Endoluminal repair of atypical dissecting aneurysm of descending thoracic aorta and fusiform aneurysm of the abdominal aorta

James May, MS, FRACS, Geoffrey White, FRACS, Weiyun Yu, BSc (Med), MB, BS, Toos Sachinwalla, FRACR, Timothy McGahan, FRACS, and **Gregory Monaghan, FRACS,** *Sydney, Australia*

A 62-year-old male patient was admitted with acute dissection of the descending thoracic aorta and an infrarenal abdominal aortic aneurysm (AAA). Investigation revealed that the thoracic dissection probably had arisen retrogradely in the posterior wall of the AAA and extended superiorly to the left subclavian artery as a blind sac. Implantation of an endoluminal graft device below the renal arteries enabled simultaneous treatment of the AAA and the thoracic aortic dissection. The patient had an uncomplicated recovery. Postoperative aortography and computed tomography demonstrated normal flow through the aorta and endograft without leak of contrast into the AAA sac or the false lumen of the dissection. Contrast computed tomography 6 months after operation demonstrated that the false lumen was no longer evident. (J VASC SURG 1995;22:167-72.)

The optimal treatment of patients with acute dissection of the descending thoracic aorta (Stanford type B,[1] De Bakey type III[2]) remains controversial. In most centers these patients are treated medically,[3,4] and surgery is generally reserved for patients with complications. These include rupture, end organ ischemia, persistent or recurrent intractable pain, dissection progression, or uncontrollable hypertension.[5] Increasing sophistication of diagnostic equipment, however, has led to reports of innovative endovascular techniques replacing open operations.[6-8] Some have involved the use of intravascular ultrasonography to evaluate the pathologic changes in the arterial anatomy, and to accurately guide percutaneous fenestration, balloon dilation, and stent placement directed to restore and maintain flow in major aortic tributaries.[8] Following this endovascular approach for dissecting aneurysms, Parodi[9] demonstrated the feasibility of endoluminal repair of fusiform aneurysms of the infrarenal aorta. We present here a unique extension of these methods of treatment in which a patient with a dissecting aneurysm of the descending thoracic aorta and an infrarenal abdominal aortic aneurysm (AAA) had both treated concurrently by transluminal placement of an endoluminal graft.

From the Departments of Vascular Surgery and Cardiothoracic Surgery, Royal Prince Alfred Hospital, and the University of Sydney.

Reprint requests: James May, MS, FRACS, Department of Surgery, Blackburn Building D06, Sydney University, Sydney, NSW 2006, Australia.

0741-5214/95/$3.00 + 0 **24/4/64867**

CASE REPORT

A 62 year old male patient was admitted with acute upper abdominal pain. Physical examination, routine hematologic tests and biochemical screening revealed no abnormality other than an elevated serum creatinine (170 mg/dl). Magnetic resonance imaging (MRI) demonstrated a dissecting aneurysm of the descending thoracic aorta with a thrombosed false lumen extending from the left subclavian artery to the infrarenal aorta (Figs. 1 to 3). MRI also demonstrated an infrarenal AAA 5.5 cm in diameter (Fig. 3). Computed tomography (CT) demonstrated a communication between the AAA lumen and the lowest extent of the thrombosed false lumen through a defect in the posterior wall (Fig. 4). A lateral abdominal aortogram demonstrated the AAA with a separate sac filling posteriorly (Fig. 5). This sac was considered to be, but not proven to be, the inferior opening of the communication between the AAA lumen and the lowest extent of the thrombosed false lumen. A transoesophageal echocardiogram failed to demonstrate an entry point for the dissection in the intima of the descending thoracic aorta.

In view of the intact intima overlying the dissection in the thoracic aorta, it was believed to be possible that the dissection was still being partially maintained by the defect in the infrarenal aorta. It was planned to repair both the dissecting thoracic aneurysm and the AAA concurrently by transluminal placement of an endograft in the infrarenal aorta immediately below the renal arteries.

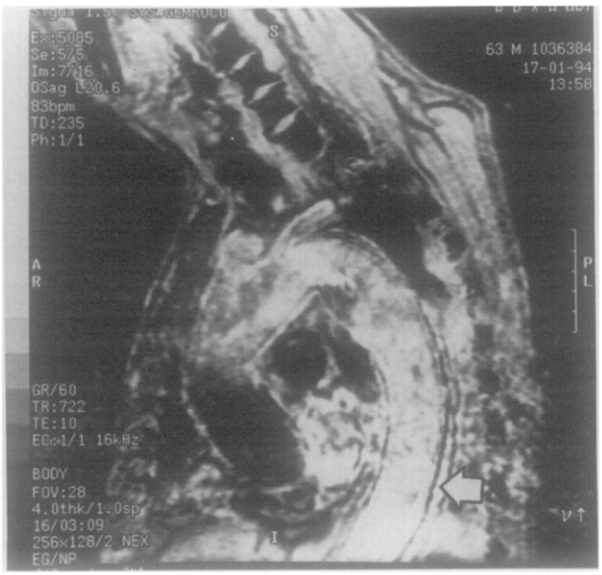

Fig. 1. Saggital projection of gradient-recalled echo MRI sequence demonstrates bright flowing blood in true lumen and bright signal in false lumen *(arrow)* consistent with methemoglobin in false lumen of aortic dissection.

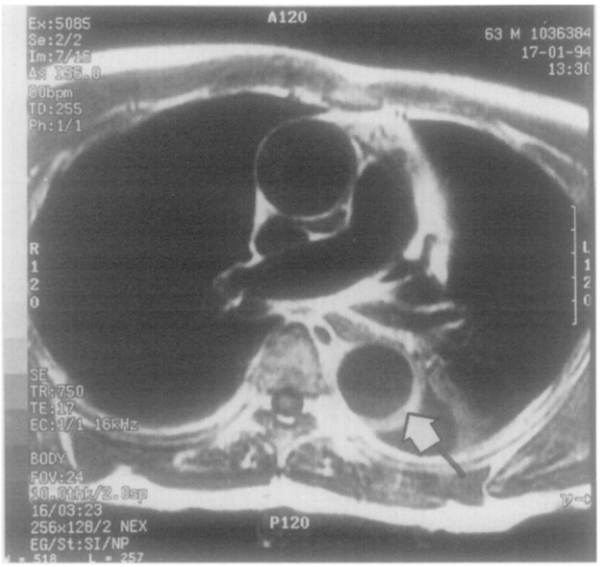

Fig. 2. T_1-weighted transverse MRI image through thoracic aorta demonstrates high signal consistent with methemoglobin in thrombosed false lumen of dissected descending thoracic aorta *(arrow)*. Note no ascending aortic component is present.

Endoluminal repair of AAA with materials currently used in vascular surgery is approved by the Institutional Review Board. The authors have used this technique in 65 patients and have published their experience on previous occasions.[10-21] They acknowledge with gratitude the help and advice given by Dr. Juan Parodi, who developed many of the techniques used in this case.[9,22] Informed consent was obtained from the patient. Approval was obtained to proceed with open thoracoabdominal repair in the event that endoluminal repair was not possible.

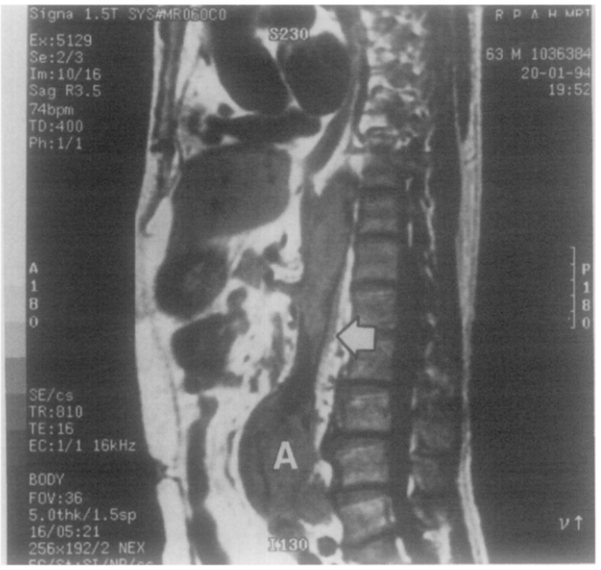

Fig. 3. Sagittal T_1-weighted image demonstrates thrombosed false lumen *(arrow)* with predominately bright signal extending inferiorly into infrarenal AAA. *A* represents lumen of AAA.

Technique of endoluminal repair

The operation was performed with the patient in the supine position on a radiolucent operating table under a general anesthetic. Provision was made for extracorporeal bypass in the event that open operation was required. The AAA lacked a distal neck (Fig. 6), which precluded the use of an endoluminal tube graft and required a tapered aortoiliac endoluminal graft as previously described by the authors.[11]

The endograft was constructed from a 22 mm diameter woven Dacron tube graft (CR Bard, Billerica, Mass.). The CT scan and aortogram were used to measure the diameter of the true lumen of the aorta immediately below the renal arteries and the diameter of the left common iliac artery. These were 22 and 16 mm, respectively. A tapered Dacron graft was constructed in the following manner. Seven centimeters from the upper end of the graft, a continuous 5/0 Prolene suture was used to unite the anterior and posterior walls at the lateral border of the flattened graft. This suture progressively reduced the lumen of the graft to 16 mm diameter over a length of 3 cm. Thereafter the diameter of the graft was maintained at this width. The excess graft material was cut off lateral to the suture line. Five metal attachment devices were incorporated into the upper 7 cm of the graft in the manner devised by White et al.[18] These can be seen in the postoperative aortogram in Fig. 7.

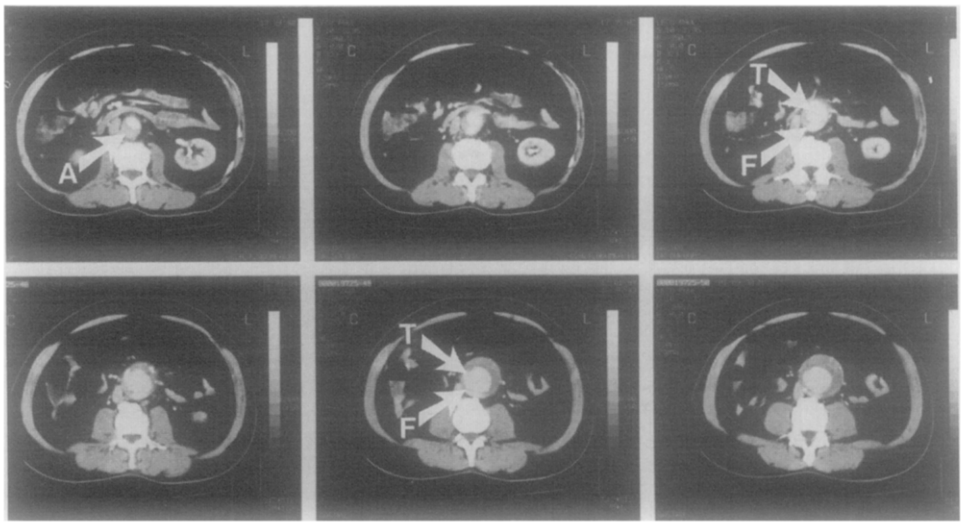

Fig. 4. Postcontrast CT (in craniocaudal direction) demonstrates AAA (*T* represents true lumen) with separate opacified posterior sac (*F* represents opacified false lumen) continuous with thrombosed false lumen *(A)* extending superiorly in dissected portions of aorta.

The endograft, a balloon-expandable one, was mounted on an 8 cm–long 23 mm–diameter balloon catheter (William Cook, Eight Mile Plains, Australia), and both were packaged within a 24F internal diameter Teflon loading sheath (William Cook). Access to the aorta was gained via an extraperitoneal approach to the left common iliac artery. A 16 mm–diameter woven Dacron graft (CR Bard) was anastomosed end to side to the common iliac artery and used as a conduit to the aorta as devised by Parodi.[22] A double sheath system was used to deliver the endograft into the aorta via the conduit. The larger outer sheath (24F inner diameter) was used as a delivery sheath, and the smaller inner sheath (21F inner diameter) was used as a pusher to advance the endograft. The smaller inner sheath does not have a closed end but functions well as a pusher because the endograft is too bulky to slide into the lumen. The pusher is used to minimize the risk of the endograft becoming displaced from the balloon. Without it advancement of the endograft is dependent on frictional forces between the balloon and endograft. Radiographic guidance was used for maneuvering the delivery sheath into the aorta and subsequently for deployment of the endograft in the appropriate position immediately below the renal arteries. The balloon catheter was withdrawn, leaving the distal endograft protruding coaxially through the conduit. The right common iliac artery was ligated to exclude the AAA from the circulation. This was accomplished through the left extraperitoneal approach. Flow to the lower extremities was restored by anastomosing a bifurcated Dacron graft to the coaxial Dacron conduit and distal endograft (Fig. 8). The right limb of the bifurcated graft was anastomosed to the right external iliac artery by use of an extraperitoneal approach above the inguinal ligament. An on-table postprocedure aortogram demonstrated nor-

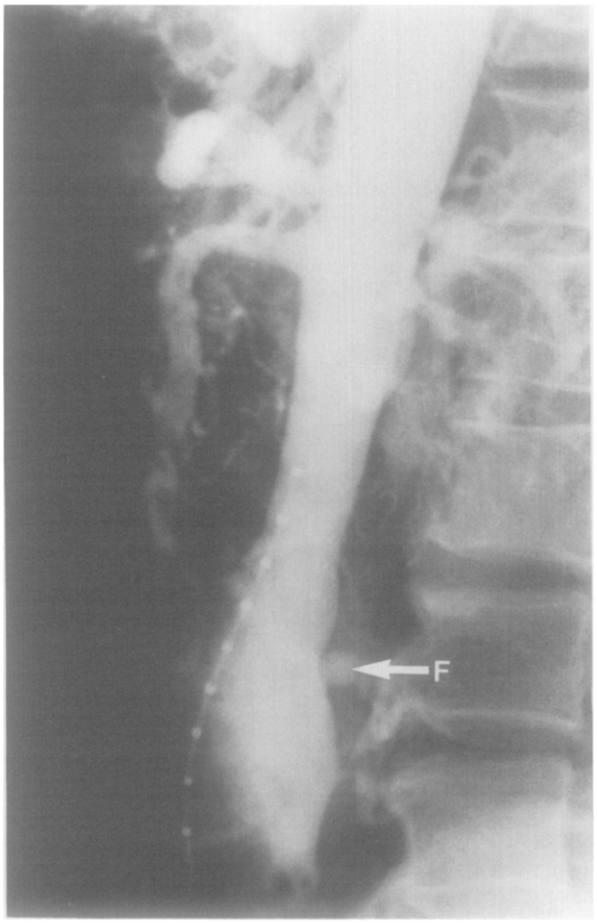

Fig. 5. Lateral abdominal aortogram demonstrates AAA with separate sac *(F)* filling posteriorly.

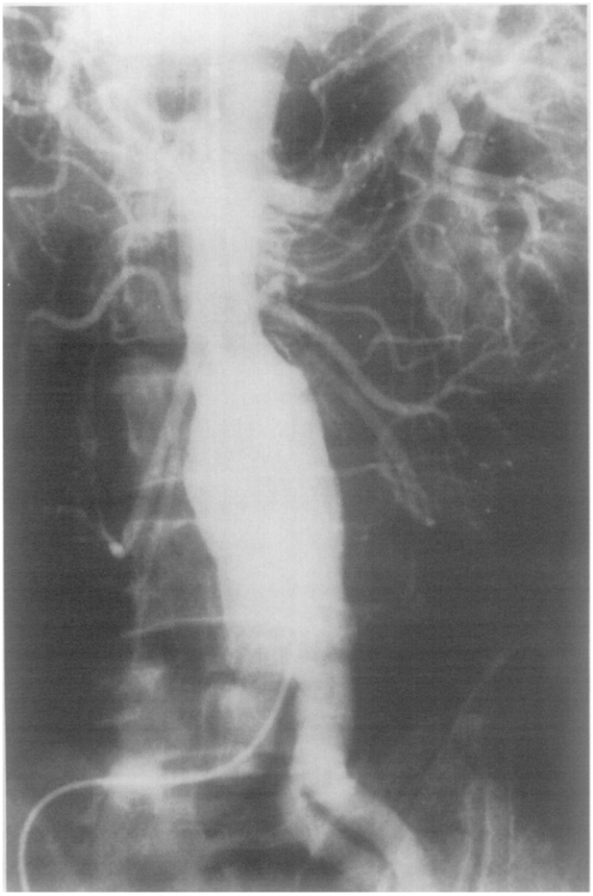

Fig. 6. Aortogram of infrarenal AAA. Note that aneurysm lacks distal neck and is unsuitable for endoluminal tube graft.

Fig. 7. Postoperative aortogram demonstrates normal flow through aorta and endograft without leak of contrast agent into aneurysmal sac. Note ligated right common iliac artery.

mal flow through the endograft with complete exclusion of the aneurysmal sac. The duration of the operation was 4½ hours, and the blood loss was 1200 ml.

The patient had an uncomplicated recovery. An aortogram (Fig. 7) obtained 1 week after operation confirmed the absence of any leak of contrast agent into the infrarenal aortic aneurysmal sac. The patient was symptom free at 6 months follow-up. A postcontrast CT scan demonstrated absence of filling of the posterior sac and no leak of contrast into the AAA. The false lumen was no longer evident (Fig. 9).

DISCUSSION

The treatment options for this patient included a conservative approach of keeping the patient under observation. Because he lived on an island in the Pacific Ocean remote from specialized vascular surgical care, this was not considered to be a safe course of action.

A further option was to treat the patient by open surgical repair. This would involve replacement of the descending thoracic aorta and abdominal aorta with revascularization of intercostal arteries, renal arteries, and abdominal visceral arteries. Such a procedure would carry a significant morbidity, including the risk of paraplegia.

The lesser surgical operation of repairing only the infrarenal AAA was feasible but believed to be inappropriate because of difficulty and risk of performing the upper anastomosis to the pararenal aorta, which was already extensively damaged by dissection.

The concept of endoluminal repair was an attractive one. It allowed the infrarenal aortic aneurysm to be treated and, at the same time, offered the opportunity to seal off the demonstrated site of origin of the dissection of the descending thoracic aorta.

Two technical points are worthy of further comment. The first concerned the sizing of the upper end of the endograft. The diameter selected matched the diameter of the true lumen of the aorta. The alternative of selecting a graft matching the diameter of the whole aorta (true lumen and dissected lumen) with the idea of the expanded endograft compressing the intima and dissected lumen out to the limits of the adventitia was rejected. It was considered that such a maneuver may well result in tearing of the intima. It was also noted that the anterior half of the circumference of the aortic wall was normal, and it was

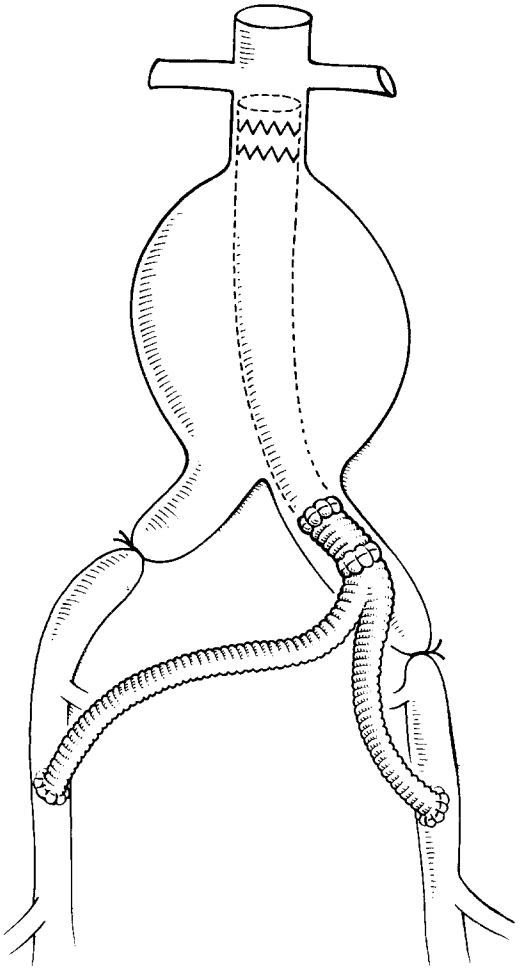

Fig. 8. Diagram demonstrates method of repair. Restoration of blood flow to lower extremities has been achieved through extraperitoneal bifurcated Dacron graft sutured proximally to coaxial Dacron conduit and endoluminal aortoiliac endograft. Only two of five metal attachment devices are shown for clarity.

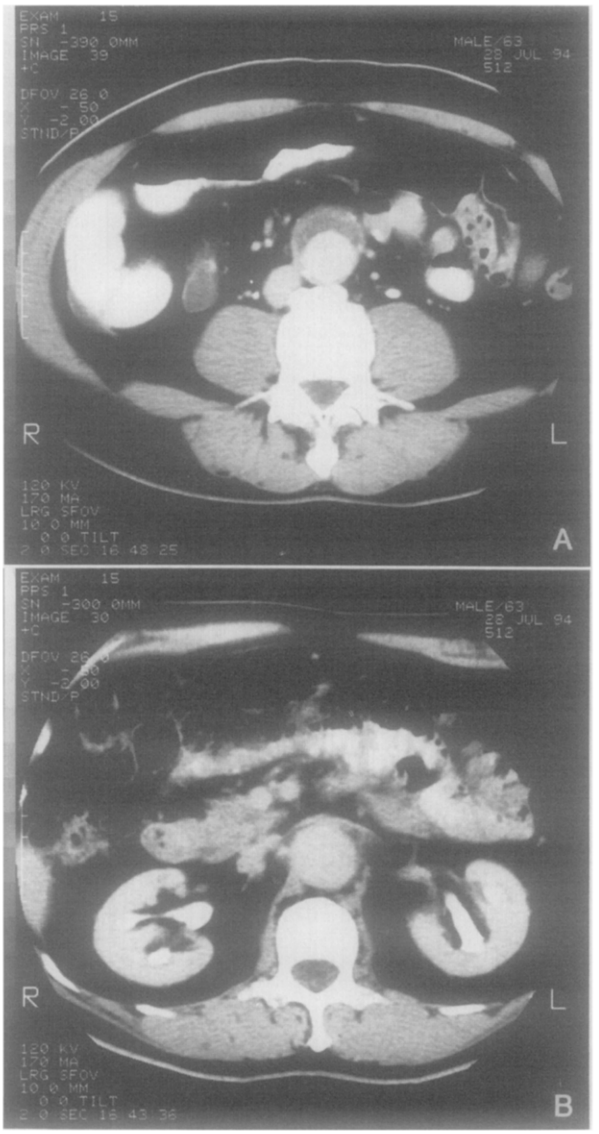

Fig. 9. A, Contrast CT section obtained 6 months after operation in region of previously present opacifying sac demonstrated in Fig. 4 with endograft in place, demonstrating that sac no longer fills. **B,** Contrast CT section obtained 6 months after operation just above endograft demonstrates false lumen is no longer evident.

believed that this would provide sufficient support to anchor the endograft.

The second technical point concerned the decision to use a Dacron tube graft to the common iliac artery as a temporary conduit rather than use the common femoral artery for delivery sheath access to the aorta. Although the external iliac artery was large enough (9 mm diameter) to accept the 24F internal diameter sheath, the endograft would have required tapering to 8 mm diameter at its distal end to enable it to be delivered through the external iliac artery. We have experienced difficulties withdrawing the deflated balloon catheter through 8 to 10 mm grafts because of poor profile of the deflated balloon. Until such time as a balloon with low profile before and after inflation is available, we have found it safer to use the iliac approach with a more accommodating diameter of 16 mm for the distal portion of the tapered endograft.

REFERENCES

1. Daily PO, Trueblood HW, Stinson EB, et al. Management of acute aortic dissections. Ann Thorac Surg 1970;10:237-47.
2. De Bakey ME, McCollum CH, Crawford ES, et al. Dissection and dissecting aneurysms of the aorta: twenty-year follow-up of 527 patients treated surgically. Surgery 1982;92:1118-34.

3. Acute aortic dissection. Lancet 1988;2:827-8. Editorial.
4. Crawford ES. The diagnosis and management of aortic dissection. JAMA 1990;264:2537-41.
5. Walker PJ, Miller DC. Aneurysmal and ischaemic complications of type B (type III) aortic dissections. Semin Vasc Surg 1992;5:198-214.
6. William DM, Brothers TE, Messina LM. Relief of mesenteric ischaemia in type III aortic dissection with percutaneous fenestration of the aortic septum. Radiology 1990;174: 450-2.
7. Shimshak TM, Giorgi LV, Hartzler GO. Successful percutaneous transluminal angioplasty of an obstructed abdominal aorta secondary to a chronic dissection. Am J Cardiol 1988;61:486-7.
8. Walker PJ, Dake MD, Mitchell RS, Miller DC. The use of endovascular techniques for the treatment of complications of aortic dissection. J VASC SURG 1993;17:1-10.
9. Parodi JC, Palmaz JC, Barone HD. Transfemoral intraluminal graft implantation for abdominal aortic aneurysms. Ann Vasc Surg 1991;5:491-9.
10. May J, White G, Waugh R, Yu W, Harris JP. Transluminal placement of a prosthetic graft-stent device for treatment of subclavian aneurysm. J VASC SURG 1993;18:1056-9.
11. May J, White G, Yu W, Waugh R, Harris JP. Treatment of complex abdominal aneurysms by a combination of endoluminal and extraluminal aorto-femoral grafts. J VASC SURG 1994;19:924-33.
12. May J, White G, Yu W, Waugh R, Stephen M, Harris JP. Transluminal placement of aorto-iliac grafts for treatment of large abdominal aortic aneurysms. In: Weimann S, ed. Thoracic and thoracoabdominal aortic aneurysm. Bologna: Monduzzi Editore, 1994:294-55.
13. May J, White G, Yu W, Waugh R, Harris JP. Endoluminal stent-grafts for intrathoracic and abdominal aortic aneurysm. In: Liermann DD, ed. Stents—state of the art and future developments. Morin Heights, Canada: Polyscience Publications (in conjunction with Boston Scientific Corporation, Watertown, Mass.), 1995:3-6.
14. May J, White G, Waugh R, Yu W, Harris JP. Endoluminal repair of large and small abdominal aortic aneurysm. J Interventional Cardiol 1994;7:109.
15. May J, White GH, Yu W, Waugh RC, Stephen MS, Harris JP. Results of endoluminal grafting of abdominal aortic aneurysms are dependent on aneurysm morphology. J VASC SURG (In press).
16. White GH, May J, Yu W. Development of a clinical program of endoluminal aneurysm grafting: experience in 60 patients. In: Parodi JC, Veith FJ, Marin ML, eds. Endovascular grafting techniques. St. Louis: Quality Medical Publishing, 1994.
17. White GH, May J, Yu W. Stented and non-stented grafts for aneurysmal disease: the Sydney experience. In: Chuter T, Donayre C, White R, eds. Endoluminal vascular prostheses Boston: Little Brown, 1994:107-52.
18. White GH, Yu W, May J, Waugh RC, Stephen M. A new nonstented endoluminal graft for straight or bifurcated repair of aneurysm. J Endovasc Surg 1994;1:16-24.
19. May J, White GH, Waugh R, Yu W, Stephen MS, Harris JP. Endoluminal repair of abdominal aortic aneurysm. Med J Aust 1994;161:541-3.
20. May J, White GH, Yu W, et al. Endoluminal grafting of abdominal aortic aneurysms: causes of failure and their prevention. J Endovasc Surg 1994;1:44-52.
21. May J, White GH. Specialised endovascular techniques: combined surgical and endovascular approaches. In: White RA, Fogarty TJ, eds. Peripheral endovascular interventions. St. Louis: Mosby–Year Book, 1994.
22. Parodi J. Endoluminal repair of abdominal aortic aneurysm. In: Whittemore A, ed. Advances in vascular surgery. St. Louis: Mosby–Year Book, 1993:85-106.

Submitted June 8, 1994; accepted March 13, 1995.