

## Partial Endografting of Prosthetic Vessels in Internal Shunts for Hemodialysis Access to Allow Early Puncture

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**Abstract:** Purpose: Expanded polytetrafluoroethylene (ePTFE) vascular grafts used for internal shunts in patients undergoing hemodialysis cannot be punctured until 1 or 2 weeks after the operation to implant them. In an attempt to allow earlier puncture of these grafts, we developed a partial intravenous endografting procedure in which a segment of the prosthetic antebrachial loop graft is inserted into the existing shunt vein.

Patients and methods: Between April 2001 and September 2002, 10 patients (5 men and 5 women; mean age,  $66 \pm 9$  years) underwent partial endografting procedure. The ePTFE vascular grafts used were 5 or 6 mm in diameter. The length of the endograft area in the vein ranged from 65 to 145 mm.

Results: In all patients, the endograft area was first punctured 1 or 2 days after operation. The only complication was one puncture in a space between the graft and vein in a patient with thrombotic occlusion. There were no cases of infection, hematoma formation, or graft stenosis during a postoperative follow-up period ranging from 1 to 18 months. Patients followed for 1 year or longer had a course similar to that of patients who have undergone a routine shunt operation using a prosthetic vascular graft.

Conclusions: Partial intravenous endografting of ePTFE grafts permitted shortening the time to initial puncture of these grafts in patients undergoing hemodialysis (Jpn. J. Vasc. Surg., 12: 515-519, 2003)

**Key words:** Hemodialysis, Prosthetic graft, Endografting, Expanded polytetrafluoroethylene, Early puncture

### Introduction

In patients given an expanded polytetrafluoroethylene (ePTFE) vascular graft to provide access for hemodialysis, the graft cannot be punctured until 1 to 2 weeks after implantation. Therefore, patients in whom shunt failure is beginning to develop undergo implantation of a vascular graft in the contralateral arm when the remaining shunt-use period is considered adequate. When the remaining shunt-use period

is short, intravenous dialysis using a double-lumen catheter is employed until the new graft can be used. Use of a catheter has several disadvantages, however, including a marked decrease in the quality of life. Because no synthetic grafts used for hemodialysis access have been found to be superior to grafts made of ePTFE, a method that allows early puncture of ePTFE grafts has been sought. We have addressed this issue by developing a partial intravenous endografting procedure in which a segment of the ePTFE antebrachial loop graft is inserted into the existing shunt vein. We here report our initial results with this technique.

### Patients and methods

Between April 2001 and September 2002, 10 patients (5

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**Table** Patients in whom partial endografting was used

Patient's age/sex	Time on dialysis	Previous dialysis access operations	Vascular graft diameter (mm)	Length of endograft (mm)	Follow-up after endografting (mo)
56/M	3 y / 1 mo	2	6	65	18
65/F	6 y / 1 mo	2	6	92	17
62/M	2 y / 7 mo	3	5	132	16
67/F	6 y / 2 mo	3	5	74	14
82/F	5 y / 2 mo	2	5	114	9
76/M	2 y / 11 mo	3	5	136	6
55/M	15 y / 9 mo	2	6	127	4
65/F	1 y / 5 mo	3	5	110	4
73/M	3 y / 7 mo	2	5	145	3
71/F	6 mo	2	5	111	1

men and 5 women aged 55 to 82 years [mean,  $66 \pm 9$  years]; **Table 1**) requiring hemodialysis underwent partial endografting of ePTFE vessels. The patients had been receiving dialysis for periods ranging from 6 months to 15 years, 9 months (mean, 4 years, 8 months). All patients had undergone hemodialysis access surgery at least twice previously. Shunt failure before operation was associated with nonthrombotic occlusion in the cubital vein in 5 patients, recoiling after percutaneous transluminal angioplasty in the antebrachial artery and vein in 3 patients, and thrombotic occlusion in 2 patients. Four patients had varication in the antebrachial vein.

The endografting procedure was performed with the patient under local anesthesia. A cubital artery, the central and distal sides of the endograft area of the antebrachial vein, and the brachial vein were dissected and exposed (**Fig. 1 and 2**). One side of the loop was buried from the brachium to the antebrachial distal side using a tunneler. The central and distal sides of the venous endograft area were ligated to interrupt shunt blood flow. The venous endograft area was opened, and predilation of the stenotic area was performed by using a bougie (3-6 mm)(**Fig. 3**). If thrombotic occlusion was observed, the lumen of the vein was irrigated with saline and as many thrombi as possible were removed before the prosthetic graft was inserted into the vein. Anastomosis was performed on the venous and artery sides. The ePTFE grafts used (Gore-Tex Vascular Grafts; W.L. Gore & Associates, Flagstaff, AZ) were either 5 mm (7 patients) or 6 mm (3

patients) in diameter. The length of the endograft area in the existing shunt vein ranged from 65 to 145 mm (mean,  $111 \pm 28$  mm). Postoperatively, angiography and ultrasonography were used to assess the endograft area.

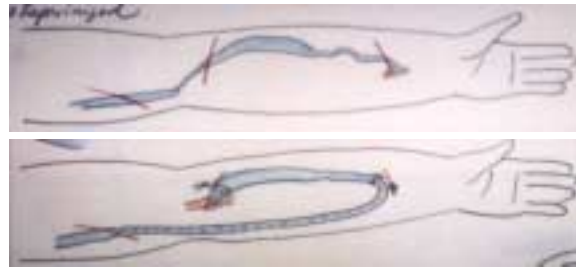
### Results

In all patients, the endograft area was first punctured 1 or 2 days after operation. Access for dialysis was readily achieved and unremarkable in 9 of the 10 patients. In the other patient, the puncture cannula entered a space between the graft and vein at the first puncture. Because this patient had shunt failure due to thrombotic occlusion preoperatively, this space may have developed as a result of excessive dilation caused by thrombi in the endograft area and inadequate removal of these thrombi by irrigation during surgery. Puncture was resumed after a week in this patient, and the subsequent course was unremarkable. No patient had infection, hematoma formation, or stenosis or narrowing in the endograft area during postoperative follow-up ranging from 1 to 18 months. The 4 patients who were followed for 1 year or longer had a course similar to that of patients who have undergone a routine shunt operation using a prosthetic vascular graft. However, slightly less antebrachial edema was observed in patients in whom the endograft area was long.

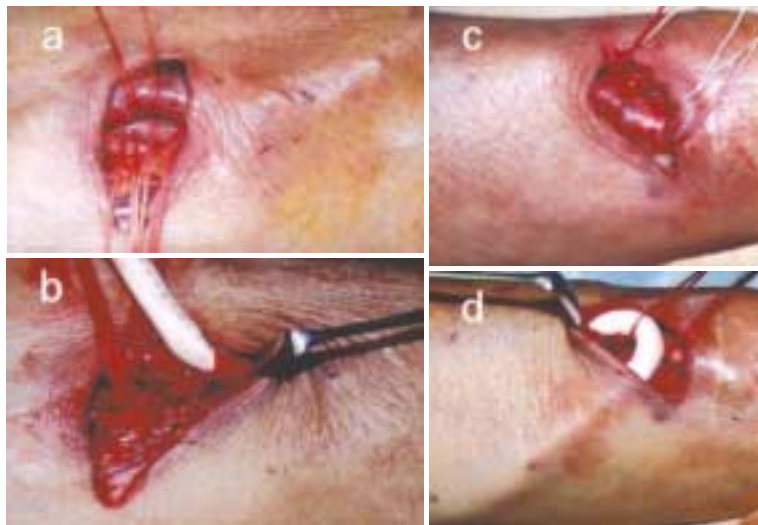
**Figures 4 and 5** show results of angiography in two patients. The patient in **Figure 4** had recoiling of the right antebrachial vein preoperatively and underwent endografting using a 5-mm ePTFE graft in a 110-mm area of the antebra-



**Fig. 1** Surgical procedure. 1-a shows pre-operation, 1-b shows endografting, 1-c shows post-operation.



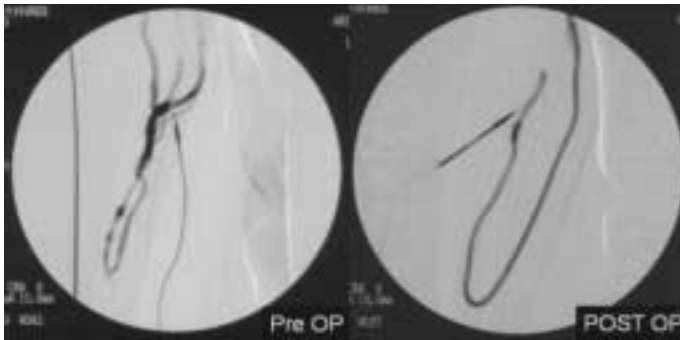
**Fig. 2** Operation scheme.



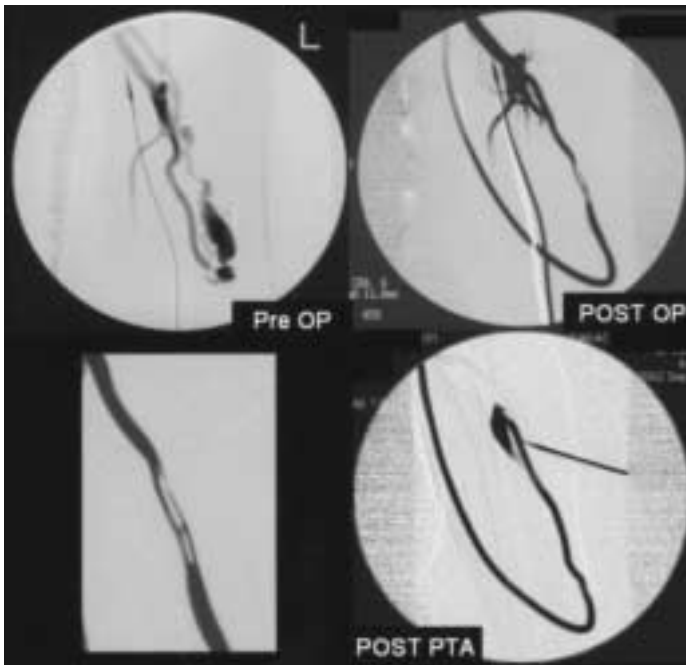
**Fig. 3** The prosthetic graft was inserted into the vein.

chial vein. The digital subtraction angiogram shown in **Figure 5** was obtained in the patient with varication in the antebrachial vein and subsequent thrombotic occlusion of the left antebrachial shunt. As a result of failure of the first puncture, the graft was compressed from outside by the puncture cannula. This area was repaired by using a balloon catheter.

**Figure 6** shows ultrasound studies done 7 days, 6 months and 12 months after the endografting procedure. The venous endograft area was compared with the segment of the graft buried subcutaneously. Early after operation, venous capsule formation was observed in the endograft area. Also, there was more space in the area surrounding the subcutane-



**Fig. 4** Recoiling of the right antebrachial vein preoperatively and underwent endografting using a 5-mm ePTFE graft in a 110-mm area of the antebrachial vein.



**Fig. 5** The patient with varication in the antebrachial vein and subsequent thrombotic occlusion of the left antebrachial shunt. The graft was compressed from outside by the puncture cannula. This area was repaired by using a balloon catheter.

ous graft than in the endograft area. Six months after surgery, the graft in the venous endograft area remained in a normal loop configuration, whereas deformation into an ellipse had occurred in the subcutaneous area.

### Discussion

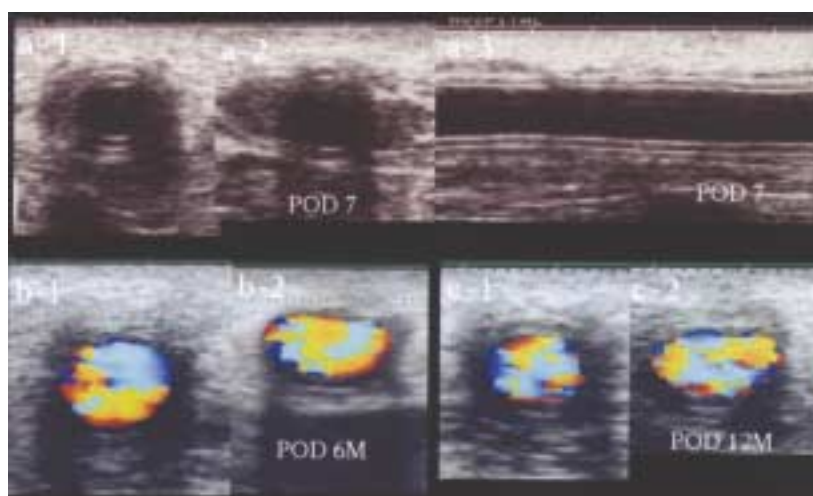
Implantation of prosthetic grafts for hemodialysis access

by using intravenous endografting has several advantages. First, because the graft is encapsulated by the autologous vein, it can be punctured as soon as 1 day after operation<sup>1-3)</sup>. Therefore, it is not necessary to use a double-lumen catheter for hemodialysis access. As a result, the hospitalization period is reduced to 3 to 5 days and the patient's quality of life is improved. Second, implantation of a new prosthetic graft into the contralateral arm is avoided, along with the risk of stenosis at the graft-vein anastomosis in that arm. Because the arm with the established shunt will already have a well-developed vein, creation of a new anastomosis between the graft and vein in that arm should be easy if the venous diameter is adequate. Moreover, any stenosis that develops at the anastomosis will be relatively mild and usually easy to treat<sup>4-7)</sup>.

Compared with polyurethane vascular grafts, ePTFE grafts have a limitation with respect to early puncture. However, the incidence of stenosis at the anastomosis has been reported to be higher with polyurethane grafts (private communication). Moreover, because polyurethane grafts have low affinity with surrounding tissue, hematomas tend to form after puncture, and this sometimes results in infection. In contrast, ePTFE vascular grafts have good bioaffinity, so most vascular surgeons preferable to use

them. Our partial venous endografting procedure may decrease the time required before first puncture of ePTFE grafts, thereby eliminating the principal limitation of these prostheses.

In general, when there is no blood flow in the lumen of a vein, intimal adhesion develops, resulting in occlusion. Thus, with high-level ligation procedures to treat varices in the



**Fig. 6** Ultrasound studies done 7 days, 6 months and 12 months after the endografting procedure. a-1 and 3, b-1 and c-1 are the endograft area. a-2, b-2 and c-2 are the nonendograft area.

lower limbs, interruption of blood flow in the varices induces adhesion and closure of the venous lumen. In shunt veins, termination of blood flow induces nonthrombotic occlusion. We found that after venous endografting, capsular adhesion developed between the vein in the endograft area and the prosthetic graft. In patients with varicose veins thicker than the external diameter of the ePTFE graft who undergo our endografting procedure, we apply an elastic bandage postoperatively to compress the endograft area to promote vein-graft adhesion and capsule formation. In our patient with preoperative thrombotic occlusion in the shunt vein in whom the first puncture failed, the presence of thrombi between the graft and vein may have impaired capsule formation in the endograft area. Therefore, in such patients, adequate removal of thrombi during the endografting procedure and confirmation of the absence of a space between the graft and vein before puncture are critical.

### Summary

We found venous endografting to be useful in reducing the time required before initial puncture of ePTFE vascular grafts. In 9 of 10 patients who underwent this operation, puncture was possible 1 to 2 days after operation, and no complications developed. Additional follow-up should focus on comparing long-term puncture-induced damage in the endograft

area with that in the nonendograft area to determine whether endografting provides some resistance to such injury.

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