Renal revascularization with polytetrafluoroethylene grafts[1]

Raja B. Khauli, M.D.
Andrew C. Novick, M.D.
George V. Coseriu, M.D.

Ten patients have undergone renal vascular reconstruction with an aortorenal bypass using a polytetrafluoroethylene (PTFE) graft. These operations were indicated as treatment for renovascular hypertension in 9 patients and for renal allotransplantation in 1. Vascular reconstruction was technically successful in all patients with no perioperative complications. Blood pressure control was improved in all patients, and in all those with renal insufficiency preoperatively, renal function was improved or stabilized. Renal revascularization with PTFE grafts has yielded excellent results and offers acceptable surgical management for renovascular disease in selected patients.

Index terms: Hypertension, renal • Polytetrafluoroethylene • Vascular surgery

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The diagnosis and management of renovascular disease were of major interest to Bruce H. Stewart, M.D., and he made many significant contributions in this area. Our current work is part of the legacy of his unusual skill and commitment in this field.

Presently, the two main indications for renal revascularization are the treatment of renovascular hypertension and the preservation of renal function. Aortorenal bypass has emerged as the preferred surgical method. The most commonly employed bypass grafts have been autogenous saphenous vein and autogenous arterial grafts, including the hypogastric and splenic arteries. Although recent reports have suggested that autogenous arterial grafts may provide optimal material for renal artery replacement,[1–3] the fre-

[1] Department of Urology, The Cleveland Clinic Foundation. Submitted for publication Dec 1983; accepted Jan 1984. jw

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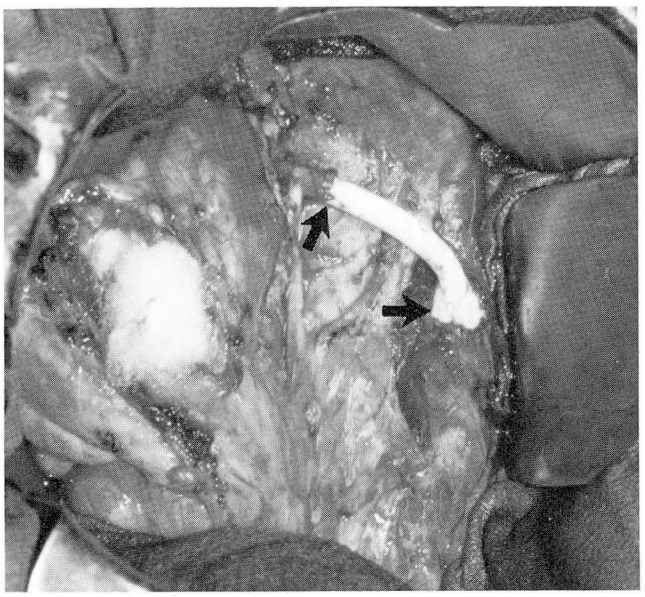

Fig. 1. Operative photograph of completed right aortorenal bypass with PTFE graft. Sites of anastomosis to the aorta and renal artery are indicated (*arrows*).

quency of atherosclerosis in such medium-size arteries has limited their use in vascular reconstruction, and autogenous saphenous vein has remained the graft of choice for most aortorenal bypass operations.[4] When an autogenous graft is unavailable, synthetic grafts, including Dacron and expanded polytetrafluoroethylene (PTFE), have been used for renal revascularization. Results with Dacron grafts for aortorenal bypass have been satisfactory; however, an increased incidence of early thrombosis has been observed.[5,6] Presently, little information is available concerning the use of the newer PTFE graft for renal revascularization. We present our experience with PTFE grafts for renal revascularization with emphasis on indications, technical aspects, and results.

Materials and methods

From October 1979 to July 1983, 10 patients (6 men, 4 women) underwent renal vascular reconstruction with expanded PTFE grafts (Gore-Tex). Their ages ranged from 45 to 67 years (mean, 59.9 yrs). Nine patients had renal artery disease diagnosed after an evaluation for diastolic hypertension that included excretory urography, renal angiography, and peripheral and differential renal vein plasma renin determinations. Eight of the 9 patients also had renal insufficiency with serum creatinine levels >2.0 mg/dl. The cause of renal artery disease was atherosclerosis in 8 patients and fibrous dysplasia in 1. In the former group, 6 patients had diffuse atherosclerotic disease with involvement of the coronary, carotid, and/or iliofemoral vessels. Prior to renal revascularization, coronary artery bypass grafting had been performed in 5 patients, carotid endarterectomy in 3, and femoral-popliteal bypass in 1. Also, 5 of these patients had previously undergone unsuccessful transluminal angioplasty of the renal artery. In 1 patient, PTFE was used to perform renal allotransplantation for end-stage renal disease.

Indications for the use of PTFE grafts were unavailability of the saphenous vein secondary to previous use in 6 patients, thrombophlebitis in 2, and a small-caliber saphenous vein in 2 others. The 9 patients with renal artery disease had an aortorenal bypass with PTFE (*Fig. 1*). Our technique for performing aortorenal bypass has been described.[4] In the patient undergoing renal allotransplantation, extensive calcific atherosclerosis was found in the lower aorta and iliac arteries; revascularization was accomplished with a 10 cm PTFE graft anastomosed end to side to the upper aorta and end to end to the transplant renal artery (*Fig. 2*).

All patients were evaluated postoperatively with radionuclide studies and digital subtraction angiography (DSA) or conventional arteriography. Follow-up monitoring included serum creatinine determinations and regular blood pressure measurements. The follow-up interval ranged from three to 48 months (mean, 22.9 mo).

Results

The clinical data and results of renal revascularization with PTFE are presented (*Table*). Criteria for judging the effect of surgery on blood pressure were as follows: *Cure* was defined as a blood pressure of 140/90mm Hg or less postoperatively; *improvement* was defined as a reduction in diastolic pressure of 15mm Hg or more or normal readings with the patient taking medications; and *failure* applied to patients not qualifying for either of the aforementioned categories. Thus, the blood pressure control of all 10 patients in this series, including the patient with a kidney transplant, was defined as cured or improved after surgery. Postoperative renal function was also improved or stable in all patients.

No operative complications or deaths occurred

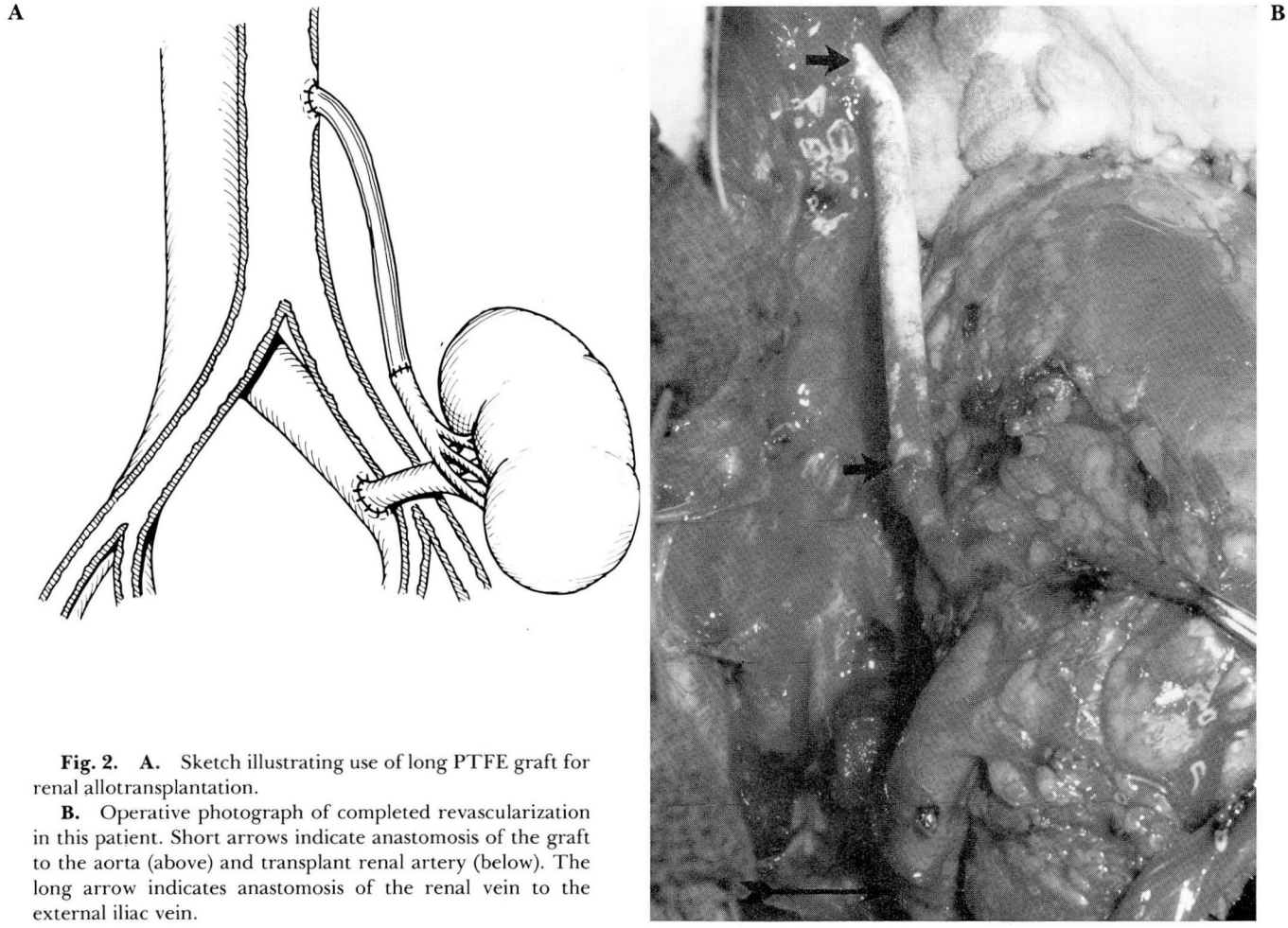

Fig. 2. A. Sketch illustrating use of long PTFE graft for renal allotransplantation.

B. Operative photograph of completed revascularization in this patient. Short arrows indicate anastomosis of the graft to the aorta (above) and transplant renal artery (below). The long arrow indicates anastomosis of the renal vein to the external iliac vein.

in this series, and graft patency was demonstrated via DSA or conventional arteriography in all patients (*Fig. 3*). Delayed long-term complications were seen in 2 patients. Patient 3 suffered a cerebrovascular accident 14 months postoperatively and required a left carotid endarterectomy. The other, patient 4, died 23 months postoperatively of severe congestive heart failure

Table. Patient characteristics and results of renal revascularization with PTFE

Patient	Age (yrs)/Sex	Disease type	Preoperative serum creatinine (mg/dL)	Preoperative bp	Operative procedure	Postoperative serum creatinine (mg/dL)	Postoperative bp	Follow-up (mo)
1	62/M	ASO	5.9	150/105	L/aortorenal	3.6	120/80	35
2	67/M	ASO	2.6	180/110	R/aortorenal	1.8	160/90	26
3	57/M	ASO	1.6	220/130	L/aortorenal	1.2	130/90	48
4	59/M	ASO	6.8	170/110	L/aortorenal	5.5	140/90	23 (died)
5	59/M	ASO	2.2	220/100	R/aortorenal	1.6	170/85	6
6	67/M	ASO	2.5	220/110	L/aortorenal	2.4	120/90	19
7	66/F	ASO	3.3	250/110	R/aortorenal	2.8	150/90	3
8	45/F	FD	2.5	180/100	L/aortorenal	1.7	120/70	6
9	66/F	ASO	1.5	200/100	R/aortorenal	0.9	140/80	26
10	51/F	ESRD	Dialysis	190/110	Renal allotransplantation	1.3	150/70	37

ASO = atherosclerosis; FD = fibrous dysplasia; ESRD = end-stage renal disease; *L* = left; and *R* = right.

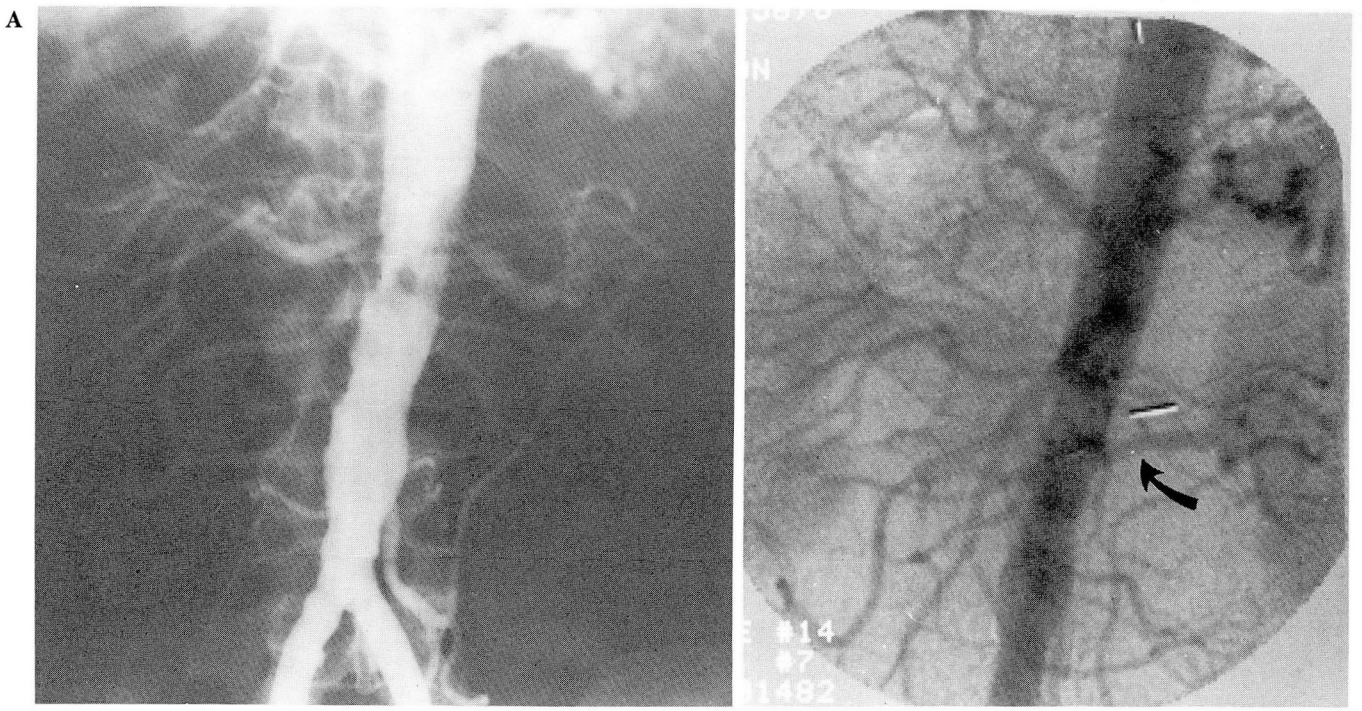

Fig. 3. A. Preoperative aortogram of a 60-year-old man, showing tight left renal artery stenosis from atherosclerosis. **B.** Following a left aortorenal bypass with PTFE graft, DSA shows patent bypass graft (*arrow*) to the left kidney.

despite stable renal function and improved blood pressure control.

Discussion

Of the various procedures presently available for renal revascularization, aortorenal bypass has become the method of choice in most cases.[4,7] Autogenous vascular grafts have proved most reliable and are currently preferred.[1–4,8] Synthetic vascular grafts are indicated when autogenous grafts are unavailable or when adjunctive aortic replacement is done. Although the results of renal revascularization with Dacron grafts have been satisfactory, a significant incidence of early postoperative thrombosis and graft failure ranging from 15% to 35% has occurred.[5,6,8] More recently, interest has grown in the use of the newer PTFE graft after the demonstration of excellent patency rates in peripheral arterial reconstruction (80% to 90% after one year).[9–12]

We have used the PTFE graft for renal revascularization in 10 patients; most were high surgical risk candidates with diffuse atherosclerotic disease and renal insufficiency. Our results, 100% graft patency over a mean follow-up interval of 23 months, are quite promising and compare favorably to patency rates of 65% to 85% reported with Dacron grafts.[5,6,8] In the few previous reports concerning the use of PTFE grafts for renal revascularization, excellent patency rates were also observed. Haimov et al[9,13] reported 100% graft patency in 7 patients who underwent aortorenal bypass and in 1 patient who underwent ilio-renal bypass with PTFE over follow-up intervals of two to 30 months. Ansel and J. M. Johnson[12] achieved 100% patency in five aortorenal reconstructions with PTFE followed for a minimum of one year. Similarly, all five aortorenal bypasses using PTFE grafts reported by W. C. Johnson[14] were patent.

The high success rate with the PTFE graft has been attributed to a low rate of infection, a reduced incidence of thrombosis, and elimination of true or false aneurysm formation.[13,14] Although equally favorable results have been obtained with both reinforced PTFE (Gore-Tex) and non-reinforced PTFE (Impra), the latter is thought to allow better cellular ingrowth and incorporation of fibroblasts in its wall, leading to a true neointimal formation.[15] Such a formation may be an important determinant of long-term patency. Regardless of the type of PTFE used, this graft is light and pliable and requires no preclotting. When PTFE is used to bypass short

distances, as in aortorenal bypass, few problems relating to angulation or kinking have been encountered.

Nevertheless, when performing vascular anastomoses with the PTFE graft, a few special details must be observed. Only monofilament suture material (i.e., Prolene) should be used to avoid the sawing effect of braided material (i.e., silk) which causes enlargement of the needle holes. Small, tapered, non-cutting needles are used, and one must take care to follow the curvature of the needle when passing it through the graft wall. The graft should be just long enough to bridge the defect without tension at the suture line, while avoiding excessive length which may tend to make the graft kink or become angular when retraction of the surgical incision is released. When graft suturing is completed and all vascular clamps have been removed, leaks from needle puncture holes are more commonly observed with PTFE than with autogenous vascular grafts. This is easily corrected by applying oxidized cellulose (Oxycel) to the suture line and maintaining gentle pressure for approximately 10 minutes.

Our results with aortorenal bypass employing PTFE grafts are encouraging and support the continued use of this prosthetic material for replacement of the renal artery when autogenous vascular grafts are unavailable.

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Commentary

John A. Libertino, M.D. (Chairman, Division of Surgery, Lahey Clinic Medical Center, Burlington, Mass.): Drs. Khauli, Novick, and Coseriu have nicely demonstrated that when autogenous saphenous vein or cephalic vein is unavailable for renal revascularization, PTFE grafts are a viable, safe, effective alternative. Their 100% patency rate clearly demonstrates this conclusion.

At our renovascular center, the aortorenal saphenous vein bypass graft or alternatives, such as the splenorenal or hepatic saphenous vein bypass graft, have emerged as the preferred method of treatment. It would appear that PTFE is preferable to Dacron when autogenous graft material is unavailable, as Dacron grafts have a higher reported thrombosis rate.

It is appropriate that this communication be included in a symposium dedicated to the memory of Dr. Bruce H. Stewart, a major innovator and contributor in the field of renovascular disease. I am certain that his colleagues at the Cleveland Clinic will continue to make major contributions to this field and to perpetuate the surgical heritage he began.