Occluding aortic endoluminal stent graft combined with extra-anatomic axillofemoral bypass as alternative management of abdominal aortic aneurysms for patients at high risk with complex anatomic features: A preliminary report

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Purpose: **To describe an exclusion endoluminal technique for management of abdominal aortic aneurysms among high-risk patients with complex anatomic features.**
Methods: **From January 1995 to December 1996, among 143 patients with infrarenal abdominal aortic aneurysm treated by means of endograft placement, 9 (6.3%) had complex aortic or aortoiliac morphologic features. For these patients, the endograft was delivered through a femoral cutdown in an occluding aortoiliac configuration. The contralateral iliac artery was occluded with an iliac endograft. Axillofemoral bypass grafting was performed. Computed tomographic scans were obtained regularly.**
Results: **There was 1 postoperative death of severe arrhythmia. All aneurysms were found to be affected by thrombosis on immediately postoperative computed tomographic scans, except in 1 patient with a proximal leak, which was managed successfully with angiographic embolization. The mean follow-up time was 12 months. Aortic aneurysm diameter decreased from 2 mm at 6 months (2 patients) to 6 mm at 12 months (6 patients). All axillofemoral bypass grafts are patent.**
Conclusions: **Placement of an occluding endograft associated with axillofemoral bypass grafting is a good alternative for patients at high risk with complex anatomic features. Longer-term follow-up study is needed to evaluate this endoluminal technique. (J Vasc Surg 1998;28:651-6.)**

Standard surgical treatment of abdominal aortic aneurysm (AAA) consists of replacing the aneurysm by means of graft interposition with or without resection of the aneurysmal pouch. Dubost et al[1] in 1952 described retroperitoneal resection and homograft replacement of AAA. Intraluminal graft suture without resection of the aneurysmal sac was popularized by Creech[2] and became the standard procedure. This method of treatment has been shown to improve life expectancy, though the overall elective mortality rate is between 2% and 5%.[3-6]

Endoluminal management of AAA has been proposed as an alternative to the standard procedure for patients at high surgical risk.[7-10] The technique is transarterial placement of an aortic stent graft to exclude completely the aneurysmal sac. This method, however, has its limitations. First, the shortness of the proximal aortic neck precludes stable anchoring of the proximal part of the endograft. When the endograft is not anchored properly, the stent graft

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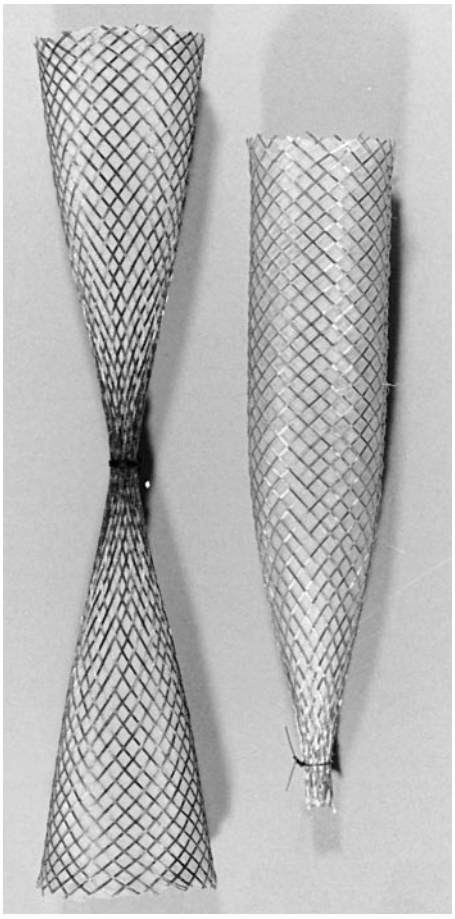

Fig 1. The occluding configuration of the Corvita aortic endoluminal stent graft.

dislodges and proximal leakage occurs.[10,11] Second, correct placement can be difficult in the presence of a complex aortic or aortoiliac anatomic configuration. For patients with this AAA morphologic characteristic, we performed extra-anatomic axillofemoral bypass combined with placement of an occluding endograft. We describe our experience with 9 patients and present their follow-up findings.

METHODS

Selection of patients. The nine patients were selected from 143 patients who underwent aortic endoluminal stent grafting for management of AAA from January 1995 to December 1996. All patients were in compassionate care status (class 3 or 4 of the American Anesthesiology Association classification). The six men and three women had an average age of 75 years (range, 68 to 85 years). Seven patients were older than 70 years. All patients had at least 2 associated pathologic conditions (Table I). All these infrarenal aortic aneurysms presented complex morphologic features, as follows: short length of the infrarenal aortic portion (proximal neck) with or without tortuous proximal neck or iliac arteries. The decision to implant an occluding endograft combined with extra-anatomic axillofemoral bypass was made in view of the difficult access for endoluminal treatment and the high risk of conventional surgical treatment.

Table I. Associated pathologic conditions

Condition	*No. of patients*
Ischemic coronary disease	9
Pulmonary insufficiency	3
Renal insufficiency (creatinine >1.8 mg/dL)	5
Hypertension	8
Previous stroke	2

Procedure. Aneurysm diameter was determined by means of spiral computed tomographic (CT) scanning for all patients. Preoperative digital substraction angiography was performed only when there were no contraindications (4 patients, 46%). All aneurysms were infrarenal with an average diameter of 6.4 ± 0.8 cm (range, 5.3 to 7.6 cm).

The Corvita stent graft (Corvita Europe, Brussels, Belgium) is composed of 2 components—a self-expandable metallic stent made of a double helix of paired wires of elgyloy and a coating of 600 layers of polycarbonate urethane fibrils (Corethane) bound to the inner wall of the metallic stent by means of an adhesive glue of polycarbonate urethane. The devices are available in standard sizes (total length 14 cm and diameters of 14, 16, 27, 40, or 45 cm). They can be cut to the required length during the operation.

Under general anesthesia, extra-anatomic axillofemoral bypass was performed at the beginning of the operation for 6 patients (66%) with 8-mm diameter externally supported polytetrafluoroethylene (PTFE) prosthesis (IMPRA, Tempe, Ariz). For 3 patients the bypass was performed at the end of the operation (33%).

After intra-arterial injection of 10,000 IU heparin the femoral artery was punctured, and an 11F angiography sheath with a dilator (Balt, Montmorency, France) was advanced over a Terumo guide wire (Terumo Europe, Leuven, Belgium) and placed at the level of the renal arteries. After removal of the dilator, an aortogram was obtained for location of the origin of the renal arteries and was frozen on the fluoroscopy screen (GE Medical Systems, Loncin, Belgium). A graduated radiopaque marker

was placed preoperatively under the patient on the operating table parallel to the left border of the patient's lumbar spine. The angiographic sheath was pulled down to the bifurcation. Angiography of the aortoiliac bifurcation was performed and stored in the computer memory.

Length of the aortic stent graft was determined with the aortogram and graduated marker and corrected for magnification. The stent graft was cut at the calculated length and made occlusive by means of placement of a nonabsorbable ligature at the distal extremity or in the middle of the device (Fig 1).

After introduction of a superstiff guide wire (Schneider, Bülach, Switzerland) the angiography sheath was removed. The endoluminal delivery device (ID18F600; Balt) is composed of an internal removable holder and an outer sheath. The aortic stent graft was introduced into the leading part of the delivery device, which was closed over by a conical flexible tip. The delivery device was loaded over the stiff guide wire and advanced up to the aortic position. Under fluoroscopic control with the frozen image and radiopaque marker as guides, the distal extremity of the delivery device was positioned just below the renal artery bifurcation. The flexible tip and stent graft were unloaded from the outer sheath by means of maintaining the stent graft in the correct position with the holder and slowly retrieving the outer sheath. Stent graft length was calculated for the distal extremity of the stent graft to be positioned within the aortic bifurcation or within a common iliac artery. The angiographic sheath and stiff guide wire were removed.

The maneuvers were repeated on the other side at the level of the common iliac artery to deliver another occluding stent graft but one that was smaller and shorter. The hypogastric arteries were maintained patent for vascularization of the colon by means of retrograde perfusion through the extra-anatomic axillofemoral bypass. At the end of the procedures, an angiogram was obtained to confirm the position of the stent grafts and to verify the absence of paraprosthetic leaks. After reversal of heparin by means of protamine, the wounds were closed. All patients received prophylactic antibiotic coverage with three doses of cefazolin beginning at induction of anesthesia. Neither anticoagulants nor antiplatelet drugs were administered postoperatively.

Follow-up protocol. Before discharge from the hospital, plain radiographs of the abdomen were obtained to verify the position of the stent graft. Color duplex flow and contrast helical CT scanning were performed to image the stent graft and to determine the extent of aortic aneurysmal thrombosis. Patency of the axillofemoral bypass was confirmed by means of clinical and Doppler examinations. Rectosigmoidoscopy was performed to exclude colonic ischemic lesions in the first 48 hours after the operation. Three, 6, 12, 18, and 24 months after the operation the patients underwent clinical examinations and imaging to evaluate the natural history of the excluded AAA sac and to determine the maximal transverse diameter of the AAA.

RESULTS

There was one postoperative death of severe arrhythmia, metabolic acidosis, and cardiac arrest on the second postoperative day. Two patients had a moderate inflammatory reaction with raised erythrocyte sedimentation rate, increased C-reactive protein value, and lowered platelet count beginning on the second postoperative day and subsiding spontaneously 1 week later. All bacterial culture results were negative. Three patients had cardiac ischemic attacks in the postoperative period. One patient had distal microembolization of the lower limbs. Thrombectomy was not required.

Systematic rectosigmoidoscopy was performed on the second postoperative day and demonstrated no ischemic colonic lesions in any patients. Postoperative CT scans showed total aortic aneurysmal thrombosis in 7 of the 8 surviving patients. The one proximal paraprosthetic leak was managed successfully by means of angiographic embolization. One patient refused follow-up CT scans. Duplex scanning was performed and confirmed aortic aneurysm thrombosis at 12 months.

The mean follow-up period was 12 months with a range of 6 to 17 months. For 2 patients the follow-up period was 6 and 7 months, and for 6 it was more than 12 months. The aortic aneurysmal diameter decreased from 2 mm in 2 patients observed for 6 months to a mean of 4 mm (range 1 to 6 mm) among the 6 patients observed for more than 12 months. All axillofemoral bypass grafts were patent at the time of this study.

DISCUSSION

Standard surgical treatment of infrarenal aortic aneurysm is replacement of the aneurysm by means of direct in-line interposition with synthetic graft. Though the overall elective operative mortality rate is low, some authors have found the mortality rate to be as high as 20% to 60% among patients with comorbid conditions.[12,13] Nonresective techniques have been described such as bilateral iliac artery

Fig 2. Aortic aneurysmal diameter decreased by 6 mm 10 months after the operation.

occlusion by means of ligature,[14] use of metallic clips,[15] or use of a balloon catheter[16] combined with axillofemoral bypass to restore distal perfusion. Proximal ligature of an infrarenal AAA or angiographic embolization is performed to ensure total clotting of the aneurysmal sac.[15,16] Deprived of both inflow and outflow, the aneurysm thus is expected to undergo complete thrombosis. The operative mortality rate for these nonresective techniques ranges from 0%[17] to 31%.[18]

Complications related to the extra-anatomic bypass have occurred among 13%[17] to 25%[19,20] of instances. Long-term patency of aortoiliac and aortofemoral grafts may be superior to that of axillofemoral grafts. However, in recent years excellent primary patency of axillofemoral bypass grafts has been reported.[21,22] Patency of these axillofemoral bypass grafts seems better among patients with aortic disease than among patients with lower limb occlusive arterial disease. In a series of 38 patients undergoing axillofemoral bypass for aortic graft infection, Bacourt et al[23] reported an 8% graft thrombosis rate for a group of patients treated for aneurysms compared with 38% for a group who underwent operations for occlusive disease.

During the past few years, transluminal management of aortic aneurysm has been reported by a number of investigators.[7-10,24-26] Placement of the endograft, however, is not without disadvantages. In addition to shortness of the proximal aortic aneurysmal neck, which precludes this procedure, complex aortic or aortoiliac morphologic characteristics may render the technique difficult or hazardous. Marked angulation of the proximal aortic aneurysmal neck more than 80 degrees can lead to misplacement or dislodgment of the stent, resulting in proximal leakage[10] or to uneven opening of the device with subsequent stenosis and endograft occlusion. Calcified and tortuous distally iliac vessels may provoke kinking of the endograft, which results in acute endograft occlusion with subsequent acute ischemia of the lower limbs. In these situations, delivery of a blind endograft as proximally as possible under the renal arteries and extending into one common iliac artery provokes thrombosis of the entire infrarenal aortic aneurysmal sac. This was shown on postoperative CT scans for 7 of 8 surviving patients. When residual periprosthetic leakage occurs, angiographic embolization is performed to ensure total aortic aneurysmal thrombosis, as occurred in one of our patients.[11] The main cause of proximal leakage is the presence of underlying atherosclerotic disease that caused a cobblestone surface at the arterial neck and provoked an incomplete friction seal between the endoluminal graft and the arterial wall.[9]

The contralateral common iliac artery is occluded by means of a second endograft or a surgical ligature if necessary. The hypogastric arteries are maintained patent to assure retrograde perfusion to the descending colon. None of our patients had colonic ischemic lesions at systematic rectosigmoidoscopic examinations performed on the second postoperative day. Extension of the aortic thrombus to the renal and superior mesenteric arteries has been described after juxtarenal aortic thrombosis.[27,28] In nonresective surgical treatment of AAA, this potential complication mentioned by Berguer et al[16] has been reported in only one patient after induction of AAA thrombosis by means of ligation of the two common iliac arteries.[29]

Rupture of thrombosed aortic aneurysm, either spontaneous or after induced maneuvers, has been described.[30,31] The rate of rupture was higher among patients treated by means of induction of aortic aneurysmal thrombosis (20%) compared with

Table II. Abdominal aortic aneurysm rupture after non resective surgery

Author	*No. of patients*	*No. of ruptures*	*Aneurysmal thrombosis confirmed by postoperative control*
Leather et al[15]	1	1	No
Savarese et al[32]	4	1	No
Cho et al[29]	5	2	1 incomplete AAA exclusion 1 autopsy showed rupture of the suprarenal portion of a suprarenal and infrarenal AAA
Karmody et al[19]	60	3	False-positive results at ^{99m}Tc scintigraphy
Kwaan et al[33]	1	1	No
Schantzer et al[34]	1	1	Angiography and CT scanning
Schwartz et al[18]	13	2	2 radiographically (with no precision)
Lynch et al[31]	206	22	No data
Pevec et al[35]	26	3	No

the total exclusion technique (6%).[20,31] One hypothesis for the higher rate of rupture after induced thrombosis is incomplete occlusion of the infrarenal aortic aneurysm so that antegrade blood flow to the lumbar or inferior mesenteric arteries was maintained with high pressure. In 36 case reports of postoperative rupture of thrombosed aortic aneurysms that we collected from the literature (Table II), only 4 aneurysms were shown to be totally occluded either at angiography[18,34] or postmortem autopsy.[29] Ligating the proximal aortic aneurysm neck or inducing AAA thrombosis with an occluding endoluminal device interrupts antegrade blood flow within the potential outflow vessels such as inferior mesenteric or lumbar arteries. Retrograde filling of the aneurysmal sac from runoff vessels may occur with low pressure. However, in our experience, most of these blind endoleaks thrombosed spontaneously after 3 months of follow-up study.[11]

There was no postoperative aortic aneurysmal rupture in our small series, but the follow-up period was limited to an average of 12 months. Regression of the aortic aneurysmal diameter 6 and 12 months after the operation confirmed total exclusion of the aneurysmal sac[11] (Fig 2). In endoluminal management of AAA the maximum transverse diameter of the aneurysmal sac has proved to be reduced by 1 mm after 6 months only in blood-tight endoluminal grafts and 6 mm after 20 months.[10]

CONCLUSION

Endoluminal management of infrarenal AAA has to be explored among patients at high risk. The method is limited by the length of the proximal neck of the aneurysm and by morphologic features that do not allow correct placement of the devices. For selected patients at high risk with complex anatomic characteristics, use of an occluding endoluminal stent graft combined with extra-anatomic axillofemoral bypass seems to be a good alternative. Longer-term follow-up study is necessary to evaluate the efficacy of endoluminal exclusion of the abdominal aortic sac.

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