after implantation of the FP-PES, the outflow vein was still patent (Fig 4, *d*).

DISCUSSION

In the present case series, FP-PESs were successfully implanted in four patients with outflow vein stenosis in

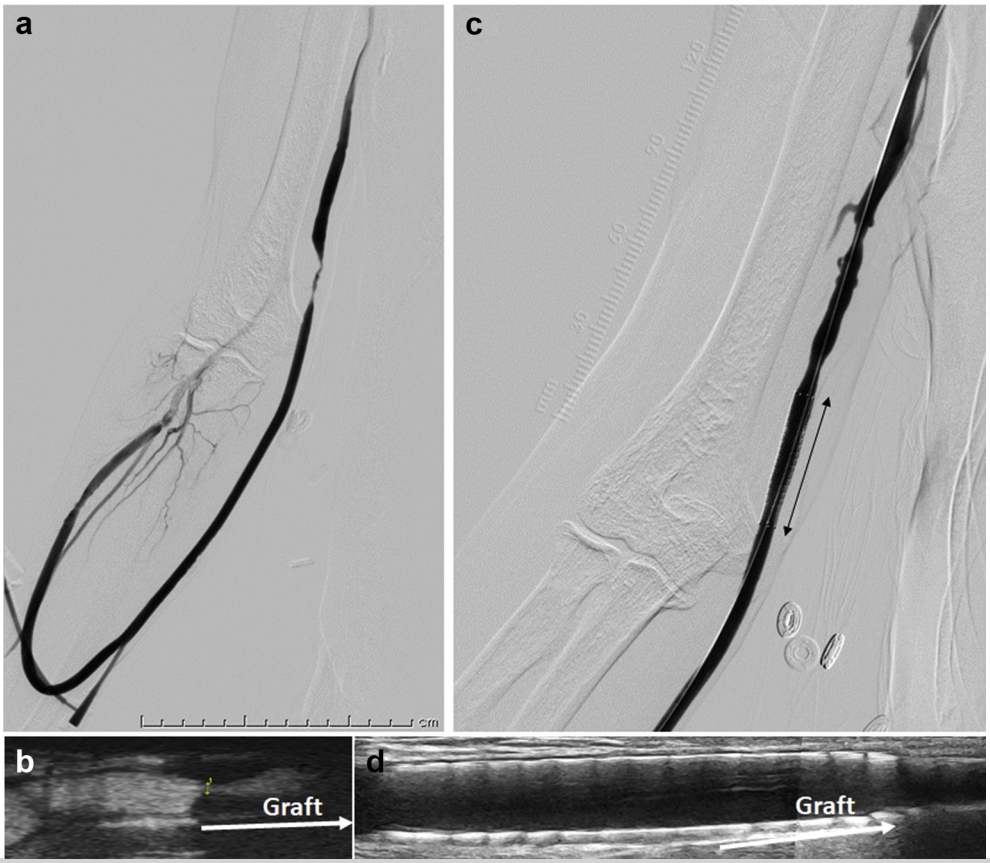

Fig 2. Angiograms and ultrasound images before and after 6.0-mm × 40-mm fluoropolymer-based paclitaxel-eluting stent (FP-PES) implantation for patient 2. **a,** Angiogram before implantation of the FP-PES showing outflow vein stenosis of the arteriovenous graft (AVG). **b,** Ultrasound image before implantation of the FP-PES showing intragraft stenosis at the graft–venous anastomosis. **c,** Angiogram after implantation of the FP-PES showing resolution of the stenosis. **d,** Ultrasound image 8 months after implantation of the FP-PES showing no restenosis.

an AVG (Table). During the mean observation period of 11.5 ± 4.7 months (range, 7.0-18.0 months) after FP-PES implantation, no neointimal hyperplasia occurred in any stent. In all four cases, no significant blood flow reduction was observed, and dialysis could be performed without any reinterventions.

PTA is still considered the first-line treatment for VA failure, with a 1-year secondary patency rate of 50% for AVFs and 25% for AVGs, which is clinically suboptimal.[6] The outflow vein stenosis of AVGs is mainly caused by intimal hyperplasia or vasoconstriction due to adventitial contraction, or a mixture of both.[7] Bare metal stents have been used in patients with refractory restenosis after PTA and have been effective for restenosis due to vasoconstriction but have not been satisfactory for restenosis caused by neointimal hyperplasia or the mixed types.[8] Drug-coated balloons might be effective for treating intimal hyperplasia restenosis but provide no scaffolding against adventitial contraction. The efficacy of stent-grafts compared with PTA has been reported in patients with AVG outflow vein stenosis, with a 1-year secondary patency rate of 47.6% compared with 24.8% for PTA[9]; however, edge stenosis and thrombotic occlusion remain clinical issues.[10]

In our case series, we used a FP-PES reported to be effective for AVFs in the treatment of outflow vein stenoses of AVGs and have confirmed a favorable clinical outcome.[11] The newer DESs with fluoropolymer coating (eg, Eluvia; Boston Scientific) releases drugs for longer and more sustainably than previous DESs.[12] We hypothesized that the stent would inhibit

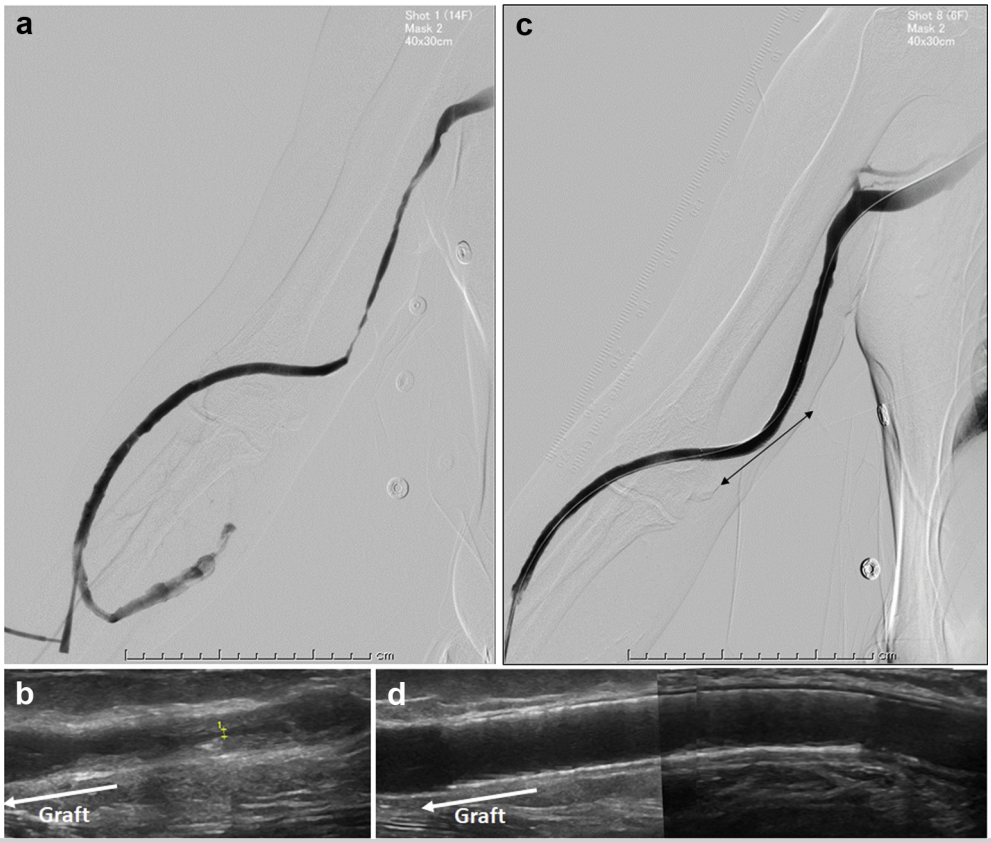

Fig 3. Angiograms and ultrasound images before and after 7.0-mm × 80-mm fluoropolymer-based paclitaxel-eluting stent (FP-PES) implantation for patient 3. **a,** Angiogram before implantation of the FP-PES stent showing outflow vein stenosis of the arteriovenous graft (AVG). **b,** Ultrasound image before implantation of the FP-PES showing intimal hyperplasia in the stenotic outflow vein of the AVG. **c,** Angiogram after implantation of the FP-PES (*double arrow*) showing improvement of the stenosis. **d,** Ultrasound image 5 months after implantation of the FP-PES showing no restenosis.

recoil, the drug would inhibit intimal hyperplasia, and the polymer would contribute to the sustained drug release and antithrombotic effects, resulting in a favorable outcome. A previous meta-analysis suggested an association between paclitaxel and increased mortality when used in association with femoropopliteal disease.[13] A randomized controlled trial of paclitaxel-coated devices and a meta-analysis of their use in AV graft access showed no differences in mortality.[14,15] More clinical studies are needed to confirm the effects and safety of the use of FP-PESs.

The present study had several limitations. The study included a small number of cases from a single-center experience with follow-up of ≤18 months. Randomized controlled trials are needed to determine whether this treatment is truly an improvement. In addition, the sustainable effect of a DES, especially after the complete elution of the paclitaxel is unknown.

CONCLUSIONS

In the present retrospective case series of four patients, we used a FP-PES for outflow vein stenosis of AVGs and obtained good early results. More studies are needed to assess the long-term effectiveness and safety of this treatment.

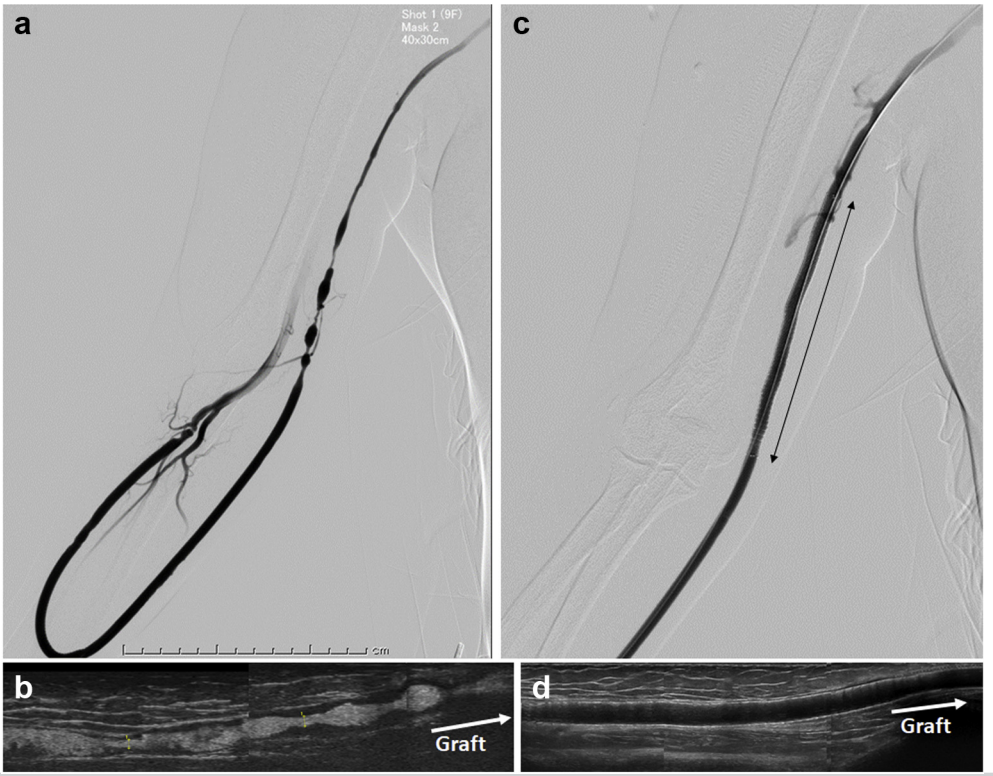

Fig 4. Angiograms and ultrasound images before and after 60-mm × 120-mm fluoropolymer-based paclitaxel-eluting stent (FP-PES) implantation for patient 4. Angiogram **(a)** and ultrasound scan **(b)** before implantation of the FP-PES showing outflow vein stenosis of the arteriovenous graft (AVG). **c,** Angiogram after implantation of the FP-PES (*double arrow*) showing improvement of the stenosis. **d,** Ultrasound image 4 months after implantation of the FP-PES showing no restenosis.

Table. Patient summary

Pt. No.	Age, years	Sex	VAIVT before FP-PES implantation, No.	Patency period, months		Flow volume, mL/min (target lesion diameter, mm)				FP-PES diameter × length, mm
				Before (mean)	After	Before FP-PES implantation	After 3 months	After 6 months	After 9 months	
1	85	F	>3	4.5	>18	232 (1.0)	729 (6.0)	876 (6.3)	961 (6.0)	7 × 120
2	63	M	>3	6.5	>11	192 (0.9)	NA	395 (5.2)	466 (5.1)	6 × 40
3	66	M	>12	4.5	>10	280 (0.7)	1025 (6.2)	989 (6.0)	642 (6.3)	7 × 80
4	64	F	>4	2.5	>7	413 (1.4)	1054 (5.3)	885 (5.3)	NA	6 × 120

F, Female; *FP-PES,* fluoropolymer-based drug-eluting stent; *M,* male; *NA,* not applicable; *Pt. No.,* patient number; *VAIVT,* vascular access intervention therapy.

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